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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

NOTICE OF APPEAL FROM THE EXAMINER TO THE BOARD OF PATENT APPEALS AND INTERFERENCES

Docket Number (Optional)

I hereby certify that this correspondence is being facsimile transmitted to the USPTO or deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to "Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450" [37 CFR 1.8(a)] on Filed by EFS, 04/17/2011

Signature /Jed Margolin/

Typed or printed name Jed Margolin

In re Application of
Jed Margolin

Application Number	Filed
11/736,356	04/17/2007

For System and Method for Safely Flying Unmanned Aerial Vehicles in Civilian Airspace

Art Unit	Examiner
3664	Ronnie M. Mancho

Applicant hereby **appeals** to the Board of Patent Appeals and Interferences from the last decision of the examiner.

The fee for this Notice of Appeal is (37 CFR 41.20(b)(1)) $ 540.00

☑ Applicant claims small entity status. See 37 CFR 1.27. Therefore, the fee shown above is reduced by half, and the resulting fee is: $ 270.00

☐ A check in the amount of the fee is enclosed.

☑ Payment by credit card. Form PTO-2038 is attached.

☐ The Director has already been authorized to charge fees in this application to a Deposit Account.

☐ The Director is hereby authorized to charge any fees which may be required, or credit any overpayment to Deposit Account No. ____________ .

☐ A petition for an extension of time under 37 CFR 1.136(a) (PTO/SB/22) is enclosed.

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

I am the

☑ applicant/inventor.

☐ assignee of record of the entire interest.
See 37 CFR 3.71. Statement under 37 CFR 3.73(b) is enclosed. (Form PTO/SB/96)

☐ attorney or agent of record.
Registration number ____________.

☐ attorney or agent acting under 37 CFR 1.34.
Registration number if acting under 37 CFR 1.34. ____________

/Jed Margolin/
Signature

Jed Margolin
Typed or printed name

775-847-7845
Telephone number

4/17/2011
Date

NOTE: Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required. Submit multiple forms if more than one signature is required, see below*.

☑ *Total of 1 forms are submitted.

Electronic Patent Application Fee Transmittal

Application Number:	11736356
Filing Date:	17-Apr-2007
Title of Invention:	System and Method For Safely Flying Unmanned Aerial Vehicles in Civilian Airspace
First Named Inventor/Applicant Name:	Jed Margolin
Filer:	Jed Margolin
Attorney Docket Number:	

Filed as Small Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Notice of appeal	2401	1	270	270
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
		Total in USD ($)		**270**

Electronic Acknowledgement Receipt

EFS ID:	9895467
Application Number:	11736356
International Application Number:	
Confirmation Number:	3649
Title of Invention:	System and Method For Safely Flying Unmanned Aerial Vehicles in Civilian Airspace
First Named Inventor/Applicant Name:	Jed Margolin
Customer Number:	23497
Filer:	Jed Margolin
Filer Authorized By:	
Attorney Docket Number:	
Receipt Date:	17-APR-2011
Filing Date:	17-APR-2007
Time Stamp:	05:28:38
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	$270
RAM confirmation Number	6577
Deposit Account	
Authorized User	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)

1	Notice of Appeal Filed	jm_rpv2_noa.pdf	58119 0d43848c109ac4bf78e3242d7b82e5f04b649dc6	no	1
Warnings:					
Information:					
2	Fee Worksheet (PTO-875)	fee-info.pdf	29351 e41b50e0892c2daad0de514dfa7f05fa3b707f23	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	87470		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

<u>New Applications Under 35 U.S.C. 111</u>
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

<u>National Stage of an International Application under 35 U.S.C. 371</u>
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

<u>New International Application Filed with the USPTO as a Receiving Office</u>
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of Jed Margolin

Serial No.: 11/736,356 Examiner: Ronnie M. Mancho

Filed: 4/17/2007 Art Unit: 3664

For: **System and Method For Safely Flying Unmanned Aerial Vehicles in Civilian Airspace**

Filed:	4/17/2007
First Office Action:	9/1/2010
Response:	11/29/2010
Second Office Action:	2/15/2011

The following is to comply with 37 CFR § 1.133 **Interviews** and MPEP Section 713.04 **Substance of Interview Must Be Made of Record**.

I called the Examiner on or about March 2, 2011. I identified myself and the patent application and asked the Examiner to withdraw making the Second Office Action Final.

He asked for my reason.

I said I wanted the opportunity to respond to the additional grounds for rejection he had made in the Second Office Action (which he had made Final).

He said that the First Office Action had been sent to me and I had had the opportunity to respond, and he believed I did.

I repeated that he had made additional grounds for rejection in the Second Office Action and I wanted the opportunity to respond.

He looked up the case and cited the 103 basis for rejection: Margolin (5,904,724) and Duggan (Published Application US 2005004723).

I told him that I am that Margolin.

I also told him that he had done a cut-and-paste of the rejection in the First Office Action but had added a few things.

He wanted to know where.

I pointed out First Office Action (page 3, third paragraph):

> *Margolin did not disclose that the vehicle is flown using an autonomous control system. However, Duggan teach of a system for safely flying an unmanned aerial vehicle in civilian airspace comprising:*

In the Second Office Action it became (page 3, third paragraph):

> Margolin did not disclose that the vehicle is flown using an autonomous control system (<u>e.g. autopilot</u>). However, Duggan teach of a system for safely flying an unmanned aerial vehicle in civilian airspace comprising:

I said that he had equated autonomous control system with an autopilot, but they are not the same.

He believed the rejection was still the same and offered a long explanation that did not make much sense. I did hear him say that he believed I did not understand the term "autopilot."

We moved on to his statement in the Second Office Action about civilian airspace (page 10, last line), where he said:

> Applicant further argues that the prior art do not disclose flying an unmanned aerial vehicle (i.e. an aircraft) in civilian airspace. The examiner does not acquiesce to applicant's remarks. The prior art clearly shows flying an unmanned aerial vehicle (i.e. an aircraft) in civilian airspace since the air space in which the vehicle is flown is not restricted. <u>As further noted applicant fails to provide a particular meaning attached to "civilian airspace".</u>

I told him that "civilian airspace" was term commonly used in the aerospace community and that FAA and the military use it. I referred him to my reference **Sensing Requirements for Unmanned Air Vehicles** which contains the passage:

> Engineers from the Air Vehicles Directorate transferred unmanned air vehicle (UAV) sensing system requirements for airspace operations to civilian UAV users and developers. These requirements represent design goals on which to base future sensing subsystem designs, filling an omission in UAV technology planning. <u>Directorate engineers are continuing to develop the technologies that will enable future UAVs to coexist with manned aircraft in both military and civilian airspace.</u> Incorporating these

> requirements will ensure that engineers design future UAVs to detect possible conflicts, such as midair collisions or runway incursions, and take action to avoid them.

He said that I had used the term but did not define it.

I said that, although I was entitled to be my own lexicographer, I was not required to be one, and I had the right to use the common meaning of terms.

He said that I still had to provide the meaning of the term, and I hadn't.

I said he could have made that rejection in the First Office Action, when I would have had the opportunity to respond to it. Instead, by introducing it in the Second Office Action he had denied me the opportunity to respond.

We moved on to his use of my own patent against me. I reminded him that I had protested his use of my own patent against me in my Response to the First Office Action.

> Applicant argued that Margolin belongs to the inventor. It is noted that the prior art is a statutory bar since it was published more that 8 years before filing of the present application.

I asked him where the 8 years comes from because I had not found it in MPEP or the U.S. Code. He said 8 years was longer than 1 year and referred me to 102(b).

Then he asked if I was a patent attorney. Since I am not, I said no. Then he suggested I get a patent attorney.

To get back to the issue at hand I read 102(b) to him and told him that it does not apply because the present invention is not the same as the one described in '724. It is a new application for '724.

At that point the Examiner was confused as to whether I was Margolin or Duggan.

{The problem is not, as he implied, that I don't know anything about patent law. The problem is that I cannot read his mind or sometimes, understand his English.}

We moved on. I explained why I had discussed the Duggan application in such detail, starting with the fact that it had issued as a patent (U.S. Patent 7,343,232 **Vehicle control system including related methods and components**) on March 11, 2008, before the First Office

Action. I also explained why I had introduced the extensive exhibit concerning the financial problems experienced by the Duggan Examiner. I explained that when I stated in my Response to the First Office Action that "Perhaps the Duggan Examiner was preoccupied with financial problems" I was being diplomatic. In fact, the evidence shows that the Duggan Examiner was either incompetent or may have committed misconduct. I explained to the Examiner that my reason for bringing up the subject was to show that the USPTO Office discriminates against *pro se* inventors. Aerospace Companies with expensive Law Firms are given a free pass, while *pro se* inventors get kicked in the head. I was not asking for a free pass, only to be treated fairly.

The telephone interview between the Examiner and myself that is described above was cordial but the Examiner refused to withdraw making the Second Office Action Final. Indeed, the Examiner displayed the USPTO's bias against *pro se* inventors.

Respectfully submitted,

/Jed Margolin/ Date: April 10, 2010

Jed Margolin

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of Jed Margolin

Serial No.: 11/736,356 Examiner: Ronnie M. Mancho

Filed: 4/17/2007 Art Unit: 3664

For: **System and Method For Safely Flying Unmanned Aerial Vehicles in Civilian Airspace**

Filed:	4/17/2007
First Office Action:	9/1/2010
Response:	11/29/2010
Second Office Action:	2/15/2011

The following is to comply with 37 CFR § 1.133 **Interviews** and MPEP Section 713.04 **Substance of Interview Must Be Made of Record**.

I called SPE Tran Khoi on or about March 22, 2011. Mr. Khoi is the SPE for the Examiner in this application. I identified myself and the patent application and explained to SPE Khoi that his Examiner had expanded his grounds for rejection in the Second Office Action, which constructively added new grounds for rejection, and had made the rejection final. I asked SPE Khoi to ask the Examiner to withdraw making the Second Office Action Final so I could respond to the new rejection and introduce new evidence.

SPE Khoi asked if I had amended the claims. I said no.

He asked if I was an attorney. I said no, I am a *pro se* applicant but I have done this before.

Then he asked for the Application Number and I gave it to him.

After he looked it up he asked where the Examiner had given new grounds for rejection.

I started with where the Examiner had equated an Autopilot with an Autonomous Control System.

Then I pointed out where the Examiner had introduce the issue of Civilian Airspace, and that he could have done that in the First Office Action but hadn't.

I brought up the issue of the Duggan Examiner and that her actions in the Duggan patent constitute either incompetence or possible misconduct. I explained that the reason I had brought up this issue was to show that the USPTO discriminates against *pro se* inventors. Aerospace companies with expensive Law Firms are given a free pass, while *pro se* inventors get kicked in the head. I was not asking for a free pass, only fair treatment.

I brought up the issue of the Examiner citing my own patent (5,904,724) against me, and that it was not proper under 102(b) because the present invention is not taught by ‘724, it is a new application of ‘724.

We discussed the issue of Civilian Airspace again.

Then I brought up the issue of the Examiner’s statement about safety. In the Second Office Action he had made the statement (page 11, third paragraph):

> Applicant thus insists that the rejection is conclusory and is not supported. The examiner disagrees and notes that any particular level of safety is not described or disclosed in the specification nor is there any meaning provided for "civilian airspace" or "safety". **It is believed that the aircraft flown in the prior art is flown safely and further that the aircraft is flown in all airspaces since a particular airspace was not prohibited.**

I explained that the Examiner’s belief is absolutely wrong and that safely flying UAVs is a major problem. I went into some detail.

SPE Khoi distinguished the section in the Second Office Action “Response to Arguments” with the Formal Rejection in “Claim Rejections” and stated that “Response to Arguments” was not subject to Rule 706.07(a).

I said that the Examiner’s Response to Arguments will be used against me at BPAI and I deserve the right to respond to it and introduce new evidence.

SPE Khoi suggested I file a Petition. I told him that filing a Petition does not toll deadlines and that I have heard of the USPTO simply waiting for the deadline to pass and then saying the Petition is moot.

After that the conversation deteriorated and will not be summarized here.

Then we talked about the current state of UAV technology and what my invention actually is.

SPE Khoi said he would look at my case and get back to me.

A few days later, on or about March 24, 2001, SPE Khoi left me message saying that the Examiner's Final Office Action was correct and proper.

The telephone interview between SPE Khoi and myself that is described above was mostly cordial but SPE Khoi decided that the Examiner's Final Office Action was correct and proper. And then he advised me to "Have a Nice Day."

Respectfully submitted,

/Jed Margolin/ Date: April 10, 2010
Jed Margolin

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Electronic Acknowledgement Receipt

EFS ID:	9846815
Application Number:	11736356
International Application Number:	
Confirmation Number:	3649
Title of Invention:	System and Method For Safely Flying Unmanned Aerial Vehicles in Civilian Airspace
First Named Inventor/Applicant Name:	Jed Margolin
Customer Number:	23497
Filer:	Jed Margolin
Filer Authorized By:	
Attorney Docket Number:	
Receipt Date:	10-APR-2011
Filing Date:	17-APR-2007
Time Stamp:	14:54:34
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Applicant summary of interview with examiner	jm_interview_mancho.pdf	32564 cacf2fccd41093080d35eadbfd7565b2f062a72a	no	4

Warnings:

Information:

2	Applicant summary of interview with examiner	jm_interview_khoi.pdf	24899 94ba5a70b8b92ba05201b358473a350b65dc8223	no	3
Warnings:					
Information:					
		Total Files Size (in bytes):	57463		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/736,356	04/17/2007	Jed Margolin		3649

23497 7590 02/15/2011

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EXAMINER	
MANCHO, RONNIE M	

ART UNIT	PAPER NUMBER
3664	

MAIL DATE	DELIVERY MODE
02/15/2011	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No. 11/736,356	Applicant(s) MARGOLIN, JED
	Examiner RONNIE MANCHO	Art Unit 3664

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *11/29/10*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-14* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-14* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08)
Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

2. Claims 1-14 are rejected under 35 U.S.C. 103(a) as being unpatentable over Margolin (5904724) in view of Duggan et al (US 2005004723).

Regarding claim 1, Margolin (abstract; figs. 1-7; col. 3, lines 8-67; col. 4, lines 1-67; col. 5, lines 1-67) discloses a system for safely flying an unmanned aerial vehicle in civilian airspace comprising:

(a) a ground station 400 (fig. 1&4) equipped with a synthetic vision system (figs. 1&3; col. 5, lines 50-60; col. 4, lines 1 to col. 5, lines 67);

(b) an unmanned aerial vehicle 300 (figs. 1&3) capable of supporting said synthetic vision system (305, 306, 307, 311 on aircraft; col. 5, lines 50-60; col. 3, lines 8-67; col. 4, lines 1-67; col. 5, lines 1-67);

(c) a remote pilot 102 operating said ground station 400 (figs. 1&4; col. 3, lines 8-67; col. 4, lines 1-67; col. 5, lines 1-67);

(d) a communications link between said unmanned aerial vehicle 300 and said ground station 400;

e) a system onboard said unmanned aerial vehicle 300 for detecting the presence and position of nearby aircraft (305, 306, 307, 311 on aircraft) and communicating this information to said remote pilot 102 (col. 3, lines 8-67; col. 4, lines 1-67; col. 5, lines 1-67);

whereas said remote pilot uses said synthetic vision system (305, 306, 307, 311 on aircraft; col. 5, lines 50-60) to control said unmanned aerial vehicle 300 during at least selected phases of the flight of said unmanned aerial vehicle (selected phases implies some or all phases during flight).

Margolin did not disclose that the vehicle is flown using an autonomous control system (e.g. autopilot). However, Duggan teach of a system for safely flying an unmanned aerial vehicle in civilian airspace comprising:

a ground station controlling an unmanned aerial vehicle (sec. 0352, 00353), wherein during phases of a flight of an unmanned aerial vehicle (UAV, sec 0318, 0322, 0353) when a synthetic vision (sec. 0356, 0365, 0388, 0390) is not used to control said unmanned aerial vehicle said unmanned aerial vehicle is flown using an autonomous control system (autopilot, sec 0346 to 0350, 0390-0329).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Margolin as taught by Duggan for the purpose of incorporating an autopilot to ensure smooth transitions (Duggan abstract, sec 0014, 0085, 0086).

The different embodiments in both prior arts are combinable as it would be obvious to ne having ordinary skill in the art.

Regarding claim 2, Margolin (abstract; figs. 1-7; col. 3, lines 8-67; col. 4, lines 1-67; col. 5, lines 1-67) in view of Duggan disclose the system of claim 1 whereby said selected phases of the flight of said unmanned aerial vehicle comprise:

(a) when said unmanned aerial vehicle is within a selected range of an airport or other designated location and is below a first specified altitude;

(b) when said unmanned aerial vehicle is outside said selected range of an airport or other designated location and is below a second specified altitude.

Regarding claim 3, Margolin (abstract; figs. 1-7; col. 3, lines 8-67; col. 4, lines 1-67; col. 5, lines 1-67) in view of Duggan disclose the system of claim 1 further comprising a system onboard said unmanned aerial vehicle for periodically transmitting the identification, location, altitude, and bearing of said unmanned aerial vehicle.

Regarding claim 4, Margolin (abstract; figs. 1-7; col. 3, lines 8-67; col. 4, lines 1-67; col. 5, lines 1-67) in view of Duggan disclose the system of claim 1 further comprising a system onboard said unmanned aerial vehicle for providing a communications channel for Air Traffic Control and the pilots of other aircraft to communicate directly with said remote pilot.

Regarding claim 5, Margolin (abstract; figs. 1-7; col. 3, lines 8-67; col. 4, lines 1-67; col. 5, lines 1-67) in view of Duggan disclose a system for safely flying an unmanned aerial vehicle in civilian airspace comprising:

(a) a ground station equipped with a synthetic vision system;

(b) an unmanned aerial vehicle capable of supporting said synthetic vision system;

(c) a remote pilot operating said ground station;

(d) a communications link between said unmanned aerial vehicle and said ground station;

e) a system onboard said unmanned aerial vehicle for detecting the presence and position of nearby aircraft and communicating this information to said remote pilot;

whereas said remote pilot uses said synthetic vision system to control said unmanned aerial vehicle during at least selected phases of the flight of said unmanned aerial vehicle, and during those phases of the flight of said unmanned aerial vehicle when said synthetic vision system is not used to control said unmanned aerial vehicle said unmanned aerial vehicle is flown using an autonomous control system, and

whereas the selected phases of the flight of said unmanned aerial vehicle comprise:

(a) when said unmanned aerial vehicle is within a selected range of an airport or other designated location and is below a first specified altitude;

(b) when said unmanned aerial vehicle is outside said selected range of an airport or other designated location and is below a second specified altitude.

Margolin did not disclose that the vehicle is flown using an autonomous control system. However, Duggan teach of a system for safely flying an unmanned aerial vehicle in civilian airspace comprising:

a ground station controlling an unmanned aerial vehicle (sec. 0352, 00353), wherein during phases of a flight of an unmanned aerial vehicle (UAV, sec 0318, 0322, 0353) when a synthetic vision (sec. 0356, 0365, 0388, 0390) is not used to control said unmanned aerial vehicle said unmanned aerial vehicle is flown using an autonomous control system (autopilot, sec 0346 to 0350, 0390-0329).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Margolin as taught by Duggan for the purpose of incorporating an autopilot to ensure smooth transitions (Duggan abstract, sec 0014, 0085, 0086).

The different embodiments in both prior arts are combinable as it would be obvious to ne having ordinary skill in the art.

Regarding claim 6, Margolin (abstract; figs. 1-7; col. 3, lines 8-67; col. 4, lines 1-67; col. 5, lines 1-67) in view of Duggan disclose the system of claim 5 further comprising a system onboard said unmanned aerial vehicle for periodically transmitting the identification, location, altitude, and bearing of said unmanned aerial vehicle.

Regarding claim 7, Margolin (abstract; figs. 1-7; col. 3, lines 8-67; col. 4, lines 1-67; col. 5, lines 1-67) in view of Duggan disclose the system of claim 5 further comprising a system onboard said unmanned aerial vehicle for providing a communications channel for Air Traffic Control and the pilots of other aircraft to communicate directly with said remote pilot.

Regarding claim 8, Margolin (abstract; figs. 1-7; col. 3, lines 8-67; col. 4, lines 1-67; col. 5, lines 1-67) in view of Duggan disclose a method for safely flying an unmanned aerial vehicle as part of a unmanned aerial system equipped with a synthetic vision system in civilian airspace comprising the steps of:

(a) using a remote pilot to fly said unmanned aerial vehicle using synthetic vision during at least selected phases of the flight of said unmanned aerial vehicle, and during those phases of the flight of said unmanned aerial vehicle when said synthetic vision system is not used to control said unmanned aerial vehicle an autonomous control system is used to fly said unmanned aerial vehicle;

(b) providing a system onboard said unmanned aerial vehicle for detecting the presence and position of nearby aircraft and communicating this information to said remote pilot.

Margolin did not disclose that the vehicle is flown using an autonomous control system. However, Duggan teach of a system for safely flying an unmanned aerial vehicle in civilian airspace comprising:

a ground station controlling an unmanned aerial vehicle (sec. 0352, 00353), wherein during phases of a flight of an unmanned aerial vehicle (UAV, sec 0318, 0322, 0353) when a synthetic vision (sec. 0356, 0365, 0388, 0390) is not used to control said unmanned aerial vehicle said unmanned aerial vehicle is flown using an autonomous control system (autopilot, sec 0346 to 0350, 0390-0329).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Margolin as taught by Duggan for the purpose of incorporating an autopilot to ensure smooth transitions (Duggan abstract, sec 0014, 0085, 0086).

The different embodiments in both prior arts are combinable as it would be obvious to ne having ordinary skill in the art.

Regarding claim 9, Margolin (abstract; figs. 1-7; col. 3, lines 8-67; col. 4, lines 1-67; col. 5, lines 1-67) in view of Duggan disclose the method of claim 8 whereby said selected phases of the flight of said unmanned aerial vehicle comprise:

(a) when said unmanned aerial vehicle is within a selected range of an airport or other designated location and is below a first specified altitude;

(b) when said unmanned aerial vehicle is outside said selected range of an airport or other designated location and is below a second specified altitude.

Regarding claim 10, Margolin (abstract; figs. 1-7; col. 3, lines 8-67; col. 4, lines 1-67; col. 5, lines 1-67) in view of Duggan disclose the method of claim 8 further comprising the step of providing a system onboard said unmanned aerial vehicle for periodically transmitting the identification, location, altitude, and bearing of said unmanned aerial vehicle.

Regarding claim 11, Margolin (abstract; figs. 1-7; col. 3, lines 8-67; col. 4, lines 1-67; col. 5, lines 1-67) in view of Duggan disclose the method of claim 8 further comprising the step of providing a system onboard said unmanned aerial vehicle for providing a communications channel for Air Traffic Control and the pilots of other aircraft to communicate directly with said remote pilot.

Regarding claim 12, Margolin (abstract; figs. 1-7; col. 3, lines 8-67; col. 4, lines 1-67; col. 5, lines 1-67) in view of Duggan disclose a method for safely flying an unmanned aerial vehicle as part of a unmanned aerial system equipped with a synthetic vision system in civilian airspace comprising the steps of:

(a) using a remote pilot to fly said unmanned aerial vehicle using synthetic vision during at least selected phases of the flight of said unmanned aerial vehicle, and during those phases of the flight of said unmanned aerial vehicle when said synthetic vision system is not used to control said unmanned aerial vehicle an autonomous control system is used to fly said unmanned aerial vehicle;

(b) providing a system onboard said unmanned aerial vehicle for detecting the presence and position of nearby aircraft and communicating this information to said remote pilot;

whereas said selected phases of the flight of said unmanned aerial vehicle comprise:

(a) when said unmanned aerial vehicle is within a selected range of an airport or other designated location and is below a first specified altitude;

(b) when said unmanned aerial vehicle is outside said selected range of an airport or other designated location and is below a second specified altitude.

Margolin did not disclose that the vehicle is flown using an autonomous control system. However, Duggan teach of a system for safely flying an unmanned aerial vehicle in civilian airspace comprising:

a ground station controlling an unmanned aerial vehicle (sec. 0352, 00353), wherein during phases of a flight of an unmanned aerial vehicle (UAV, sec 0318, 0322, 0353) when a synthetic vision (sec. 0356, 0365, 0388, 0390) is not used to control said unmanned aerial vehicle said unmanned aerial vehicle is flown using an autonomous control system (autopilot, sec 0346 to 0350, 0390-0329).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Margolin as taught by Duggan for the purpose of incorporating an autopilot to ensure smooth transitions (Duggna abstract, sec 0014, 0085, 0086).

The different embodiments in both prior arts are combinable as it would be obvious to ne having ordinary skill in the art.

Regarding claim 13, Margolin (abstract; figs. 1-7; col. 3, lines 8-67; col. 4, lines 1-67; col. 5, lines 1-67) in view of Duggan disclose the method of claim 12 further comprising the step of providing a system onboard said unmanned aerial vehicle for periodically transmitting the identification, location, altitude, and bearing of said unmanned aerial vehicle.

Regarding claim 14, Margolin (abstract; figs. 1-7; col. 3, lines 8-67; col. 4, lines 1-67; col. 5, lines 1-67) in view of Duggan disclose the method of claim 12 further comprising the step of providing a system onboard said unmanned aerial vehicle for providing a communications channel for Air Traffic Control and the pilots of other aircraft to communicate directly with said remote pilot.

Response to Arguments

3. Applicant's arguments filed 11/29/10 have been fully considered but they are not persuasive.

Applicant's specification is ONLY 16 pages long. However, applicant has provided an affidavit and remarks that are over 200 pages. The affidavits are referring to paying rents and mortgages, etc. The examiner does not understand how paying rents and mortgages are related to the present invention drawn to flying an un-manned aerial vehicle.

Applicant further argues that Margolin belongs to the inventor. It is noted that the prior art is a statutory bar since it was published more that 8 years before filing of the present application.

Applicant further argues that the prior art do not disclose flying an unmanned aerial vehicle (i.e. an aircraft) in civilian airspace. The examiner does not acquiesce to applicant's remarks. The prior art clearly shows flying an unmanned aerial vehicle (i.e. an aircraft) in civilian airspace since the air space in which the vehicle is flown is not restricted. As further noted applicant fails to provide a particular meaning attached to "civilian airspace".

Applicant further argues that both prior art do not disclose “a synthetic vision system”. The examiner disagrees. It appears that applicant is insisting that the prior art must recite the exact same terms as disclosed in the claims. Applicant first of all does not present an argument which first provide the meaning of the claimed “synthetic vision system”. As disclosed in applicant's specification the claimed, “a synthetic vision system” is referring to 3-D vision. The prior art disclose 3-D presentation of image to a pilot (here a remote pilot) thus the prior art anticipates the claimed, “a synthetic vision system”.

Applicant further argues about the abstract cited in the prior. The purpose of the argument is not understood since applicant is arguing that the popular interpretation of 608.01 (b) is that the purpose of the abstract is to provide search terms. It is unclear whether “popular" refers to the manner abstracts are interpreted in Florida, Washington, or somewhere else. Abstracts are not excluded during the examination process.

Some of applicant’s remarks are that the prior art does not recite the phrase, “safely flying an unmanned aerial vehicle in civilian airspace comprising: ...". Applicant thus insists that the rejection is conclusory and is not supported. The examiner disagrees and notes that any particular level of safety is not described or disclosed in the specification nor is there any meaning provided for " civilian airspace” or “safety”. It is believed that the aircraft flown in the prior art is flown safely and further that the aircraft is flown in all airspaces since a particular airspace was not prohibited.

Applicant continues that the examiner fails to address all of the recitations of the rejected claims. The examiner disagrees and notes that the prior art anticipates all limitations in the claims. There is not rule in MPEP that insist that the prior must recite the terms in the claims exactly as they are disclosed in the claims.

4. Claims 1-14 are rejected under 35 U.S.C. 103(a) as being unpatentable over Margolin (5904724) in view of Duggan et al (US 2005004723).

Margolin (abstract; figs. 1-7; col. 3, lines 8-67; col. 4, lines 1-67; col. 5, lines 1-67) discloses a system for safely flying an unmanned aerial vehicle in civilian airspace comprising:

(a) a ground station 400 (fig. 1&4) equipped with a synthetic vision system (figs. 1&3; col. 5, lines 50-60; col. 4, lines 1 to col. 5, lines 67);

(b) an unmanned aerial vehicle 300 (figs. 1&3) capable of supporting said synthetic vision system (305, 306, 307, 311 on aircraft; col. 5, lines 50-60; col. 3, lines 8-67; col. 4, lines 1-67; col. 5, lines 1-67);

(c) a remote pilot 102 operating said ground station 400 (figs. 1&4; col. 3, lines 8-67; col. 4, lines 1-67; col. 5, lines 1-67);

(d) a communications link between said unmanned aerial vehicle 300 and said ground station 400;

e) a system onboard said unmanned aerial vehicle 300 for detecting the presence and position of nearby aircraft (305, 306, 307, 311 on aircraft) and communicating this information to said remote pilot 102 (col. 3, lines 8-67; col. 4, lines 1-67; col. 5, lines 1-67);

whereas said remote pilot uses said synthetic vision system (305, 306, 307, 311 on aircraft) to control said unmanned aerial vehicle 300 during at least selected phases of the flight of said unmanned aerial vehicle.

Margolin did not disclose that the vehicle is flown using an autonomous control system (e.g. an autopilot). However, Duggan teach of a system for safely flying an unmanned aerial vehicle in civilian airspace comprising:

a ground station controlling an unmanned aerial vehicle (sec. 0352, 00353), wherein during phases of a flight of an unmanned aerial vehicle (UAV, sec 0318, 0322, 0353) when a synthetic vision (sec. 0356, 0365, 0388, 0390) is not used to control said unmanned aerial vehicle said unmanned aerial vehicle is flown using an autonomous control system (autopilot, sec 0346 to 0350, 0390-0329).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Margolin as taught by Duggan for the purpose of incorporating an autopilot to ensure smooth transitions (Duggan abstract, sec 0014, 0085, 0086).

The different embodiments in both prior arts are combinable as it would be obvious to ne having ordinary skill in the art.

It is believed that the rejection is proper and thus shall stand. Applicant may file an RCE, Appeal to the Board, or abandon the case.

Conclusion

5. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Communication

6. Any inquiry concerning this communication or earlier communications from the examiner should be directed to RONNIE MANCHO whose telephone number is (571)272-6984. The examiner can normally be reached on Mon-Thurs: 9-5.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Tran Khoi can be reached on 571-272-6919. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Ronnie Mancho/
Primary Examiner, Art Unit 3664

/Ronnie Mancho/
Primary Examiner, Art Unit 3664

Index of Claims

Application/Control No.	Applicant(s)/Patent under Reexamination
11/736,356	MARGOLIN, JED
Examiner	**Art Unit**
RONNIE MANCHO	3664

√	Rejected	–	(Through numeral) Cancelled	N	Non-Elected	A	Appeal
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of Jed Margolin

Serial No.: 11/736,356 Examiner: Ronnie M. Mancho

Filed: 04/17/2007 Art Unit: 3664

For: SYSTEM AND METHOD FOR SAFELY FLYING UNMANNED AERIAL VEHICLES IN CIVILIAN AIRSPACE

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

RESPONSE

Dear Sir:

In response to the Office Action mailed September 1, 2010, please consider the following remarks.

Section 1. General Summary

Claims 1 - 14 were rejected solely under 35 U.S.C. §103(a) as being obvious by combining U.S. Patent 5,904,724 ("Margolin '724") and published Patent Application US 2005004723 ("Duggan"). Applicant will show that the Examiner has failed his burden of establishing a *prima facie* case of obviousness.

a. The Examiner has failed to distinctly point out where all of the claim elements and limitations of Applicant's claims are present in the two cited references.

b. The Examiner has mischaracterized the two cited references as teaching all of the claim elements and limitations of Applicant's claims, when they do not.

c. The present Applicant is the named inventor on one of the Examiner's cited references (U.S. Patent 5,904,724).

Section 2 - Detailed Response

Part A - Examiner's Detailed Action Paragraph 2

2. Claims 1-14 are rejected under 35 U.S.C. 103(a) as being unpatentable over Margolin (5904724) in view of Duggan et al (US 2005004723).

Regarding claim 1, Margolin (abstract; figs. 1-7; col. 3, lines 8-67; col. 4, lines 1-67; col. 5, lines 1-67) discloses a system for safely flying an unmanned aerial vehicle in civilian airspace comprising:

(a) a ground station 400 (fig. 1 & 4) equipped with a synthetic vision system (figs. 1 &3; col. 4, lines 1 to col. 5, lines 67);

(b) an unmanned aerial vehicle 300 (figs. 1 &3) capable of supporting said synthetic vision system (305, 306, 307, 311 on aircraft; col. 3, lines 8-67; col. 4, lines 1-67; col. 5, lines 1-67);

(c) a remote pilot 102 operating said ground station 400 (figs. 1&4; col. 3, lines 8-67; col. 4, lines 1-67; col. 5, lines 1-67);

(d) a communications link between said unmanned aerial vehicle 300 and said ground station 400;

(e) a system onboard said unmanned aerial vehicle 300 for detecting the presence and position of nearby aircraft (305, 306, 307, 311 on aircraft) and communicating this information to said remote pilot 102 (col. 3, lines 8-67; col. 4, lines 1-67; col. 5, lines 1-67);

whereas said remote pilot uses said synthetic vision system (305, 306, 307, 311 on aircraft) to control said unmanned aerial vehicle 300 during at least selected phases of the flight of said unmanned aerial vehicle.

Applicant Responds.

MPEP § 2142 states under the heading **ESTABLISHING A PRIMA FACIE CASE OF OBVIOUSNESS**

> a. **>**<u>The key to supporting any rejection under 35 U.S.C. 103 is the clear articulation of the reason(s) why the claimed invention would have been obvious</u>**. The Supreme Court in KSR International Co. v. Teleflex Inc., 550 U.S. ___, ___, 82 USPQ2d 1385, 1396 (2007) noted that the analysis supporting a rejection under 35 U.S.C. <u>103</u> should be **made explicit**. The Federal Circuit has stated that "**<u>rejections on obviousness cannot be sustained with mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness.</u>**" In re Kahn, 441 F.3d 977, 988, 78 USPQ2d 1329, 1336 (Fed. Cir. 2006). See also KSR, 550 U.S. at ___ , 82 USPQ2d at 1396 (quoting Federal Circuit statement with approval). <

{Emphasis added}

The Examiner has cited lengthy passages in the above rejection and made conclusory statements as to their contents.

<u>Examiner:</u>

Regarding claim 1, Margolin (abstract; figs. 1-7; col. 3, lines 8-67; col. 4, lines 1-67; col. 5, lines 1-67) discloses a system for safely flying an unmanned aerial vehicle in civilian airspace comprising:

<u>Applicant:</u>

In Margolin '724: Column 3, lines 8-67; Column 4, lines 1-67; and Column 5, lines 1-67 form a continuous passage from Column 3, line 8 to Column 5, line 67. This passage of approximately 1619 words forms the core of the Margolin '724 DETAILED DESCRIPTION. The remainder of the Margolin '724 DETAILED DESCRIPTION teaches additional topics such as **Flight Control** (with headings *Flight Control*, *Direct Control Non-Remotely Piloted Vehicles*, *Computer Mediated Non-Remotely Piloted Vehicles*, *Second Order Flight Control Mode*, *First Order Flight Control Mode*

{See Column 6, line 19 - Column 8, line 3}, the features of a Control Panel (See Column 8, line 64 - Column 9, line 18}, the use of a Head-Mounted Display {See Column 9, lines 19 - 32}, the use of the invention for training {See Column 9, lines 33 - 63}, and **The Database** {See Column 9, line 64 - Column 10, line 50.}

The Examiner cites Figures 1 - 7 in Margolin '724. These constitute all the figures in Margolin '724.

The Examiner also cites the Abstract in Margolin '724. According to **608.01(b) Abstract of the Disclosure [R-7]:**

> **37 CFR 1.72 Title and abstract.**
>
> *****
>
> (b) A brief abstract of the technical disclosure in the specification must commence on a separate sheet, preferably following the claims, under the heading "Abstract" or "Abstract of the Disclosure." The sheet or sheets presenting the abstract may not include other parts of the application or other material. The abstract in an application filed under 35 U.S.C. 111 may not exceed 150 words in length. <u>The purpose of the abstract is to enable the United States Patent and Trademark Office and the public generally to determine quickly from a cursory inspection the nature and gist of the technical disclosure.</u><

{Emphasis added}

The popular interpretation of 608.01(b) is that the purpose of the Abstract is to provide search terms. In any event, the Abstract in Margolin '724 does not say anything about civilian airspace.

The Examiner has made a conclusory statement by repeating the title of Applicant's invention (leaving out the words "and method") and citing the core of the DETAILED DESCRIPTION in Margolin '724.

In the remaining sections of the Examiner's rejection of Applicant's Claim 1 he asserts that he has found all of the elements and limitations of Applicant's invention.

It is not surprising that some of the elements of Applicant's invention are present in Margolin '724 since Margolin '724 is probably the pioneering patent for the use of what is now called *synthetic vision* in remotely piloted aircraft (now commonly called Unmanned Aerial Vehicles) and Applicant's present invention uses synthetic vision as an element.

However, there are limitations in Applicant's current invention that are not present in Margolin '724.

Examiner:

> whereas said remote pilot uses said synthetic vision system (305, 306, 307, 311 on aircraft) to control said unmanned aerial vehicle 300 during at least selected phases of the flight of said unmanned aerial vehicle.

{From Applicant's Claim 1}

References 305, 306, 307, 311, and 300 come from Margolin '724 Figure 3 which shows the structural elements in Margolin '724 Remote Aircraft Unit 300. There is nothing in these structural elements which show that synthetic vision is used "during at least selected phases of the flight of said unmanned aerial vehicle."

The Examiner has not shown that this limitation is taught in Margolin '724. He has only made a conclusory statement.

Although *KSR* may have loosened the required reasoning that may be employed for combining prior art references in an obviousness rejection, the Examiner must still provide a factual basis for each of the claimed features of a rejected claim. MPEP 2143.03 entitled "**All Claim Limitations must be Considered**" states: "all words in a claim must be considered in judging the patentability of that claim against the prior art." *In re Wilson*, 424 F.2d 1382, 1385, 165 USPQ 494, 496 (CCPA 1970)."

If an examiner fails to address all of the recitations of a rejected claim, a *prima facie* case of obviousness has not been established because such a deficiency fails to satisfy the evidentiary requirements articulated by the Supreme Court in *KSR* (e.g. "the key to supporting any rejection under 35 U.S.C. 103 is the clear articulation of the reason(s) why the claimed invention would have been obvious" and that "a rejection under 35 U.S.C. 103 should be made explicit.")

The BPAI in a recent decision (*Ex parte Wehling et al.)* stated (with emphases added}: "the dispositive issue in this case is **whether the Examiner has explicitly articulated a prima facie case of obviousness which addresses all of the limitations of the claimed invention**." The BPAI was guided by the following legal principles:

"When determining whether a claim is obvious, an Examiner must make 'a searching comparison of the claimed invention – including all its limitations – with the teachings of the prior art.' *In re Ochiai*, 71 F.3d 1565, 1572 (Fed. Cir. 1995) (emphasis added). Thus, 'obviousness requires a suggestion of all limitations in a claim.' *CFMT, Inc. v. Yieldup Int'l. Corp.*, 349 F.3d 1333, 1342 (Fed. Cir. 2003) (citing *In re Royka*, 490 F.2d 981, 985 (CCPA 1974)). Furthermore, in *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 418 (2007) (citing *In re Kahn*, 441 F.3d 977, 988 (Fed. Cir. 2006), the Supreme Court noted that '[t]o facilitate review, this [obviousness] analysis should be made explicit.'" (*Ex parte Wehling et al.*, Appeal No. 2009-8111 (BPAI))

The BPAI in *Ex Parte Wehling et al.* held that "absent a fact-based analysis which explicitly compares all the limitations of the claimed invention with the combined teachings of Gioffre and Rockliffe, we are constrained to reverse the rejection of claims 1, 21, 29, and 31 and the claims dependent thereon under § 103 over the combined teachings of Gioffre and Rockliffe."

Note that *Ex Parte Wehling et al.* (Appeal 2009-008111, Application 10/743,118) was decided May 17, 2010. According to the BPAI online database the decision was issued 10/19/2010 which is after the mail date of the Examiner's rejection (9/1/2010).

<u>Examiner's Detailed Action Paragraph 2</u> *<u>(Continued)</u>*

The Examiner continues

Margolin did not disclose that the vehicle is flown using an autonomous control system. However, Duggan teach of a system for safely flying an unmanned aerial vehicle in civilian airspace comprising:

a ground station controlling an unmanned aerial vehicle (sec. 0352, 00353), wherein *during phases of a flight of an unmanned aerial vehicle (UAV, sec 0318, 0322, 0353) when a synthetic vision (sec. 0356, 0365, 0388, 0390) is not used to control said unmanned aerial vehicle said unmanned aerial vehicle is flown using an autonomous control system (autopilot, sec 0346 to 0350, 0390-0329).*

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Margolin as taught by Duggan for the purpose of incorporating an autopilot to ensure smooth transitions (Duggna abstract, sec 0014, 0085, 0086).

The different embodiments in both prior arts are combinable as it would be obvious to ne[sic] *having ordinary skill in the art.*

(Applicant assumes Examiner meant to say, "*The different embodiments in both prior arts are combinable as it would be obvious to one having ordinary skill in the art.)*

The Examiner has mischaracterized Duggan.

Examiner	**Duggan**
Margolin did not disclose that the vehicle is flown using an autonomous control system. However, Duggan teach of a system for safely flying an unmanned aerial vehicle in civilian airspace comprising: a ground station controlling an unmanned aerial vehicle (sec. 0352,	[0352] In one aspect of the present invention, an operator station (also referred to as the ground control station or GCS) is designed to accommodate command and control of multiple vehicles or a single vehicle by a single operator. In accordance with one embodiment, the ground control station is platform independent and implements an application program interface that provides windowing and communications interfaces (e.g., the platform is implemented in Open Source wxWindows API). The underlying operating system is illustratively masked and enables a developer to code in a high level environment.
00353),	[0353] In one embodiment, the ground control station incorporates several specialized user interface concepts

	designed to effectively support a single operator tasked to control multiple vehicles. The GCS also illustratively supports manual control and sensor steering modes. In the manual control mode, the operator can assume control authority of the vehicles individually from the ground control station at any time in flight. In the sensor steering mode, a vehicle will autonomously fly in the direction the operator is manually pointing the on-board imaging sensor (e.g., operator views video output from a digital camera on a TV interface, computer screen display, etc.). A custom data link is illustratively, utilized to support a two-way transfer of data between the ground control station and the UAV's. These design concepts together provide a flexible, multiple vehicle control system. The details of the concepts are discussed below.
wherein during phases of a flight of an unmanned aerial vehicle (UAV, sec 0318,	[0318] If the pilot chooses a surveillance location outside the total FOV, then the outer loop guidance will illustratively follow a command-to-LOS mode guide law until the UAV flight path points toward the target. Once the desired staring-point comes within a minimum range threshold, the guidance automatically trips into a loiter pattern (either constant-radius or elliptical) to maintain a station with a single key-click while he/she conducts other activities. FIGS. 22A & 22B together demonstrate the surveillance-point approach scenario.
0322,	[0322] In accordance with one aspect of the present invention, sensor-slave mode commands are generated by an autonomous line-of-sight driven function, in which the command objectives are generated by the necessities of the function rather than by an operator. For example, a function

	designed to command a raster-scan of a particular surveillance area, or a function designed to scan a long a roadway could be used to generate sensor slave commands. Another example is a function designed to generate line-of-sight commands for UAV-to-UAV rendezvous formation flying.
0353)	[0353] In one embodiment, the ground control station incorporates several specialized user interface concepts designed to effectively support a single operator tasked to control multiple vehicles. The GCS also illustratively supports manual control and sensor steering modes. In the manual control mode, the operator can assume control authority of the vehicles individually from the ground control station at any time in flight. In the sensor steering mode, a vehicle will autonomously fly in the direction the operator is manually pointing the on-board imaging sensor (e.g., operator views video output from a digital camera on a TV interface, computer screen display, etc.). A custom data link is illustratively, utilized to support a two-way transfer of data between the ground control station and the UAV's. These design concepts together provide a flexible, multiple vehicle control system. The details of the concepts are discussed below.
when a synthetic vision (sec. 0356,	[0356] a synthetic vision display
0365,	[0365] The two video monitors are illustratively used to display real-time data linked camera imagery from two air vehicles having cameras (of course, fewer, more or none of the vehicles might have cameras and the number of monitor displays can be altered accordingly). In accordance with one

	embodiment, camera imagery is recorded on videotapes during a mission. In accordance with one embodiment, the two repeater displays are used to provide redundant views of the GUI and synthetic vision display. The laptop illustratively serves as a GUI backup in the event that the main GUI fails.
0388,	[0388] In one aspect of the present invention, synthetic vision display technical approach of the present invention is based upon integrating advanced simulated visuals, originally developed for training purposes, into UAV operational systems. In accordance with one embodiment, the simulated visuals are integrated with data derived from the ground control station during flight to enable real-time synthetic visuals.
0390) is not used to control said unmanned aerial vehicle said unmanned aerial vehicle is flown using an autonomous control system	[0390] In one aspect of the present invention, through GUI display 2622, an operator can maintain a variable level of control over a UAV, from fully manual to fully autonomous, with simple user-friendly inputs. For example, if an operator decides to divert a UAV to a new route, the operator has a plurality of options to select from. The following are examples of some of the options that an operator has. Those skilled in the art should recognize that this is not an exhaustive list. In one embodiment, the operator could graphically edit the existing route on mission situation display 2629 by adding a waypoint or orbit pattern in the vicinity of a desired target region. Prior to accepting the edited route, the control system evaluates the revised route against the vehicle performance capability as well as terrain obstructions. If the route is within acceptable bounds, the control system registers the modified route and maneuvers the vehicle accordingly. In another

	embodiment, the operator could select a park mode on selections pane 2630. After selected, the control system queues the operator to click the location of and graphical size (via a mouse) the desired orbit pattern in which the vehicle will fly while "parked" over a desired target. In another embodiment, the operator can select a manual control mode on selections pane 2630. By selecting RDC (remote directional command), for example, the control system controls the UAV into a constant altitude, heading and speed flight until the operator instructs a maneuver. While in RDC mode, the operator can either pseudo-manually direct the UAV using the control stick (e.g. joystick) or the operator can program a fixed heading, altitude and speed using the control options provided in selections pane 2630.
(autopilot, sec 0346 to 0350,	[0346] In accordance with one embodiment, an exemplary translation layer implementation will now be provided. After the guidance algorithms execute, the outputs are translated to the native vehicle autopilot commands. The equations below provide example kinematic translations from the guidance acceleration commands to native vehicle autopilot commands. These equations demonstrate the principal that vehicle motion is activated through acceleration. The methods that various vehicles employ to generate acceleration are numerous (bank angle autopilot, acceleration autopilot, heading control autopilot, altitude control autopilot, etc). Since the control algorithms described herein generate acceleration commands that can be kinematically translated into any of these native autopilot commands, the guidance algorithms truly provide a generalized library of control laws that can control any vehicle through that vehicle's native atomic functions. Ubiquitous

acceleration control techniques enable VACS to synthesize control commands for any vehicle, including air, ground, or sea-based. 35 a v = vertical plane acceleration command a h = horizontal plane acceleration command = tan - 1 (a h a v) = bank angle command a T = a v 2 + a h 2 = total body acceleration command . = a h V = turn rate command i = i - 1 + . t = heading command . = (a v - g) V = flight path rate command i = i - 1 + . t = flight path angle command h . = V sin ( ) = climb rate command h i = h i = 1 + h . t = altitude command Eq . 57

[0347] Additional functionality that can be enabled in a translation layer is means for discouraging or preventing an operator (e.g., the human or non-human operator interfacing the VACS architecture) from overdriving, stalling, or spinning the vehicle frame. This being said, limiting algorithms can also be employed in the guidance or autopilot functions.

[0348] X. Autopilot

[0349] As has been addressed, the present invention is not limited to, and does not require, a particular autopilot system. The control system and architecture embodiments of the present invention can be adapted to accommodate virtually any autopilot system.

[0350] For the purpose of providing an example, an illustrative suitable autopilot software system will now be described. The illustrative autopilot system incorporates a three-axis design (pitch and yaw with an attitude control loop in the roll axis) for vehicle stabilization and guidance

	command tracking. The autopilot software design incorporates flight control techniques, which allow vehicle control algorithms to dynamically adjust airframe stabilization parameters in real-time during flight. The flight computer is programmed directly with the airframe physical properties, so that it can automatically adjust its settings with changes in airframe configuration, aerodynamic properties, and/or flight state. This provides for a simple and versatile design, and possesses the critical flexibility needed when adjustments to the airframe configuration become necessary. The three-loop design includes angular rate feedback for stability augmentation, attitude feedback for closed-loop stiffness, and acceleration feedback for command tracking. In addition, an integral controller in the forward loop illustratively provides enhanced command tracking, low frequency disturbance rejection and an automatic trim capability.
0390-0329).	{The Examiner may have meant 0390-0392. Otherwise the range is not credible} [0390] In one aspect of the present invention, through GUI display 2622, an operator can maintain a variable level of control over a UAV, from fully manual to fully autonomous, with simple user-friendly inputs. For example, if an operator decides to divert a UAV to a new route, the operator has a plurality of options to select from. The following are examples of some of the options that an operator has. Those skilled in the art should recognize that this is not an exhaustive list. In one embodiment, the operator could graphically edit the existing route on mission situation display 2629 by adding a waypoint or orbit pattern in the vicinity of a desired target region. Prior to accepting the edited route, the control system

	evaluates the revised route against the vehicle performance capability as well as terrain obstructions. If the route is within acceptable bounds, the control system registers the modified route and maneuvers the vehicle accordingly. In another embodiment, the operator could select a park mode on selections pane 2630. After selected, the control system queues the operator to click the location of and graphical size (via a mouse) the desired orbit pattern in which the vehicle will fly while "parked" over a desired target. In another embodiment, the operator can select a manual control mode on selections pane 2630. By selecting RDC (remote directional command), for example, the control system controls the UAV into a constant altitude, heading and speed flight until the operator instructs a maneuver. While in RDC mode, the operator can either pseudo-manually direct the UAV using the control stick (e.g. joystick) or the operator can program a fixed heading, altitude and speed using the control options provided in selections pane 2630. [0391] The described Intelligent displays with smart variables represent an effective approach to actively displaying information for different types of vehicles. However, a problem can arise when a new vehicle is integrated into the ground control station with a completely foreign command and control interface. Under these circumstances, the ground control station is not concerned about displaying data, but is tasked to provide a command and control interface for the operator to perform the required operations. This conundrum is the motivation for another embodiment of the present invention, namely, the integration of vehicle specific panels in the ground control station.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention	[0392] In one embodiment, a generic vehicle class (GVC) is illustratively a software component that provides a rapid development environment API to add new vehicle classes and types to the ground control station. The GVC also illustratively serves as a software construct that allows the inclusion of multiple vehicles within the ground control station framework. One of the variables in the application is a vector of pointers to a generic vehicle class. This list is constructed by allocating new specific vehicles and returning a type case to the base generic vehicle class. When a new vehicle is integrated into the ground control station, the generic vehicle class provides all of the virtual functions to integrate with system control components (e.g., to integrate with a map display, a communications package, PCIG imagery and/or appropriate display windows). An important object in the application framework is illustratively a pointer to the current vehicle generic class. When the user switches vehicles, this pointer is updated and all displays grab the appropriate smart variables from the pointer to the new base class. This is the mechanism by which windows immediately update to the current vehicle information whenever the user switches vehicles. The default windows use the pointer to the current vehicle to grab information. In this manner, if the user switches to a new vehicle with a different set of datalink variables, that fact is immediately apparent on the display windows.

was made to modify Margolin as taught by Duggan for the purpose of incorporating an autopilot to ensure smooth transitions (Duggna abstract, sec 0014, 0085, 0086). The different embodiments in both prior arts are combinable as it would be obvious to ne [sic] having ordinary skill in the art.	**Abstract** Embodiments are disclosed for a vehicle control system and related sub-components that together provide an operator with a plurality of specific modes of operation, wherein various modes of operation incorporate different levels of autonomous control. Through a control user interface, an operator can move between certain modes of control even after vehicle deployment. Specialized autopilot system components and methods are employed to ensure smooth transitions between control modes. Empowered by the multi-modal control system, an operator can even manage multiple vehicles simultaneously. [0014] Embodiments of the present invention pertain to a hierarchical control system, user interface system, and control architecture that together incorporate a broad range of user-selectable control modes representing variable levels of autonomy and vehicle control functionality. A unified autopilot is provided to process available modes and mode transitions. An intelligence synthesizer is illustratively provided to assist in resolving functional conflicts and transitioning between control modes, although certain resolutions and transitions can be incorporated directly into the functional sub-components associated with the different control modes. In accordance with one embodiment, all modes and transitions are funneled through an acceleration-based autopilot system. Accordingly, control commands and transitions are generally reduced to an acceleration vector to

	be processed by a centralized autopilot system. [0085] As will be discussed in greater detail below, the control system and architecture embodiments of the present invention essentially enable any autopilot design to support control of a vehicle in numerous control modes that are executed with switches between modes during flight. All control modes are supported even in the presence of sensor errors, such as accelerometer and gyro biases. This robustness is at least partially attributable to the fact that the closed-loop system, in all control modes, is essentially slaved to an inertial path and, hence, the sensor biases wash out in the closed loop, assuming the biases are not so grossly large that they induce stability problems in the autopilot system. Furthermore, winds are generally not an issue in the overall control scheme in that the flight control system will regulate to the inertial path, adjusting for winds automatically in the closed loop. Given the precision afforded by inertial navigation aided by GPS technology, inertial path regulation offers a highly effective and robust UAV control approach. Generally speaking, the autopilot system functions such that winds, medium Dryden turbulence levels, sensor errors, airframe aerodynamic and mass model parameter uncertainties, servo non-linearity (slew rate limits, etc.), and various other atmospheric and noise disturbances will non have a critically negative impact on flight path regulation. [0086] Component 408 receives commands generated by component 404 and filtered by autopilot component 406. The commands received by component 408 are executed to actually manipulate the vehicle's control surfaces. Autopilot component 406 then continues to monitor vehicle stabilization

	and/or command tracking, making additional commands to component 408 as necessary.

At the beginning of this subsection, the Examiner asserts, "Margolin did not disclose that the vehicle is flown using an autonomous control system. However, Duggan teach of a system for safely flying an unmanned aerial vehicle in civilian airspace comprising: …"

The Examiner's statement, "However, Duggan teach of a system for safely flying an unmanned aerial vehicle in civilian airspace comprising: …" is conclusory and is not supported by the Examiner's citations to Duggan.

In addition, none of the Duggan citations teach that either synthetic vision or Duggan's Variable Autonomy System is used "during at least selected phases of the flight of said unmanned aerial vehicle" which is a limitation in Applicant's Claim 1.

Duggan fails to teach the limitation that his Variable Autonomy System is used during selected phases of a UAV's flight and Margolin '724 fails to teach the limitation that synthetic vision is used during selected phases of a UAV's flight. Therefore, the combination of Duggan and Margolin '724 does not read on Applicant's Claim 1.

As cited above by Applicant, MPEP 2143.03 "**All Claim Limitations must be Considered**" states: "all words in a claim must be considered in judging the patentability of that claim against the prior art." *In re Wilson*, 424 F.2d 1382, 1385, 165 USPQ 494, 496 (CCPA 1970)."

The Examiner has failed his duty under MPEP 2143.03 (and in view of *Wehling*) to present a *prima facie* case of obviousness for rejecting Applicant's Claim 1.

Examiner's Regarding Claim 2, a claim dependent on Claim 1. Applicant has shown that Claim 1 is nonobvious. Therefore, under **2143.03 All Claim Limitations Must Be Considered**, Claim 2 is non-obvious.

2143.03 All Claim Limitations Must Be **>Considered< [R-6]

** "All words in a claim must be considered in judging the patentability of that claim against the prior art." *In re Wilson*, 424 F.2d 1382, 1385, 165 USPQ 494, 496 (CCPA 1970). If an independent claim is nonobvious under 35 U.S.C. 103, then any claim depending therefrom is nonobvious. *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988).

Examiner's Regarding Claim 3, a claim dependent on Claim 1. Applicant has shown that Claim 1 is nonobvious. Therefore, under 2143.03 **All Claim Limitations Must Be Considered**, Claim 3 is non-obvious.

2143.03 All Claim Limitations Must Be ** >Considered< [R-6]

** "All words in a claim must be considered in judging the patentability of that claim against the prior art." *In re Wilson*, 424 F.2d 1382, 1385, 165 USPQ 494, 496 (CCPA 1970). If an independent claim is nonobvious under 35 U.S.C. 103, then any claim depending therefrom is nonobvious. *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988).

Examiner's Regarding Claim 4, a claim dependent on Claim 1. Applicant has shown that Claim 1 is nonobvious. Therefore, under 2143.03 **All Claim Limitations Must Be Considered**, Claim 4 is non-obvious.

2143.03 All Claim Limitations Must Be ** >Considered< [R-6]

** "All words in a claim must be considered in judging the patentability of that claim against the prior art." *In re Wilson*, 424 F.2d 1382, 1385, 165 USPQ 494, 496 (CCPA 1970). If an independent claim is nonobvious under 35 U.S.C. 103, then any claim depending therefrom is nonobvious. *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988).

Examiner:

> Regarding claim 5, Margolin (abstract; figs. 1-7; col. 3, lines 8-67; col. 4, lines 1-67; col. 5, lines 1-67) in view of Duggan disclose a system for safely flying an unmanned aerial vehicle in civilian airspace comprising:
>
> (a) a ground station equipped with a synthetic vision system;
>
> (b) an unmanned aerial vehicle capable of supporting said synthetic vision system;
>
> (c) a remote pilot operating said ground station;

(d) a communications link between said unmanned aerial vehicle and said ground station;

e) a system onboard said unmanned aerial vehicle for detecting the presence and position of nearby aircraft and communicating this information to said remote pilot;

whereas said remote pilot uses said synthetic vision system to control said unmanned aerial vehicle during at least selected phases of the flight of said unmanned aerial vehicle, and during those phases of the flight of said unmanned aerial vehicle when said synthetic vision system is not used to control said unmanned aerial vehicle said unmanned aerial vehicle is flown using an autonomous control system, and

whereas the selected phases of the flight of said unmanned aerial vehicle comprise:

(a) when said unmanned aerial vehicle is within a selected range of an airport or other designated location and is below a first specified altitude;

(b) when said unmanned aerial vehicle is outside said selected range of an airport or other designated location and is below a second specified altitude.

Applicant:

In Margolin ‘724: Column 3, lines 8-67; Column 4, lines 1-67; and Column 5, lines 1-67 form a continuous passage from Column 3, line 8 to Column 5, line 67. This passage of approximately 1619 words forms the core of the Margolin ‘724 DETAILED DESCRIPTION. The remainder of the Margolin ‘724 DETAILED DESCRIPTION teaches additional topics such as **Flight Control** (with headings *Flight Control*, *Direct Control Non-Remotely Piloted Vehicles*, *Computer Mediated Non-Remotely Piloted Vehicles*, *Second Order Flight Control Mode*, *First Order Flight Control Mode* {See Column 6, line 19 - Column 8, line 3}, the features of a Control Panel (See Column 8, line 64 - Column 9, line 18}, the use of a Head-Mounted Display {See Column 9, lines 19 - 32}, the use of the invention for training {See Column 9, lines 33 - 63}, and **The Database** {See Column 9, line 64 - Column 10, line 50.}

The Examiner cites Figures 1 - 7 in Margolin ‘724. These constitute all the figures in Margolin ‘724.

The Examiner also cites the Abstract in Margolin ‘724. According to **608.01(b) Abstract of the Disclosure [R-7]:**

37 CFR 1.72 Title and abstract.

*****

(b) A brief abstract of the technical disclosure in the specification must commence on a separate sheet, preferably following the claims, under the heading "Abstract" or "Abstract of the Disclosure." The sheet or sheets presenting the abstract may not include other parts of the application or other material. The abstract in an application filed under 35 U.S.C. 111 may not exceed 150 words in length. <u>The purpose of the abstract is to enable the United States Patent and Trademark Office and the public generally to determine quickly from a cursory inspection the nature and gist of the technical disclosure.</u><

{Emphasis added}

The popular interpretation of 608.01(b) is that the purpose of the Abstract is to provide search terms. In any event, the Abstract in Margolin '724 does not say anything about civilian airspace.

The Examiner has made a conclusory statement by repeating the title of Applicant's invention (leaving out the words "and method") and citing the core of the DETAILED DESCRIPTION in Margolin '724.

In the remaining sections of the Examiner's rejection of Applicant's Claim 5 he asserts that he has found all of the elements and limitations of Applicant's invention.

It is not surprising that some of the elements of Applicant's invention are present in Margolin '724 since Margolin '724 is probably the pioneering patent for the use of what is now called *synthetic vision* in remotely piloted aircraft (now commonly called Unmanned Aerial Vehicles) and Applicant's present invention uses synthetic vision as an element.

However, there are limitations in Applicant's current invention that are not present in Margolin '724.

Examiner:

whereas said remote pilot uses said synthetic vision system to control said unmanned aerial vehicle during at least selected phases of the flight of said unmanned aerial vehicle, and during those phases of the flight of said unmanned aerial vehicle when said synthetic vision system is not used to control said unmanned aerial vehicle said unmanned aerial vehicle is flown using an autonomous control system, and

whereas the selected phases of the flight of said unmanned aerial vehicle comprise:
(a) when said unmanned aerial vehicle is within a selected range of an airport or other designated location and is below a first specified altitude;
(b) when said unmanned aerial vehicle is outside said selected range of an airport or other designated location and is below a second specified altitude.

The Examiner has not even attempted to show where these limitations are taught in Margolin '724. As noted, he has cited the core of the Margolin '724 DETAILED DESCRIPTION, all of the drawings, and the abstract. His rejection is purely conclusory and does not follow the requirements for making a *prima facie* rejection required by MPEP § 2143.03 **All Claim Limitations Must Be Considered**, *KSR*, and *Wehling*, as well as MPEP § 2142 **ESTABLISHING A PRIMA FACIE CASE OF OBVIOUSNESS.**

The Examiner continues:

Margolin did not disclose that the vehicle is flown using an autonomous control system. However, Duggan teach of a system for safely flying an unmanned aerial vehicle in civilian airspace comprising:

a ground station controlling an unmanned aerial vehicle (sec. 0352, 00353), wherein during phases of a flight of an unmanned aerial vehicle (UAV, sec 0318, 0322, 0353) when a synthetic vision (sec. 0356, 0365, 0388, 0390) is not used to control said unmanned aerial vehicle said unmanned aerial vehicle is flown using an autonomous control system (autopilot, sec 0346 to 0350, 0390-0329).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Margolin as taught by Duggan for the purpose of incorporating an autopilot to ensure smooth transitions (Duggna abstract, sec 0014, 0085, 0086).

The different embodiments in both prior arts are combinable as it would be obvious to ne having ordinary skill in the art.

<u>Examiner</u>	**<u>Duggan</u>**
Margolin did not disclose that the vehicle is flown using an autonomous control system. However, Duggan teach of a system for safely flying an unmanned aerial vehicle in civilian airspace comprising: a ground station controlling an unmanned aerial vehicle (sec. 0352,	[0352] In one aspect of the present invention, an operator station (also referred to as the ground control station or GCS) is designed to accommodate command and control of multiple vehicles or a single vehicle by a single operator. In accordance with one embodiment, the ground control station is platform independent and implements an application program interface that provides windowing and communications interfaces (e.g., the platform is implemented in Open Source wxWindows API). The underlying operating system is illustratively masked and enables a developer to code in a high level environment.
00353),	[0353] In one embodiment, the ground control station incorporates several specialized user interface concepts designed to effectively support a single operator tasked to control multiple vehicles. The GCS also illustratively supports manual control and sensor steering modes. In the manual control mode, the operator can assume control authority of the vehicles individually from the ground control station at any time in flight. In the sensor steering mode, a vehicle will autonomously fly in the direction the operator is manually pointing the on-board imaging sensor (e.g., operator views video output from a digital camera on a TV interface, computer screen display, etc.). A custom data link is illustratively, utilized to support a two-way transfer of data between the ground control station and the UAV's. These design concepts together provide a flexible, multiple vehicle

	control system. The details of the concepts are discussed below.
wherein during phases of a flight of an unmanned aerial vehicle (UAV, sec 0318,	[0318] If the pilot chooses a surveillance location outside the total FOV, then the outer loop guidance will illustratively follow a command-to-LOS mode guide law until the UAV flight path points toward the target. Once the desired staring-point comes within a minimum range threshold, the guidance automatically trips into a loiter pattern (either constant-radius or elliptical) to maintain a station with a single key-click while he/she conducts other activities. FIGS. 22A & 22B together demonstrate the surveillance-point approach scenario.
0322,	[0322] In accordance with one aspect of the present invention, sensor-slave mode commands are generated by an autonomous line-of-sight driven function, in which the command objectives are generated by the necessities of the function rather than by an operator. For example, a function designed to command a raster-scan of a particular surveillance area, or a function designed to scan a long a roadway could be used to generate sensor slave commands. Another example is a function designed to generate line-of-sight commands for UAV-to-UAV rendezvous formation flying.
0353)	[0353] In one embodiment, the ground control station incorporates several specialized user interface concepts designed to effectively support a single operator tasked to control multiple vehicles. The GCS also illustratively supports manual control and sensor steering modes. In the manual control mode, the operator can assume control authority of the vehicles individually from the ground control station at any

	time in flight. In the sensor steering mode, a vehicle will autonomously fly in the direction the operator is manually pointing the on-board imaging sensor (e.g., operator views video output from a digital camera on a TV interface, computer screen display, etc.). A custom data link is illustratively, utilized to support a two-way transfer of data between the ground control station and the UAV's. These design concepts together provide a flexible, multiple vehicle control system. The details of the concepts are discussed below.
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0365,	[0365] The two video monitors are illustratively used to display real-time data linked camera imagery from two air vehicles having cameras (of course, fewer, more or none of the vehicles might have cameras and the number of monitor displays can be altered accordingly). In accordance with one embodiment, camera imagery is recorded on videotapes during a mission. In accordance with one embodiment, the two repeater displays are used to provide redundant views of the GUI and synthetic vision display. The laptop illustratively serves as a GUI backup in the event that the main GUI fails.
0388,	[0388] In one aspect of the present invention, synthetic vision display technical approach of the present invention is based upon integrating advanced simulated visuals, originally developed for training purposes, into UAV operational systems. In accordance with one embodiment, the simulated visuals are integrated with data derived from the ground control station during flight to enable real-time synthetic

	visuals.
0390) is not used to control said unmanned aerial vehicle said unmanned aerial vehicle is flown using an autonomous control system	[0390] In one aspect of the present invention, through GUI display 2622, an operator can maintain a variable level of control over a UAV, from fully manual to fully autonomous, with simple user-friendly inputs. For example, if an operator decides to divert a UAV to a new route, the operator has a plurality of options to select from. The following are examples of some of the options that an operator has. Those skilled in the art should recognize that this is not an exhaustive list. In one embodiment, the operator could graphically edit the existing route on mission situation display 2629 by adding a waypoint or orbit pattern in the vicinity of a desired target region. Prior to accepting the edited route, the control system evaluates the revised route against the vehicle performance capability as well as terrain obstructions. If the route is within acceptable bounds, the control system registers the modified route and maneuvers the vehicle accordingly. In another embodiment, the operator could select a park mode on selections pane 2630. After selected, the control system queues the operator to click the location of and graphical size (via a mouse) the desired orbit pattern in which the vehicle will fly while "parked" over a desired target. In another embodiment, the operator can select a manual control mode on selections pane 2630. By selecting RDC (remote directional command), for example, the control system controls the UAV into a constant altitude, heading and speed flight until the operator instructs a maneuver. While in RDC mode, the operator can either pseudo-manually direct the UAV using the control stick (e.g. joystick) or the operator can program a fixed heading, altitude and speed using the control

	options provided in selections pane 2630.
(autopilot, sec 0346 to 0350,	[0346] In accordance with one embodiment, an exemplary translation layer implementation will now be provided. After the guidance algorithms execute, the outputs are translated to the native vehicle autopilot commands. The equations below provide example kinematic translations from the guidance acceleration commands to native vehicle autopilot commands. These equations demonstrate the principal that vehicle motion is activated through acceleration. The methods that various vehicles employ to generate acceleration are numerous (bank angle autopilot, acceleration autopilot, heading control autopilot, altitude control autopilot, etc). Since the control algorithms described herein generate acceleration commands that can be kinematically translated into any of these native autopilot commands, the guidance algorithms truly provide a generalized library of control laws that can control any vehicle through that vehicle's native atomic functions. Ubiquitous acceleration control techniques enable VACS to synthesize control commands for any vehicle, including air, ground, or sea-based. 35 a v = vertical plane acceleration command a h = horizontal plane acceleration command = tan - 1 (a h a v) = bank angle command a T = a v 2 + a h 2 = total body acceleration command . = a h V = turn rate command i = i - 1 + . t = heading command . = (a v - g) V = flight path rate command i = i - 1 + . t = flight path angle command h . = V sin ( ) = climb rate command h i = h i = 1 + h . t = altitude command Eq . 57 [0347] Additional functionality that can be enabled in a translation layer is means for discouraging or preventing an

	operator (e.g., the human or non-human operator interfacing the VACS architecture) from overdriving, stalling, or spinning the vehicle frame. This being said, limiting algorithms can also be employed in the guidance or autopilot functions. [0348] X. Autopilot [0349] As has been addressed, the present invention is not limited to, and does not require, a particular autopilot system. The control system and architecture embodiments of the present invention can be adapted to accommodate virtually any autopilot system. [0350] For the purpose of providing an example, an illustrative suitable autopilot software system will now be described. The illustrative autopilot system incorporates a three-axis design (pitch and yaw with an attitude control loop in the roll axis) for vehicle stabilization and guidance command tracking. The autopilot software design incorporates flight control techniques, which allow vehicle control algorithms to dynamically adjust airframe stabilization parameters in real-time during flight. The flight computer is programmed directly with the airframe physical properties, so that it can automatically adjust its settings with changes in airframe configuration, aerodynamic properties, and/or flight state. This provides for a simple and versatile design, and possesses the critical flexibility needed when adjustments to the airframe configuration become necessary. The three-loop design includes angular rate feedback for stability augmentation, attitude feedback for closed-loop stiffness, and acceleration feedback for command tracking. In addition, an

	integral controller in the forward loop illustratively provides enhanced command tracking, low frequency disturbance rejection and an automatic trim capability.
0390-0329).	{The Examiner may have meant 0390-0392. Otherwise the range is not credible} [0390] In one aspect of the present invention, through GUI display 2622, an operator can maintain a variable level of control over a UAV, from fully manual to fully autonomous, with simple user-friendly inputs. For example, if an operator decides to divert a UAV to a new route, the operator has a plurality of options to select from. The following are examples of some of the options that an operator has. Those skilled in the art should recognize that this is not an exhaustive list. In one embodiment, the operator could graphically edit the existing route on mission situation display 2629 by adding a waypoint or orbit pattern in the vicinity of a desired target region. Prior to accepting the edited route, the control system evaluates the revised route against the vehicle performance capability as well as terrain obstructions. If the route is within acceptable bounds, the control system registers the modified route and maneuvers the vehicle accordingly. In another embodiment, the operator could select a park mode on selections pane 2630. After selected, the control system queues the operator to click the location of and graphical size (via a mouse) the desired orbit pattern in which the vehicle will fly while "parked" over a desired target. In another embodiment, the operator can select a manual control mode on selections pane 2630. By selecting RDC (remote directional command), for example, the control system controls the UAV into a constant altitude, heading and speed

	flight until the operator instructs a maneuver. While in RDC mode, the operator can either pseudo-manually direct the UAV using the control stick (e.g. joystick) or the operator can program a fixed heading, altitude and speed using the control options provided in selections pane 2630. [0391] The described Intelligent displays with smart variables represent an effective approach to actively displaying information for different types of vehicles. However, a problem can arise when a new vehicle is integrated into the ground control station with a completely foreign command and control interface. Under these circumstances, the ground control station is not concerned about displaying data, but is tasked to provide a command and control interface for the operator to perform the required operations. This conundrum is the motivation for another embodiment of the present invention, namely, the integration of vehicle specific panels in the ground control station. [0392] In one embodiment, a generic vehicle class (GVC) is illustratively a software component that provides a rapid development environment API to add new vehicle classes and types to the ground control station. The GVC also illustratively serves as a software construct that allows the inclusion of multiple vehicles within the ground control station framework. One of the variables in the application is a vector of pointers to a generic vehicle class. This list is constructed by allocating new specific vehicles and returning a type case to the base generic vehicle class. When a new vehicle is integrated into the ground control station, the generic vehicle class provides all of the virtual functions to

	integrate with system control components (e.g., to integrate with a map display, a communications package, PCIG imagery and/or appropriate display windows). An important object in the application framework is illustratively a pointer to the current vehicle generic class. When the user switches vehicles, this pointer is updated and all displays grab the appropriate smart variables from the pointer to the new base class. This is the mechanism by which windows immediately update to the current vehicle information whenever the user switches vehicles. The default windows use the pointer to the current vehicle to grab information. In this manner, if the user switches to a new vehicle with a different set of datalink variables, that fact is immediately apparent on the display windows.
Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Margolin as taught by Duggan for the purpose of incorporating an autopilot to ensure smooth transitions (Duggna abstract, sec 0014, 0085, 0086).	**Abstract**
The different embodiments in both prior arts are combinable as it would be obvious to ne[sic] having ordinary skill in the art.	Embodiments are disclosed for a vehicle control system and related sub-components that together provide an operator with a plurality of specific modes of operation, wherein various modes of operation incorporate different levels of autonomous control. Through a control user interface, an operator can move between certain modes of control even after vehicle deployment. Specialized autopilot system components and methods are employed to ensure smooth transitions between

	control modes. Empowered by the multi-modal control system, an operator can even manage multiple vehicles simultaneously. [0014] Embodiments of the present invention pertain to a hierarchical control system, user interface system, and control architecture that together incorporate a broad range of user-selectable control modes representing variable levels of autonomy and vehicle control functionality. A unified autopilot is provided to process available modes and mode transitions. An intelligence synthesizer is illustratively provided to assist in resolving functional conflicts and transitioning between control modes, although certain resolutions and transitions can be incorporated directly into the functional sub-components associated with the different control modes. In accordance with one embodiment, all modes and transitions are funneled through an acceleration-based autopilot system. Accordingly, control commands and transitions are generally reduced to an acceleration vector to be processed by a centralized autopilot system. [0085] As will be discussed in greater detail below, the control system and architecture embodiments of the present invention essentially enable any autopilot design to support control of a vehicle in numerous control modes that are executed with switches between modes during flight. All control modes are supported even in the presence of sensor errors, such as accelerometer and gyro biases. This robustness is at least partially attributable to the fact that the closed-loop system, in all control modes, is essentially slaved to an inertial path and, hence, the sensor biases wash out in the closed loop,

	assuming the biases are not so grossly large that they induce stability problems in the autopilot system. Furthermore, winds are generally not an issue in the overall control scheme in that the flight control system will regulate to the inertial path, adjusting for winds automatically in the closed loop. Given the precision afforded by inertial navigation aided by GPS technology, inertial path regulation offers a highly effective and robust UAV control approach. Generally speaking, the autopilot system functions such that winds, medium Dryden turbulence levels, sensor errors, airframe aerodynamic and mass model parameter uncertainties, servo non-linearity (slew rate limits, etc.), and various other atmospheric and noise disturbances will non have a critically negative impact on flight path regulation. [0086] Component 408 receives commands generated by component 404 and filtered by autopilot component 406. The commands received by component 408 are executed to actually manipulate the vehicle's control surfaces. Autopilot component 406 then continues to monitor vehicle stabilization and/or command tracking, making additional commands to component 408 as necessary.

At the beginning of this subsection, the Examiner asserts, “Margolin did not disclose that the vehicle is flown using an autonomous control system. However, Duggan teach of a system for safely flying an unmanned aerial vehicle in civilian airspace comprising: …”

The Examiner’s statement, “However, Duggan teach of a system for safely flying an unmanned aerial vehicle in civilian airspace comprising: …” is conclusory and is not supported by the Examiner’s citations to Duggan.

In addition, none of the Duggan citations teach the limitations in Applicant's Claim 5 that either synthetic vision or Duggan's Variable Autonomy System is used:

1. "during at least selected phases of the flight of said unmanned aerial vehicle"
2. that the selected phases comprise:
   (a) when said unmanned aerial vehicle is within a selected range of an airport or other designated location and is below a first specified altitude;
   (b) when said unmanned aerial vehicle is outside said selected range of an airport or other designated location and is below a second specified altitude.

Duggan fails to teach the limitation that his Variable Autonomy System is used during selected phases of a UAV's flight and Margolin '724 fails to teach the limitation that synthetic vision is used during selected phases of a UAV's flight. Therefore, the combination of Duggan and Margolin '724 does not read on Applicant's Claim 5.

As cited above by Applicant, MPEP 2143.03 "**All Claim Limitations must be Considered**" states: "all words in a claim must be considered in judging the patentability of that claim against the prior art." *In re Wilson*, 424 F.2d 1382, 1385, 165 USPQ 494, 496 (CCPA 1970)."

The Examiner has failed his duty under MPEP 2143.03 (and in view of *Wehling*) to present a *prima facie* case of obviousness for rejecting Applicant's Claim 5.

<u>**Examiner's Regarding Claim 6**</u>, a claim dependent on Claim 5. Applicant has shown that Claim 5 is nonobvious. Therefore, under **2143.03 All Claim Limitations Must Be Considered**, Claim 6 is non-obvious.

> **2143.03 All Claim Limitations Must Be **>Considered< [R-6]**
>
> ** "All words in a claim must be considered in judging the patentability of that claim against the prior art." *In re Wilson*, 424 F.2d 1382, 1385, 165 USPQ 494, 496 (CCPA 1970). If an independent claim is nonobvious under <u>35 U.S.C. 103</u>, then any claim depending therefrom is nonobvious. *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988).

<u>Examiner's Regarding Claim 7</u>, a claim dependent on Claim 5. Applicant has shown that Claim 5 is nonobvious. Therefore, under **2143.03 All Claim Limitations Must Be Considered**, Claim 7 is non-obvious.

2143.03 All Claim Limitations Must Be **>Considered< [R-6]

** "All words in a claim must be considered in judging the patentability of that claim against the prior art." *In re Wilson*, 424 F.2d 1382, 1385, 165 USPQ 494, 496 (CCPA 1970). If an independent claim is nonobvious under 35 U.S.C. 103, then any claim depending therefrom is nonobvious. *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988).

Examiner:

> Regarding claim 8, Margolin (abstract; figs. 1-7; col. 3, lines 8-67; col. 4, lines 1-67; col. 5, lines 1-67) in view of Duggan disclose a method for safely flying an unmanned aerial vehicle as part of a unmanned aerial system equipped with a synthetic vision system in civilian airspace comprising the steps of-
>
> (a) using a remote pilot to fly said unmanned aerial vehicle using synthetic vision during at least selected phases of the flight of said unmanned aerial vehicle, and during those phases of the flight of said unmanned aerial vehicle when said synthetic vision system is not used to control said unmanned aerial vehicle an autonomous control system is used to fly said unmanned aerial vehicle;
>
> (b) providing a system onboard said unmanned aerial vehicle for detecting the presence and position of nearby aircraft and communicating this information to said remote pilot.

<u>Applicant:</u>

In Margolin '724: Column 3, lines 8-67; Column 4, lines 1-67; and Column 5, lines 1-67 form a continuous passage from Column 3, line 8 to Column 5, line 67. This passage of approximately 1619 words forms the core of the Margolin '724 DETAILED DESCRIPTION. The remainder of the Margolin '724 DETAILED DESCRIPTION teaches additional topics such as **Flight Control** (with headings *Flight Control*, *Direct Control Non-Remotely Piloted Vehicles*, *Computer Mediated Non-Remotely Piloted Vehicles*, *Second Order Flight Control Mode*, *First Order Flight Control Mode* {See Column 6, line 19 - Column 8, line 3}, the features of a Control Panel (See Column 8, line 64 - Column 9, line 18}, the use of a Head-Mounted Display {See Column 9, lines 19 - 32}, the use of the invention for training {See Column 9, lines 33 - 63}, and **The Database** {See Column 9, line 64 - Column 10, line 50.}

The Examiner cites Figures 1 - 7 in Margolin ‘724. These constitute all the figures in Margolin ‘724.

The Examiner also cites the Abstract in Margolin ‘724. According to **608.01(b) Abstract of the Disclosure [R-7]:**

> **37 CFR 1.72 Title and abstract.**
>
> *****
>
> (b) A brief abstract of the technical disclosure in the specification must commence on a separate sheet, preferably following the claims, under the heading "Abstract" or "Abstract of the Disclosure." The sheet or sheets presenting the abstract may not include other parts of the application or other material. The abstract in an application filed under 35 U.S.C. 111 may not exceed 150 words in length. <u>The purpose of the abstract is to enable the United States Patent and Trademark Office and the public generally to determine quickly from a cursory inspection the nature and gist of the technical disclosure.</u><

{Emphasis added}

The popular interpretation of 608.01(b) is that the purpose of the Abstract is to provide search terms. In any event, the Abstract in Margolin ‘724 does not say anything about civilian airspace.

The Examiner has made a conclusory statement by repeating the title of Applicant’s invention (leaving out the words “and method”) and citing the core of the DETAILED DESCRIPTION in Margolin ‘724.

In the remaining sections of the Examiner’s rejection of Applicant’s Claim 8 he asserts that he has found the elements and limitations of Applicant’s invention.

> (a) using a remote pilot to fly said unmanned aerial vehicle using synthetic vision during at least selected phases of the flight of said unmanned aerial vehicle, and during those phases of the flight of said unmanned aerial vehicle when said synthetic vision system is not used to

control said unmanned aerial vehicle an autonomous control system is used to fly said unmanned aerial vehicle;

(b) providing a system onboard said unmanned aerial vehicle for detecting the presence and position of nearby aircraft and communicating this information to said remote pilot.

The Examiner has not even attempted to show where these limitations are taught in Margolin '724. He has particularly failed to show where the following is taught:

(a) using a remote pilot to fly said unmanned aerial vehicle using synthetic vision during at least selected phases of the flight of said unmanned aerial vehicle, and during those phases of the flight of said unmanned aerial vehicle when said synthetic vision system is not used to control said unmanned aerial vehicle an autonomous control system is used to fly said unmanned aerial vehicle;

As noted, he has cited the core of the Margolin '724 DETAILED DESCRIPTION, all of the drawings, and the abstract. His rejection is purely conclusory and does not follow the requirements for making a *prima facie* rejection required by MPEP § 2143.03 **All Claim Limitations Must Be Considered**, *KSR*, and *Wehling*, as well as MPEP § 2142 **ESTABLISHING A PRIMA FACIE CASE OF OBVIOUSNESS.**

The Examiner continues:

Margolin did not disclose that the vehicle is flown using an autonomous control system. However, Duggan teach of a system for safely flying an unmanned aerial vehicle in civilian airspace comprising:

a ground station controlling an unmanned aerial vehicle (sec. 0352, 00353), wherein during phases of a flight of an unmanned aerial vehicle (UAV, sec 0318, 0322, 0353) when a synthetic vision (sec. 0356, 0365, 0388, 0390) is not used to control said unmanned aerial vehicle said unmanned aerial vehicle is flown using an autonomous control system (autopilot, sec 0346 to 0350, 0390-0329).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Margolin as taught by Duggan for the purpose of incorporating an autopilot to ensure smooth transitions (Duggna abstract, sec 0014, 0085, 0086).

The different embodiments in both prior arts are combinable as it would be obvious to ne having ordinary skill in the art.

Examiner	**Duggan**
Margolin did not disclose that the vehicle is flown using an autonomous control system. However, Duggan teach of a system for safely flying an unmanned aerial vehicle in civilian airspace comprising: a ground station controlling an unmanned aerial vehicle (sec. 0352,	[0352] In one aspect of the present invention, an operator station (also referred to as the ground control station or GCS) is designed to accommodate command and control of multiple vehicles or a single vehicle by a single operator. In accordance with one embodiment, the ground control station is platform independent and implements an application program interface that provides windowing and communications interfaces (e.g., the platform is implemented in Open Source wxWindows API). The underlying operating system is illustratively masked and enables a developer to code in a high level environment.
00353),	[0353] In one embodiment, the ground control station incorporates several specialized user interface concepts designed to effectively support a single operator tasked to control multiple vehicles. The GCS also illustratively supports manual control and sensor steering modes. In the manual control mode, the operator can assume control authority of the vehicles individually from the ground control station at any time in flight. In the sensor steering mode, a vehicle will autonomously fly in the direction the operator is manually pointing the on-board imaging sensor (e.g., operator views video output from a digital camera on a TV interface, computer screen display, etc.). A custom data link is illustratively, utilized to support a two-way transfer of data between the ground control station and the UAV's. These

	design concepts together provide a flexible, multiple vehicle control system. The details of the concepts are discussed below.
wherein during phases of a flight of an unmanned aerial vehicle (UAV, sec 0318,	[0318] If the pilot chooses a surveillance location outside the total FOV, then the outer loop guidance will illustratively follow a command-to-LOS mode guide law until the UAV flight path points toward the target. Once the desired staring-point comes within a minimum range threshold, the guidance automatically trips into a loiter pattern (either constant-radius or elliptical) to maintain a station with a single key-click while he/she conducts other activities. FIGS. 22A & 22B together demonstrate the surveillance-point approach scenario.
0322,	[0322] In accordance with one aspect of the present invention, sensor-slave mode commands are generated by an autonomous line-of-sight driven function, in which the command objectives are generated by the necessities of the function rather than by an operator. For example, a function designed to command a raster-scan of a particular surveillance area, or a function designed to scan a long a roadway could be used to generate sensor slave commands. Another example is a function designed to generate line-of-sight commands for UAV-to-UAV rendezvous formation flying.
0353)	[0353] In one embodiment, the ground control station incorporates several specialized user interface concepts designed to effectively support a single operator tasked to control multiple vehicles. The GCS also illustratively supports manual control and sensor steering modes. In the manual control mode, the operator can assume control authority of the

	vehicles individually from the ground control station at any time in flight. In the sensor steering mode, a vehicle will autonomously fly in the direction the operator is manually pointing the on-board imaging sensor (e.g., operator views video output from a digital camera on a TV interface, computer screen display, etc.). A custom data link is illustratively, utilized to support a two-way transfer of data between the ground control station and the UAV's. These design concepts together provide a flexible, multiple vehicle control system. The details of the concepts are discussed below.
when a synthetic vision (sec. 0356,	[0356] a synthetic vision display
0365,	[0365] The two video monitors are illustratively used to display real-time data linked camera imagery from two air vehicles having cameras (of course, fewer, more or none of the vehicles might have cameras and the number of monitor displays can be altered accordingly). In accordance with one embodiment, camera imagery is recorded on videotapes during a mission. In accordance with one embodiment, the two repeater displays are used to provide redundant views of the GUI and synthetic vision display. The laptop illustratively serves as a GUI backup in the event that the main GUI fails.
0388,	[0388] In one aspect of the present invention, synthetic vision display technical approach of the present invention is based upon integrating advanced simulated visuals, originally developed for training purposes, into UAV operational systems. In accordance with one embodiment, the simulated visuals are integrated with data derived from the ground

	control station during flight to enable real-time synthetic visuals.
0390) is not used to control said unmanned aerial vehicle said unmanned aerial vehicle is flown using an autonomous control system	[0390] In one aspect of the present invention, through GUI display 2622, an operator can maintain a variable level of control over a UAV, from fully manual to fully autonomous, with simple user-friendly inputs. For example, if an operator decides to divert a UAV to a new route, the operator has a plurality of options to select from. The following are examples of some of the options that an operator has. Those skilled in the art should recognize that this is not an exhaustive list. In one embodiment, the operator could graphically edit the existing route on mission situation display 2629 by adding a waypoint or orbit pattern in the vicinity of a desired target region. Prior to accepting the edited route, the control system evaluates the revised route against the vehicle performance capability as well as terrain obstructions. If the route is within acceptable bounds, the control system registers the modified route and maneuvers the vehicle accordingly. In another embodiment, the operator could select a park mode on selections pane 2630. After selected, the control system queues the operator to click the location of and graphical size (via a mouse) the desired orbit pattern in which the vehicle will fly while "parked" over a desired target. In another embodiment, the operator can select a manual control mode on selections pane 2630. By selecting RDC (remote directional command), for example, the control system controls the UAV into a constant altitude, heading and speed flight until the operator instructs a maneuver. While in RDC mode, the operator can either pseudo-manually direct the UAV using the control stick (e.g. joystick) or the operator can

	program a fixed heading, altitude and speed using the control options provided in selections pane 2630.
(autopilot, sec 0346 to 0350,	[0346] In accordance with one embodiment, an exemplary translation layer implementation will now be provided. After the guidance algorithms execute, the outputs are translated to the native vehicle autopilot commands. The equations below provide example kinematic translations from the guidance acceleration commands to native vehicle autopilot commands. These equations demonstrate the principal that vehicle motion is activated through acceleration. The methods that various vehicles employ to generate acceleration are numerous (bank angle autopilot, acceleration autopilot, heading control autopilot, altitude control autopilot, etc). Since the control algorithms described herein generate acceleration commands that can be kinematically translated into any of these native autopilot commands, the guidance algorithms truly provide a generalized library of control laws that can control any vehicle through that vehicle's native atomic functions. Ubiquitous acceleration control techniques enable VACS to synthesize control commands for any vehicle, including air, ground, or sea-based. 35 a v = vertical plane acceleration command a h = horizontal plane acceleration command = tan - 1 (a h a v) = bank angle command a T = a v 2 + a h 2 = total body acceleration command . = a h V = turn rate command i = i - 1 + . t = heading command . = (a v - g) V = flight path rate command i = i - 1 + . t = flight path angle command h . = V sin ( ) = climb rate command h i = h i = 1 + h . t = altitude command Eq . 57 [0347] Additional functionality that can be enabled in a

	translation layer is means for discouraging or preventing an operator (e.g., the human or non-human operator interfacing the VACS architecture) from overdriving, stalling, or spinning the vehicle frame. This being said, limiting algorithms can also be employed in the guidance or autopilot functions. [0348] X. Autopilot [0349] As has been addressed, the present invention is not limited to, and does not require, a particular autopilot system. The control system and architecture embodiments of the present invention can be adapted to accommodate virtually any autopilot system. [0350] For the purpose of providing an example, an illustrative suitable autopilot software system will now be described. The illustrative autopilot system incorporates a three-axis design (pitch and yaw with an attitude control loop in the roll axis) for vehicle stabilization and guidance command tracking. The autopilot software design incorporates flight control techniques, which allow vehicle control algorithms to dynamically adjust airframe stabilization parameters in real-time during flight. The flight computer is programmed directly with the airframe physical properties, so that it can automatically adjust its settings with changes in airframe configuration, aerodynamic properties, and/or flight state. This provides for a simple and versatile design, and possesses the critical flexibility needed when adjustments to the airframe configuration become necessary. The three-loop design includes angular rate feedback for stability augmentation, attitude feedback for closed-loop stiffness, and

	acceleration feedback for command tracking. In addition, an integral controller in the forward loop illustratively provides enhanced command tracking, low frequency disturbance rejection and an automatic trim capability.
0390-0329).	{The Examiner may have meant 0390-0392. Otherwise the range is not credible} [0390] In one aspect of the present invention, through GUI display 2622, an operator can maintain a variable level of control over a UAV, from fully manual to fully autonomous, with simple user-friendly inputs. For example, if an operator decides to divert a UAV to a new route, the operator has a plurality of options to select from. The following are examples of some of the options that an operator has. Those skilled in the art should recognize that this is not an exhaustive list. In one embodiment, the operator could graphically edit the existing route on mission situation display 2629 by adding a waypoint or orbit pattern in the vicinity of a desired target region. Prior to accepting the edited route, the control system evaluates the revised route against the vehicle performance capability as well as terrain obstructions. If the route is within acceptable bounds, the control system registers the modified route and maneuvers the vehicle accordingly. In another embodiment, the operator could select a park mode on selections pane 2630. After selected, the control system queues the operator to click the location of and graphical size (via a mouse) the desired orbit pattern in which the vehicle will fly while "parked" over a desired target. In another embodiment, the operator can select a manual control mode on selections pane 2630. By selecting RDC (remote directional command), for example, the control system

	controls the UAV into a constant altitude, heading and speed flight until the operator instructs a maneuver. While in RDC mode, the operator can either pseudo-manually direct the UAV using the control stick (e.g. joystick) or the operator can program a fixed heading, altitude and speed using the control options provided in selections pane 2630. [0391] The described Intelligent displays with smart variables represent an effective approach to actively displaying information for different types of vehicles. However, a problem can arise when a new vehicle is integrated into the ground control station with a completely foreign command and control interface. Under these circumstances, the ground control station is not concerned about displaying data, but is tasked to provide a command and control interface for the operator to perform the required operations. This conundrum is the motivation for another embodiment of the present invention, namely, the integration of vehicle specific panels in the ground control station. [0392] In one embodiment, a generic vehicle class (GVC) is illustratively a software component that provides a rapid development environment API to add new vehicle classes and types to the ground control station. The GVC also illustratively serves as a software construct that allows the inclusion of multiple vehicles within the ground control station framework. One of the variables in the application is a vector of pointers to a generic vehicle class. This list is constructed by allocating new specific vehicles and returning a type case to the base generic vehicle class. When a new vehicle is integrated into the ground control station, the

	generic vehicle class provides all of the virtual functions to integrate with system control components (e.g., to integrate with a map display, a communications package, PCIG imagery and/or appropriate display windows). An important object in the application framework is illustratively a pointer to the current vehicle generic class. When the user switches vehicles, this pointer is updated and all displays grab the appropriate smart variables from the pointer to the new base class. This is the mechanism by which windows immediately update to the current vehicle information whenever the user switches vehicles. The default windows use the pointer to the current vehicle to grab information. In this manner, if the user switches to a new vehicle with a different set of datalink variables, that fact is immediately apparent on the display windows.
Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Margolin as taught by Duggan for the purpose of incorporating an autopilot to ensure smooth transitions (Duggna abstract, sec 0014, 0085, 0086). The different embodiments in both prior arts are combinable as it would be obvious to ne[sic] having ordinary skill in the art.	**Abstract** Embodiments are disclosed for a vehicle control system and related sub-components that together provide an operator with a plurality of specific modes of operation, wherein various modes of operation incorporate different levels of autonomous control. Through a control user interface, an operator can move between certain modes of control even after vehicle deployment. Specialized autopilot system components and methods are employed to ensure smooth transitions between

	control modes. Empowered by the multi-modal control system, an operator can even manage multiple vehicles simultaneously. [0014] Embodiments of the present invention pertain to a hierarchical control system, user interface system, and control architecture that together incorporate a broad range of user-selectable control modes representing variable levels of autonomy and vehicle control functionality. A unified autopilot is provided to process available modes and mode transitions. An intelligence synthesizer is illustratively provided to assist in resolving functional conflicts and transitioning between control modes, although certain resolutions and transitions can be incorporated directly into the functional sub-components associated with the different control modes. In accordance with one embodiment, all modes and transitions are funneled through an acceleration-based autopilot system. Accordingly, control commands and transitions are generally reduced to an acceleration vector to be processed by a centralized autopilot system. [0085] As will be discussed in greater detail below, the control system and architecture embodiments of the present invention essentially enable any autopilot design to support control of a vehicle in numerous control modes that are executed with switches between modes during flight. All control modes are supported even in the presence of sensor errors, such as accelerometer and gyro biases. This robustness is at least partially attributable to the fact that the closed-loop system, in all control modes, is essentially slaved to an inertial path and, hence, the sensor biases wash out in the closed loop,

	assuming the biases are not so grossly large that they induce stability problems in the autopilot system. Furthermore, winds are generally not an issue in the overall control scheme in that the flight control system will regulate to the inertial path, adjusting for winds automatically in the closed loop. Given the precision afforded by inertial navigation aided by GPS technology, inertial path regulation offers a highly effective and robust UAV control approach. Generally speaking, the autopilot system functions such that winds, medium Dryden turbulence levels, sensor errors, airframe aerodynamic and mass model parameter uncertainties, servo non-linearity (slew rate limits, etc.), and various other atmospheric and noise disturbances will non have a critically negative impact on flight path regulation. [0086] Component 408 receives commands generated by component 404 and filtered by autopilot component 406. The commands received by component 408 are executed to actually manipulate the vehicle's control surfaces. Autopilot component 406 then continues to monitor vehicle stabilization and/or command tracking, making additional commands to component 408 as necessary.

At the beginning of this subsection, the Examiner asserts, “Margolin did not disclose that the vehicle is flown using an autonomous control system. However, Duggan teach of a system for safely flying an unmanned aerial vehicle in civilian airspace comprising: …”

The Examiner’s statement, “However, Duggan teach of a system for safely flying an unmanned aerial vehicle in civilian airspace comprising: …” is conclusory and is not supported by the Examiner’s citations to Duggan.

In addition, none of the Duggan citations teach the limitations in Applicant's Claim 8 that either synthetic vision or Duggan's Variable Autonomy System comprises the step of:

> (a) using a remote pilot to fly said unmanned aerial vehicle using synthetic vision during at least selected phases of the flight of said unmanned aerial vehicle, and during those phases of the flight of said unmanned aerial vehicle when said synthetic vision system is not used to control said unmanned aerial vehicle an autonomous control system is used to fly said unmanned aerial vehicle;

Duggan fails to teach the limitation that his Variable Autonomy System is used during selected phases of a UAV's flight and Margolin '724 fails to teach the limitation that synthetic vision is used during selected phases of a UAV's flight. Therefore, the combination of Duggan and Margolin '724 does not read on Applicant's Claim 8.

As cited above by Applicant, MPEP 2143.03 "**All Claim Limitations must be Considered**" states: "all words in a claim must be considered in judging the patentability of that claim against the prior art." *In re Wilson*, 424 F.2d 1382, 1385, 165 USPQ 494, 496 (CCPA 1970)."

The Examiner has failed his duty under MPEP 2143.03 (and in view of *Wehling*) to present a *prima facie* case of obviousness for rejecting Applicant's Claim 8.

Examiner's Regarding Claim 9, a claim dependent on Claim 8. Applicant has shown that Claim 8 is nonobvious. Therefore, under **2143.03 All Claim Limitations Must Be Considered**, Claim 9 is non-obvious.

> **2143.03 All Claim Limitations Must Be **>Considered< [R-6]**
>
> ** "All words in a claim must be considered in judging the patentability of that claim against the prior art." *In re Wilson*, 424 F.2d 1382, 1385, 165 USPQ 494, 496 (CCPA 1970). If an independent claim is nonobvious under 35 U.S.C. 103, then any claim depending therefrom is nonobvious. *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988).

Examiner's Regarding Claim 10, a claim dependent on Claim 8. Applicant has shown that Claim 8 is nonobvious. Therefore, under **2143.03 All Claim Limitations Must Be Considered**, Claim 10 is non-obvious.

2143.03 All Claim Limitations Must Be **>Considered< [R-6]

** "All words in a claim must be considered in judging the patentability of that claim against the prior art." *In re Wilson*, 424 F.2d 1382, 1385, 165 USPQ 494, 496 (CCPA 1970). If an independent claim is nonobvious under 35 U.S.C. 103, then any claim depending therefrom is nonobvious. *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988).

Examiner's Regarding Claim 11, a claim dependent on Claim 8. Applicant has shown that Claim 8 is nonobvious. Therefore, under **2143.03 All Claim Limitations Must Be Considered**, Claim 11 is non-obvious.

2143.03 All Claim Limitations Must Be **>Considered< [R-6]

** "All words in a claim must be considered in judging the patentability of that claim against the prior art." *In re Wilson*, 424 F.2d 1382, 1385, 165 USPQ 494, 496 (CCPA 1970). If an independent claim is nonobvious under 35 U.S.C. 103, then any claim depending therefrom is nonobvious. *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988).

Examiner:

Regarding claim 12, Margolin (abstract; figs. 1-7; col. 3, lines 8-67; col. 4, lines 1-67; col. 5, lines 1-67) in view of Duggan disclose a method for safely flying an unmanned aerial vehicle as part of a unmanned aerial system equipped with a synthetic vision system in civilian airspace comprising the steps of:

(a) using a remote pilot to fly said unmanned aerial vehicle using synthetic vision during at least selected phases of the flight of said unmanned aerial vehicle, and during those phases of the flight of said unmanned aerial vehicle when said synthetic vision system is not used to control said unmanned aerial vehicle an autonomous control system is used to fly said unmanned aerial vehicle;

(b) providing a system onboard said unmanned aerial vehicle for detecting the presence and position of nearby aircraft and communicating this information to said remote pilot;

whereas said selected phases of the flight of said unmanned aerial vehicle comprise:

(a) when said unmanned aerial vehicle is within a selected range of an airport or other designated location and is below a first specified altitude;

(b) when said unmanned aerial vehicle is outside said selected range of an airport or other designated location and is below a second specified altitude.

Applicant:

In Margolin '724: Column 3, lines 8-67; Column 4, lines 1-67; and Column 5, lines 1-67 form a continuous passage from Column 3, line 8 to Column 5, line 67. This passage of approximately 1619 words forms the core of the Margolin '724 DETAILED DESCRIPTION. The remainder of the Margolin '724 DETAILED DESCRIPTION teaches additional topics such as **Flight Control** (with headings *Flight Control*, *Direct Control Non-Remotely Piloted Vehicles*, *Computer Mediated Non-Remotely Piloted Vehicles*, *Second Order Flight Control Mode*, *First Order Flight Control Mode* {See Column 6, line 19 - Column 8, line 3}, the features of a Control Panel (See Column 8, line 64 - Column 9, line 18}, the use of a Head-Mounted Display {See Column 9, lines 19 - 32}, the use of the invention for training {See Column 9, lines 33 - 63}, and **The Database** {See Column 9, line 64 - Column 10, line 50.}

The Examiner cites Figures 1 - 7 in Margolin '724. These constitute all the figures in Margolin '724.

The Examiner also cites the Abstract in Margolin '724. According to **608.01(b) Abstract of the Disclosure [R-7]:**

> **37 CFR 1.72 Title and abstract.**
>
> *****
>
> (b) A brief abstract of the technical disclosure in the specification must commence on a separate sheet, preferably following the claims, under the heading "Abstract" or "Abstract of the Disclosure." The sheet or sheets presenting the abstract may not include other parts of the application or other material. The abstract in an application filed under 35 U.S.C. 111 may not exceed 150 words in length. <u>The purpose of the abstract is to enable the United States Patent and Trademark Office and the public generally to determine quickly from a cursory inspection the nature and gist of the technical disclosure.</u><

{Emphasis added}

The popular interpretation of 608.01(b) is that the purpose of the Abstract is to provide search terms. In any event, the Abstract in Margolin '724 does not say anything about civilian airspace.

The Examiner has made a conclusory statement by repeating the title of Applicant's invention (leaving out the words "and method") and citing the core of the DETAILED DESCRIPTION in Margolin '724.

In the remaining sections of the Examiner's rejection of Applicant's Claim 8 he asserts that he has found the elements and limitations of Applicant's invention.

(a) using a remote pilot to fly said unmanned aerial vehicle using synthetic vision during at least selected phases of the flight of said unmanned aerial vehicle, and during those phases of the flight of said unmanned aerial vehicle when said synthetic vision system is not used to control said unmanned aerial vehicle an autonomous control system is used to fly said unmanned aerial vehicle;

(b) providing a system onboard said unmanned aerial vehicle for detecting the presence and position of nearby aircraft and communicating this information to said remote pilot;

whereas said selected phases of the flight of said unmanned aerial vehicle comprise:

(a) when said unmanned aerial vehicle is within a selected range of an airport or other designated location and is below a first specified altitude;

(b) when said unmanned aerial vehicle is outside said selected range of an airport or other designated location and is below a second specified altitude.

The Examiner has not even attempted to show where these limitations are taught in Margolin '724. He has particularly failed to show where the following is taught:

(a) using a remote pilot to fly said unmanned aerial vehicle using synthetic vision during at least selected phases of the flight of said unmanned aerial vehicle, and during those phases of the flight of said unmanned aerial vehicle when said synthetic vision system is not used to control said unmanned aerial vehicle an autonomous control system is used to fly said unmanned aerial vehicle;

and

whereas said selected phases of the flight of said unmanned aerial vehicle comprise:

(a) when said unmanned aerial vehicle is within a selected range of an airport or other designated location and is below a first specified altitude;

(b) when said unmanned aerial vehicle is outside said selected range of an airport or other designated location and is below a second specified altitude.

As noted, he has cited the core of the Margolin '724 DETAILED DESCRIPTION, all of the drawings, and the abstract. His rejection is purely conclusory and does not follow the requirements for making a *prima facie* rejection required by MPEP § 2143.03 **All Claim Limitations Must Be Considered**, *KSR*, and *Wehling*, as well as MPEP § 2142 **ESTABLISHING A PRIMA FACIE CASE OF OBVIOUSNESS.**

The Examiner continues:

Margolin did not disclose that the vehicle is flown using an autonomous control system. However, Duggan teach of a system for safely flying an unmanned aerial vehicle in civilian airspace comprising:

a ground station controlling an unmanned aerial vehicle (sec. 0352, 00353), wherein during phases of a flight of an unmanned aerial vehicle (UAV, sec 0318, 0322, 0353) when a synthetic vision (sec. 0356, 0365, 0388, 0390) is not used to control said unmanned aerial vehicle said unmanned aerial vehicle is flown using an autonomous control system (autopilot, sec 0346 to 0350, 0390-0329).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Margolin as taught by Duggan for the purpose of incorporating an autopilot to ensure smooth transitions (Duggna abstract, sec 0014, 0085, 0086).

The different embodiments in both prior arts are combinable as it would be obvious to ne having ordinary skill in the art.

Examiner	**Duggan**
Margolin did not disclose that the	[0352] In one aspect of the present invention, an operator

vehicle is flown using an autonomous control system. However, Duggan teach of a system for safely flying an unmanned aerial vehicle in civilian airspace comprising: a ground station controlling an unmanned aerial vehicle (sec. 0352,	station (also referred to as the ground control station or GCS) is designed to accommodate command and control of multiple vehicles or a single vehicle by a single operator. In accordance with one embodiment, the ground control station is platform independent and implements an application program interface that provides windowing and communications interfaces (e.g., the platform is implemented in Open Source wxWindows API). The underlying operating system is illustratively masked and enables a developer to code in a high level environment.
00353),	[0353] In one embodiment, the ground control station incorporates several specialized user interface concepts designed to effectively support a single operator tasked to control multiple vehicles. The GCS also illustratively supports manual control and sensor steering modes. In the manual control mode, the operator can assume control authority of the vehicles individually from the ground control station at any time in flight. In the sensor steering mode, a vehicle will autonomously fly in the direction the operator is manually pointing the on-board imaging sensor (e.g., operator views video output from a digital camera on a TV interface, computer screen display, etc.). A custom data link is illustratively, utilized to support a two-way transfer of data between the ground control station and the UAV's. These design concepts together provide a flexible, multiple vehicle control system. The details of the concepts are discussed below.
wherein during phases of a flight of an unmanned aerial vehicle (UAV, sec 0318,	[0318] If the pilot chooses a surveillance location outside the total FOV, then the outer loop guidance will illustratively

	follow a command-to-LOS mode guide law until the UAV flight path points toward the target. Once the desired staring-point comes within a minimum range threshold, the guidance automatically trips into a loiter pattern (either constant-radius or elliptical) to maintain a station with a single key-click while he/she conducts other activities. FIGS. 22A & 22B together demonstrate the surveillance-point approach scenario.
0322,	[0322] In accordance with one aspect of the present invention, sensor-slave mode commands are generated by an autonomous line-of-sight driven function, in which the command objectives are generated by the necessities of the function rather than by an operator. For example, a function designed to command a raster-scan of a particular surveillance area, or a function designed to scan a long a roadway could be used to generate sensor slave commands. Another example is a function designed to generate line-of-sight commands for UAV-to-UAV rendezvous formation flying.
0353)	[0353] In one embodiment, the ground control station incorporates several specialized user interface concepts designed to effectively support a single operator tasked to control multiple vehicles. The GCS also illustratively supports manual control and sensor steering modes. In the manual control mode, the operator can assume control authority of the vehicles individually from the ground control station at any time in flight. In the sensor steering mode, a vehicle will autonomously fly in the direction the operator is manually pointing the on-board imaging sensor (e.g., operator views video output from a digital camera on a TV interface, computer screen display, etc.). A custom data link is

	illustratively, utilized to support a two-way transfer of data between the ground control station and the UAV's. These design concepts together provide a flexible, multiple vehicle control system. The details of the concepts are discussed below.
when a synthetic vision (sec. 0356,	[0356] a synthetic vision display
0365,	[0365] The two video monitors are illustratively used to display real-time data linked camera imagery from two air vehicles having cameras (of course, fewer, more or none of the vehicles might have cameras and the number of monitor displays can be altered accordingly). In accordance with one embodiment, camera imagery is recorded on videotapes during a mission. In accordance with one embodiment, the two repeater displays are used to provide redundant views of the GUI and synthetic vision display. The laptop illustratively serves as a GUI backup in the event that the main GUI fails.
0388,	[0388] In one aspect of the present invention, synthetic vision display technical approach of the present invention is based upon integrating advanced simulated visuals, originally developed for training purposes, into UAV operational systems. In accordance with one embodiment, the simulated visuals are integrated with data derived from the ground control station during flight to enable real-time synthetic visuals.
0390) is not used to control said unmanned aerial vehicle said unmanned aerial vehicle is flown	[0390] In one aspect of the present invention, through GUI display 2622, an operator can maintain a variable level of control over a UAV, from fully manual to fully autonomous,

using an autonomous control system	with simple user-friendly inputs. For example, if an operator decides to divert a UAV to a new route, the operator has a plurality of options to select from. The following are examples of some of the options that an operator has. Those skilled in the art should recognize that this is not an exhaustive list. In one embodiment, the operator could graphically edit the existing route on mission situation display 2629 by adding a waypoint or orbit pattern in the vicinity of a desired target region. Prior to accepting the edited route, the control system evaluates the revised route against the vehicle performance capability as well as terrain obstructions. If the route is within acceptable bounds, the control system registers the modified route and maneuvers the vehicle accordingly. In another embodiment, the operator could select a park mode on selections pane 2630. After selected, the control system queues the operator to click the location of and graphical size (via a mouse) the desired orbit pattern in which the vehicle will fly while "parked" over a desired target. In another embodiment, the operator can select a manual control mode on selections pane 2630. By selecting RDC (remote directional command), for example, the control system controls the UAV into a constant altitude, heading and speed flight until the operator instructs a maneuver. While in RDC mode, the operator can either pseudo-manually direct the UAV using the control stick (e.g. joystick) or the operator can program a fixed heading, altitude and speed using the control options provided in selections pane 2630.
(autopilot, sec 0346 to 0350,	[0346] In accordance with one embodiment, an exemplary translation layer implementation will now be provided. After the guidance algorithms execute, the outputs are translated to

	the native vehicle autopilot commands. The equations below provide example kinematic translations from the guidance acceleration commands to native vehicle autopilot commands. These equations demonstrate the principal that vehicle motion is activated through acceleration. The methods that various vehicles employ to generate acceleration are numerous (bank angle autopilot, acceleration autopilot, heading control autopilot, altitude control autopilot, etc). Since the control algorithms described herein generate acceleration commands that can be kinematically translated into any of these native autopilot commands, the guidance algorithms truly provide a generalized library of control laws that can control any vehicle through that vehicle's native atomic functions. Ubiquitous acceleration control techniques enable VACS to synthesize control commands for any vehicle, including air, ground, or sea-based. 35 a v = vertical plane acceleration command a h = horizontal plane acceleration command = tan - 1 (a h a v) = bank angle command a T = a v 2 + a h 2 = total body acceleration command . = a h V = turn rate command i = i - 1 + . t = heading command . = (a v - g) V = flight path rate command i = i - 1 + . t = flight path angle command h . = V sin ( ) = climb rate command h i = h i = 1 + h . t = altitude command Eq . 57 [0347] Additional functionality that can be enabled in a translation layer is means for discouraging or preventing an operator (e.g., the human or non-human operator interfacing the VACS architecture) from overdriving, stalling, or spinning the vehicle frame. This being said, limiting algorithms can also be employed in the guidance or autopilot functions.

	[0348] X. Autopilot [0349] As has been addressed, the present invention is not limited to, and does not require, a particular autopilot system. The control system and architecture embodiments of the present invention can be adapted to accommodate virtually any autopilot system. [0350] For the purpose of providing an example, an illustrative suitable autopilot software system will now be described. The illustrative autopilot system incorporates a three-axis design (pitch and yaw with an attitude control loop in the roll axis) for vehicle stabilization and guidance command tracking. The autopilot software design incorporates flight control techniques, which allow vehicle control algorithms to dynamically adjust airframe stabilization parameters in real-time during flight. The flight computer is programmed directly with the airframe physical properties, so that it can automatically adjust its settings with changes in airframe configuration, aerodynamic properties, and/or flight state. This provides for a simple and versatile design, and possesses the critical flexibility needed when adjustments to the airframe configuration become necessary. The three-loop design includes angular rate feedback for stability augmentation, attitude feedback for closed-loop stiffness, and acceleration feedback for command tracking. In addition, an integral controller in the forward loop illustratively provides enhanced command tracking, low frequency disturbance rejection and an automatic trim capability.
0390-0329).	{The Examiner may have meant 0390-0392. Otherwise the

	range is not credible} [0390] In one aspect of the present invention, through GUI display 2622, an operator can maintain a variable level of control over a UAV, from fully manual to fully autonomous, with simple user-friendly inputs. For example, if an operator decides to divert a UAV to a new route, the operator has a plurality of options to select from. The following are examples of some of the options that an operator has. Those skilled in the art should recognize that this is not an exhaustive list. In one embodiment, the operator could graphically edit the existing route on mission situation display 2629 by adding a waypoint or orbit pattern in the vicinity of a desired target region. Prior to accepting the edited route, the control system evaluates the revised route against the vehicle performance capability as well as terrain obstructions. If the route is within acceptable bounds, the control system registers the modified route and maneuvers the vehicle accordingly. In another embodiment, the operator could select a park mode on selections pane 2630. After selected, the control system queues the operator to click the location of and graphical size (via a mouse) the desired orbit pattern in which the vehicle will fly while "parked" over a desired target. In another embodiment, the operator can select a manual control mode on selections pane 2630. By selecting RDC (remote directional command), for example, the control system controls the UAV into a constant altitude, heading and speed flight until the operator instructs a maneuver. While in RDC mode, the operator can either pseudo-manually direct the UAV using the control stick (e.g. joystick) or the operator can program a fixed heading, altitude and speed using the control options provided in selections pane 2630.

	[0391] The described Intelligent displays with smart variables represent an effective approach to actively displaying information for different types of vehicles. However, a problem can arise when a new vehicle is integrated into the ground control station with a completely foreign command and control interface. Under these circumstances, the ground control station is not concerned about displaying data, but is tasked to provide a command and control interface for the operator to perform the required operations. This conundrum is the motivation for another embodiment of the present invention, namely, the integration of vehicle specific panels in the ground control station. [0392] In one embodiment, a generic vehicle class (GVC) is illustratively a software component that provides a rapid development environment API to add new vehicle classes and types to the ground control station. The GVC also illustratively serves as a software construct that allows the inclusion of multiple vehicles within the ground control station framework. One of the variables in the application is a vector of pointers to a generic vehicle class. This list is constructed by allocating new specific vehicles and returning a type case to the base generic vehicle class. When a new vehicle is integrated into the ground control station, the generic vehicle class provides all of the virtual functions to integrate with system control components (e.g., to integrate with a map display, a communications package, PCIG imagery and/or appropriate display windows). An important object in the application framework is illustratively a pointer to the current vehicle generic class. When the user switches vehicles, this pointer is updated and all displays grab the

	appropriate smart variables from the pointer to the new base class. This is the mechanism by which windows immediately update to the current vehicle information whenever the user switches vehicles. The default windows use the pointer to the current vehicle to grab information. In this manner, if the user switches to a new vehicle with a different set of datalink variables, that fact is immediately apparent on the display windows.
Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Margolin as taught by Duggan for the purpose of incorporating an autopilot to ensure smooth transitions (Duggna abstract, sec 0014, 0085, 0086).	**Abstract** Embodiments are disclosed for a vehicle control system and related sub-components that together provide an operator with
The different embodiments in both prior arts are combinable as it would be obvious to ne[sic] having ordinary skill in the art.	a plurality of specific modes of operation, wherein various modes of operation incorporate different levels of autonomous control. Through a control user interface, an operator can move between certain modes of control even after vehicle deployment. Specialized autopilot system components and methods are employed to ensure smooth transitions between control modes. Empowered by the multi-modal control system, an operator can even manage multiple vehicles simultaneously.
	[0014] Embodiments of the present invention pertain to a hierarchical control system, user interface system, and control architecture that together incorporate a broad range of user-

	selectable control modes representing variable levels of autonomy and vehicle control functionality. A unified autopilot is provided to process available modes and mode transitions. An intelligence synthesizer is illustratively provided to assist in resolving functional conflicts and transitioning between control modes, although certain resolutions and transitions can be incorporated directly into the functional sub-components associated with the different control modes. In accordance with one embodiment, all modes and transitions are funneled through an acceleration-based autopilot system. Accordingly, control commands and transitions are generally reduced to an acceleration vector to be processed by a centralized autopilot system. [0085] As will be discussed in greater detail below, the control system and architecture embodiments of the present invention essentially enable any autopilot design to support control of a vehicle in numerous control modes that are executed with switches between modes during flight. All control modes are supported even in the presence of sensor errors, such as accelerometer and gyro biases. This robustness is at least partially attributable to the fact that the closed-loop system, in all control modes, is essentially slaved to an inertial path and, hence, the sensor biases wash out in the closed loop, assuming the biases are not so grossly large that they induce stability problems in the autopilot system. Furthermore, winds are generally not an issue in the overall control scheme in that the flight control system will regulate to the inertial path, adjusting for winds automatically in the closed loop. Given the precision afforded by inertial navigation aided by GPS technology, inertial path regulation offers a highly effective

	and robust UAV control approach. Generally speaking, the autopilot system functions such that winds, medium Dryden turbulence levels, sensor errors, airframe aerodynamic and mass model parameter uncertainties, servo non-linearity (slew rate limits, etc.), and various other atmospheric and noise disturbances will non have a critically negative impact on flight path regulation. [0086] Component 408 receives commands generated by component 404 and filtered by autopilot component 406. The commands received by component 408 are executed to actually manipulate the vehicle's control surfaces. Autopilot component 406 then continues to monitor vehicle stabilization and/or command tracking, making additional commands to component 408 as necessary.

At the beginning of this subsection, the Examiner asserts, “Margolin did not disclose that the vehicle is flown using an autonomous control system. However, Duggan teach of a system for safely flying an unmanned aerial vehicle in civilian airspace comprising: …”

The Examiner’s statement, “However, Duggan teach of a system for safely flying an unmanned aerial vehicle in civilian airspace comprising: …” is conclusory and is not supported by the Examiner’s citations to Duggan.

In addition, none of the Duggan citations teach the limitations in Applicant’s Claim 12 that either synthetic vision or Duggan’s Variable Autonomy System comprises the step of:

(a) using a remote pilot to fly said unmanned aerial vehicle using synthetic vision during at least selected phases of the flight of said unmanned aerial vehicle, and during those phases of the flight of said unmanned aerial vehicle when said synthetic vision system is not used to control said unmanned aerial vehicle an autonomous control system is used to fly said unmanned aerial vehicle;

and

whereas said selected phases of the flight of said unmanned aerial vehicle comprise:

(a) when said unmanned aerial vehicle is within a selected range of an airport or other designated location and is below a first specified altitude;

(b) when said unmanned aerial vehicle is outside said selected range of an airport or other designated location and is below a second specified altitude.

Duggan fails to teach the limitation that his Variable Autonomy System is used during selected phases of a UAV's flight and Margolin '724 fails to teach the limitation that synthetic vision is used during selected phases of a UAV's flight. Therefore, the combination of Duggan and Margolin '724 does not read on Applicant's Claim 12.

As cited above by Applicant, MPEP 2143.03 "**All Claim Limitations must be Considered**" states: "all words in a claim must be considered in judging the patentability of that claim against the prior art." *In re Wilson*, 424 F.2d 1382, 1385, 165 USPQ 494, 496 (CCPA 1970)."

The Examiner has failed his duty under MPEP 2143.03 (and in view of *Wehling*) to present a *prima facie* case of obviousness for rejecting Applicant's Claim 12.

<u>Examiner's Regarding Claim 13</u>, a claim dependent on Claim 12. Applicant has shown that Claim 12 is nonobvious. Therefore, under **2143.03 All Claim Limitations Must Be Considered**, Claim 13 is non-obvious.

> **2143.03 All Claim Limitations Must Be **>Considered< [R-6]**
>
> ** "All words in a claim must be considered in judging the patentability of that claim against the prior art." *In re Wilson*, 424 F.2d 1382, 1385, 165 USPQ 494, 496 (CCPA 1970). If an independent claim is nonobvious under 35 U.S.C. 103, then any claim depending therefrom is nonobvious. *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988).

<u>Examiner's Regarding Claim 14</u>, a claim dependent on Claim 12. Applicant has shown that Claim 12 is nonobvious. Therefore, under **2143.03 All Claim Limitations Must Be Considered**, Claim 14 is non-obvious.

> **2143.03 All Claim Limitations Must Be **>Considered< [R-6]**

** "All words in a claim must be considered in judging the patentability of that claim against the prior art." *In re Wilson*, 424 F.2d 1382, 1385, 165 USPQ 494, 496 (CCPA 1970). If an independent claim is nonobvious under 35 U.S.C. 103, then any claim depending therefrom is nonobvious. *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988).

Part B - The Present Applicant is the named inventor on 5,904,724.

The present Applicant (Jed Margolin) is the named inventor on U.S. Patent 5,904,724. See the attached DECLARATION OF JED MARGOLIN. The Examiner is barred from citing '724 as prior art in a 35 U.S.C. §103 rejection. *See ISCO INTERN v. Conductus*, Inc, 279 F.Supp.2d 489 (D.Del. 2003) Footnote 4:

[4] Although § 102 relates to prior invention by another, anticipation, and abandonment, its standard for determining prior art is applied to the § 103 obviousness inquiry as well. *See, e.g., Panduit Corp. v. Dennison Mfg. Co.,* 810 F.2d 1561, 1568 (Fed.Cir.1987), *cert. denied,* 481 U.S. 1052, 107 S.Ct. 2187, 95 L.Ed.2d 843 (1987) ("Before answering *Graham's* `content' inquiry, it must be known whether a patent or publication is in the prior art under 35 U.S.C. § 102.") (citing *Graham v. John Deere Co.,* 383 U.S. 1, 86 S.Ct. 684, 15 L.Ed.2d 545 (1966)); *Ex parte Andresen,* 212 U.S.P.Q. 100, 102 (Pat.& Tr. Office Bd.App. 1981) (citing congressional committee record and commentary and concluding that Congress intended § 103 to "includ[e] all of the various bars to a patent as set forth in section 102").

As MPEP 2129 explains, "However, even if labeled as "prior art," the work of the same inventive entity may not be considered prior art against the claims unless it falls under one of the statutory categories."

2129 Admissions as Prior Art [R-6]

I. ADMISSIONS BY APPLICANT CONSTI-TUTE PRIOR ART

A statement by an applicant >in the specification or made< during prosecution identifying the work of another as "prior art" is an admission **>which can be relied upon for both anticipation and obviousness determinations, regardless of whether the admitted prior art would otherwise qualify as prior art under the statutory categories of 35 U.S.C. 102. *Riverwood Int'l Corp. v. R.A. Jones & Co.*, 324 F.3d 1346, 1354, 66 USPQ2d 1331, 1337 (Fed. Cir. 2003); *Constant v. Advanced Micro-Devices Inc.*, 848 F.2d 1560, 1570, 7 USPQ2d 1057, 1063 (Fed. Cir. 1988).< However, even if labeled as "prior art," the <u>work of the same inventive entity</u> may not be considered prior art against the claims unless it falls under one of the statutory categories. *Id.*; see also *Reading & Bates Construction Co. v. Baker Energy Resources Corp.*, 748 F.2d 645, 650, 223 USPQ 1168, 1172 (Fed. Cir. 1984) ("[W]here the inventor continues to improve upon his own work product, his foundational work product should not, without a statutory basis, be treated as prior art solely because he admits knowledge of his own work. It is common sense that an inventor, regardless of an admission, has knowledge of his own work.").

Consequently, the examiner must determine whether the subject matter identified as "prior art" is applicant's own work, or the work of another. In the absence of another credible explanation, examiners should treat such subject matter as the work of another.

<u>Part D - Applicant's invention meets a long felt but unmet need.</u>

According to the article **NASA Plans UAS Push** (Exhibit 1 at 81):

NASA is seeking industry feedback on its plans for a new five-year, $150-million program to help integrate unmanned aircraft into civil airspace. The feedback is likely to be mixed, as the agency's last major unmanned aircraft research program was canceled before it got off the ground, despite industry backing.

Briefed to industry experts in early August, the Unmanned Air Systems (UAS) Integration in the National Airspace System (NAS) project is planned to begin in Fiscal 2011. It would be NASAs first major unmanned aircraft effort since the High-Altitude Long-Endurance Remotely Operated Aircraft (HALE ROA) project was killed in 2005.

The new program would focus on separation assurance and collision avoidance, pilot-aircraft interface, certification requirements and communications, involving a series of increasingly complex flight demonstrations. The main goal is to generate data to help the FAA and

> standards organizations develop guidelines and regulations for the design and operation of UASs in the NAS. The research is expected to have an impact in the 2015-25 timeframe.

Applicant's invention solves a long-felt unmet need to safely fly UAVs in civilian airspace. (See MPEP 716.04 **Long-Felt Need and Failure of Others.**) Otherwise it would not be necessary for NASA to set up "a new five-year, $150-million program to help integrate unmanned aircraft into civilian airspace."

Part E - The Duggan Application.

The Examiner's choice of Duggan Patent Application US 2005004723 as a reference is interesting. By a coincidence Applicant ("Margolin") discovered the Duggan Application not long after the USPTO published it.

Margolin analyzed the Dugan claims and found some deficiencies. For example, Duggan Claim 1:

> 1. A computer-implemented method for providing an operator of a vehicle with a plurality of control modes, wherein the system is configured to support transitioning between control modes during operation of the vehicle, the method comprising: receiving a first operator input that corresponds to a first control mode; generating a first directional representation of the first operator input; processing the first directional representation through a unified autopilot system so as to generate a first control output; mechanically adjusting a control component associated with the vehicle based on the first control output; receiving a second operator input that corresponds to a request to transition from the first control mode to a second control mode; transitioning from the first control mode to the second control mode; receiving a third operator input that corresponds to the second control mode; generating a second directional representation of the third operator input; processing the second directional representation through the unified autopilot system so as to generate a second control output; and mechanically adjusting a control component associated with the vehicle based on the second control output.

{Emphasis added}

This claims a method where the operator of a vehicle is able to select two or more control modes and the system transitions between them. The claim does not say how the system transitions between them other than that the autopilot does it. The term "directional representation" does not appear in the Specification. What is the "directional representation" of an operator input? Common English usage suggests that it is the line or course along which the operator moves the joystick or mouse. Also, by definition an autopilot mechanically adjusts control components so this part of the claim is redundant.

Duggan's Dependent claim 2 is redundant. Duggan's Claim 1 already specifies the use of a unified autopilot.

> 2. The method of claim 1, wherein said transitioning comprises processing a transition command through the unified autopilot system.

Duggan Dependent claim 3:

> 3. The method of claim 1, wherein generating a first directional representation comprises generating a first set of acceleration and bank angle commands.

Finally, something real. A directional representation can be a set of acceleration and bank angle commands. What else can a "directional representation" be? Duggan does not teach it, so Claim 1 is indistinct.

Even so, this may have already been done. For example see U.S. Patent 4,155,525 **Maneuver detector circuit for use in autothrottle control systems having thrust and flight path control decoupling** issued May 22, 1979 to Peter-Contesse (assigned to Boeing). From Column 1, lines 15-28:

> It is an object of this invention to provide a flight control system having thrust and flight path control decoupling utilizing maneuver detector and limited integrator circuit means in lieu of the aforementioned time-constant programmer circuit means.
>
> It is yet another object of this invention to provide circuit means responsive to elevator, normal acceleration, and pitch attitude signals for providing a signal having a first predetermined polarity when a purposeful maneuver of the aircraft is effected and a further signal having a polarity opposite to said first predetermined polarity when a non-maneuver is indicated, a

> purposeful maneuver being defined as one initiated by the pilot as contrasted to non-pilot initiated aircraft maneuvers.

There is also U.S. Patent 6,062,513 **Total energy based flight control system** issued May 16, 2000 to Lambregts (also assigned to Boeing). From Column 6, line 65 - Column 7, line 14:

> The present invention modifies the known TEC system by using an alternate control strategy and flight path command .gamma..sub.C processing scheme. This alternate strategy is used during manual control mode (using a control column or the like) when the thrust has been driven to a preset value (such as a maximum or minimum thrust limit) or when the automatic throttle is disengaged. Under these circumstances, instead of reverting to a pure path priority scheme for stick or control column inputs (by opening switch 30 and letting the airspeed increase or decreases until a speed limit is reached as is done in the known TEC system), the present invention transitions to a combined speed and path priority scheme, where flight path angle is the short term control priority and the set speed command is the long term priority. In this scheme, switch 30' remains closed and the normal speed control feedback is continued after thrust reaches a limit.

Duggan Claim 31:

> 31. A multi-modal variable autonomy control system, the system comprising:
>
> a plurality of control mode components each corresponding to a different mode of control and being configured to respond to command inputs by generating directionally descriptive control commands; and
>
> a unified autopilot component for processing said directionally descriptive control commands.
>
> an vehicle control component for receiving processed commands from the unified autopilot system and actuating control devices accordingly.

This claim contains inexcusable punctuation errors. These errors were not introduced by the Patent Office; they are in the Application in the File Wrapper. See Exhibit 2 at 83.

Margolin gave his analysis to Optima Technology, Inc. (now Optima Technology Group) who was then acting as Margolin's agent for selling or licensing his patents. Optima contacted Geneva Aerospace, the assignee of the Duggan application.

Geneva responded by filing a Supplemental IDS listing all of Margolin's patents (even though only 5,566,073 and 5,904,724 were relevant), U.S. Patents 4,155,525 and 6,062,513, along with some of the non-patent literature that Margolin had presented, such as:

Beringer, D.; **Applying Performance-Controlled Systems, Fuzzy Logic, and Fly-By-Wire Controls to General Aviation**, Office of Aerospace Medicine, May 2002.

Abernathy, M.; "**Virtual Cockpit Window" for a Windowless Aerospacecraft.** http://www.nasatech.com/Briefs/Jan03/MSC23096.html Jan. 2003.

See Exhibit 2 at 84-88.

Geneva also licensed Margolin Patents 5,566,073 and 5,904,724. See Exhibit 3 at 91.

It came as a complete surprise to Applicant when the Duggan Application was allowed as filed (despite its defects) in the FOAM. Geneva's attorneys may have been surprised as well. They had to ask the Duggan Examiner to correct the punctuation errors in Duggan Claim 31. See Exhibit 2 at 89.

Perhaps the Duggan Examiner was preoccupied with financial problems. See Exhibit 4 at 109. But where were the Second Set of Eyes? Perhaps they were sleeping that day.

Margolin wishes to note that the Examiner in the present case cited the Duggan Application even though it had already issued as U.S. Patent 7,343,232 ('232) **Vehicle control system including related methods and components** on March 11, 2008.

The Duggan Application may have other problems as well. The Duggan Application claims priority from Provisional Application Ser. No. 60/480,192, filed Jun. 20, 2003. According to 35 U.S.C. 102

Conditions for patentability; novelty and loss of right to patent.

A person shall be entitled to a patent unless -

*****

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

There is evidence that this might have occurred. The paper **UCAV Distributed Mission Training Testbed: Lessons Learned and Future Challenges** by Dr. Dutch Guckenberger and Matt Archer; The Interservice/Industry Training, Simulation & Education Conference (I/ITSEC), Volume: 2000 (Conference Theme: Partnerships for Learning in the New Millennium) was presented at the I/ITSEC Conference in 2000. The title page and page 7 are reproduced in Exhibit 5 at 180. On document page 7 (Exhibit 5 at 183), under the heading **Variable Autonomy Control System (VACS)** it refers to Geneva Aerospace's Variable Autonomy Control System:

> As a portion of the DMT UCAV Testbed development, the **Geneva AeroSpace Variable Autonomy Control System (VACS) was added to LiteFlite. The VACS is designed to be effective for UAV and UCAV systems as usable to individuals whose training is focused on the requirements of a given mission or the usability of the payload, rather than on the aviation of the vehicle.** As the dependence on UAVs for military operations grows and UAV technology is integrated into the emerging global command and control architecture, the cost and complexity of managing and controlling these assets can easily become substantial. The VACS solution to this UAV control problem lies in the appropriate functional allocation between the human and the machine. By merging modern stand-off missile flight control, advanced aircraft flight control, and state-of-the-art communications technologies, **Geneva has developed a novel hierarchical flight control structure with varied levels of remote operator input to address the human-machine functional allocation problem.**
>
> **The VACS has been successfully demonstrated enabling a diverse range of users to effectively operate UAVs**. Furthermore, the VACS solution eliminates the requirement for UAVs to be controlled by highly trained, rated pilots. In a continuing development and demonstration effort VACS is to be used Joint STARS MTE workstation and the Freewing Scorpion 100-50 UAV and conduct a flight test demonstration. This program will demonstrate the benefits of the variable autonomy flight control system design with simplified manual control modes, demonstrate the compatibility of such a system with the military s emerging C4I

> architecture, and demonstrate the synergism between Joint STARS and UAVs using the simplified UAV flight control technology.

{Emphasis added}

Geneva Aerospace filed a trademark application with the USPTO on 1/22/2004 for the trademark "Variable Autonomy Control System." See Exhibit 6 at 185. In the application Geneva Aerospace declared, under penalty of perjury:

> The applicant, or the applicant's related company or licensee, is using the mark in commerce, and lists below the dates of use by the applicant, or the applicant's related company, licensee, or predecessor in interest, of the mark on or in connection with the identified goods and/or services. 15 U.S.C. Section 1051(a), as amended.
>
> > International Class 009: computer software for autonomous aerial vehicle guidance and control systems
>
> In International Class 009, the mark was first used at least as early as 09/01/1998, **<u>and first used in commerce at least as early as 09/01/1998</u>**, and is now in use in such commerce. The applicant is submitting or will submit one specimen for each class showing the mark as used in commerce on or in connection with any item in the class of listed goods and/or services, consisting of a(n) Portion of company website describing product.

{Emphasis added}

The mark "Variable Autonomy Control System" is for "computer software for autonomous aerial vehicle guidance and control systems".

Geneva declares that the "Variable Autonomy Control System" was first used in commerce as early as 09/01/1998, which is more than one year prior to the 6/20/2003 filing date of the provisional application.

Is the "Variable Autonomy Control System" in the Duggan '232 patent the same "Variable Autonomy Control System" that Geneva wished to trademark? Their trademark application included a portion of the company website describing the product, which states (Exhibit 6 at 188):

> **Products: Variable Autonomy Control System (VACS)™**
>
> **<u>Under Air Force Research Lab funding</u>** Geneva has developed an innovative UAV control design that combines state-of-the-art missile technologies with fixed-wing aircraft control. Our design balances autonomous flight control **<u>With manual control to provide variable levels of directional independence</u>** and minimizes the personnel and training requirements for the operation of the UAV, The truly enabled UAV operator is not required to be a trained aviator, but still retains a wide range of control flexibility in order to successfully execute the mission objectives that call upon his/her specialized expertise.
>
> **<u>Our solution is a hierarchical flight control structure with multiple levels of remote operator input combined with an off-board controller software package and intuitive human system interface.</u>** Research of the UAV control problem has indicated that the best solution lies in the appropriate functional allocation between the human and the machine, leading to the organization of the control problem between the two fundamental categories: flight governance and flight management.

{Emphasis added}

It sounds like it is.

Therefore, the Duggan '232 patent is invalid for failing to meet the requirements of 35 U.S.C 102.

Note that the Duggan "Variable Autonomy Control System" was developed under Air Force Research Lab funding. That would give the Government certain patent rights in the invention. This is not stated in the Duggan '232 patent.

Geneva also filed an application to trademark "VCAS". They made the same declaration as they did for "Variable Autonomy Control System" and included the same company website page. See Exhibit 7 at 190.

Dave Duggan of Geneva Aerospace and Luis A. Piñeiro of AFRL presented a paper at the 2002 AUVSI Symposium. The paper from the Proceedings is reproduced as Exhibit 8 at 195. From Exhibit 8 at 196, last paragraph under the heading **VACS Overview**:

> Funding for the variable autonomy control concept was provided under the Small Business Innovative Research (SBIR) program Phase I, Phase II, and Phase III funding vehicles through the Air Force Research Laboratory (AFRL) Human Effectiveness and Air Vehicles Integration Directorates (Reference 1).

Reference 1 says:

1. Duggan, David S., "Demonstration of an Integrated Variable Autonomy UAV Flight Control System", Phase II SBIR Final Report, AFRL-HE-WP-TR-2001-0035, January 2001

Applicant has not been able to obtain this reference from DTIC.

However, Duggan/Geneva Aerospace's Provisional Application (Application Number 60/480,192) contains Geneva Aerospace's **Small Business Innovation Research (SBIR) Program Projects Summary**, Topic Number AF98-179 (Exhibit 9 at 211), which shows that Geneva Aerospace had the invention described in '232 in its possession as early as the date the SBIR Project Summary for AF98-179 was submitted. According to the Air Force SBIR Web site at http://www.afsbirsttr.com/TechMall/Default.aspx?kwa=AF98-179 the SBIR Phase I Contract started 5/14/1998, ended 2/14/1999, and the date of the DTIC report is 3/20/2001. See Exhibit 10 at 235.

This suggests that Geneva Aerospace was being truthful in their Trademark Applications, that the products named Variable Autonomy Control Systems and VACS were first used commercially as early as 09/01/1998.

The '232 patent claims priority from Provisional Application 60/480,192 filed June 20, 2003 and incorporates the Provisional Application in its entirety in the '232 patent. See '232 Column 1, lines 6 - 9. However, Provisional Application 60/480,192 was not made available to the public on PAIR until November 22, 2010. See Margolin Declaration § 14. As a result, the public was not able to read the entire '232 patent until November 22, 2010.

The Duggan Provisional Application contains an Information Disclosure Statement (PTO-1449), filed July 29, 2004 listing a number of patent references. See Exhibit 11 at 237. With the exception of U.S. Patent 5,904,724 none of the other patent references are listed on the '232 patent. And, with the exception of 5,904,724 none of the references cited by Duggan in his Provisional Application are marked as having been considered by the Duggan Examiner.

The irregularities surrounding the '232 patent would call for an investigation by the USPTO's Inspector General, but the USPTO does not seem to have an Inspector General.

Section 3.

For the foregoing reasons, Applicant submits that all objections and rejections have been overcome. Applicant requests that the rejection of pending claims 1-14 be withdrawn and that the application be allowed as filed.

Respectfully submitted,

/Jed Margolin/ Date: November 29, 2010
Jed Margolin

Jed Margolin
1981 Empire Rd.
Reno, NV 89521-7430
(775) 847-7845

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of Jed Margolin
Serial No.: 11/736,356 Examiner: Ronnie M. Mancho
Filed: 04/17/2007 Art Unit: 3664
For: SYSTEM AND METHOD FOR SAFELY FLYING UNMANNED AERIAL VEHICLES IN CIVILIAN AIRSPACE

DECLARATION OF JED MARGOLIN

I, Jed Margolin, declare as follows:

1. I am the Applicant in the above patent application.

2. I am the named inventor (Jed Margolin) on U.S. Patent 5,904,724 **Method and apparatus for remotely piloting an aircraft** issued May 18, 1999.

3. Exhibit 1 is a true and accurate reproduction of the article **NASA Plans UAS Push** by Graham Warwick that appeared in Aviation Week & Space Technology, August 16, 2010, page 13.

4. Exhibit 2 is a true and accurate reproduction of documents from the image filewrapper for the Duggan Application 10/871,612 that I downloaded from the USPTO's PAIR Web site on or about November 1, 2010.

5. Exhibit 3 is a true and accurate reproduction of the License Agreement between Geneva Aerospace, Optima Technology, Inc., and myself. I have redacted financial information as per Federal Rules of Civil Procedure Rule 5.2. I have also redacted other sensitive information. (Note that Optima Technology, Inc. subsequently changed their name to Optima Technology Group.)

6. Exhibit 4 is a true and accurate reproduction of public documents that I downloaded from the Palm Beach County, Florida Web site at http://oris.co.palm-beach.fl.us/or_web1/or_sch_1.asp between approximately August 30, 2010 and September 13, 2010.

7. Exhibit 5 is a true and accurate reproduction of the Web page that I downloaded from http://ntsa.metapress.com/link.asp?id=4mrrc0aupmjpf8e6 on or about November 16, 2010, showing the availability of the paper **Lessons Learned and Future Challenges** by Dr. Dutch Guckenberger and Matt Archer presented at the 2000 Interservice/Industry Training, Simulation & Education Conference (I/ITSEC), and part of Volume: 2000 (Conference Theme: Partnerships for Learning in the New Millennium, followed by the title page and the seventh page from the paper that I purchased from Meta Press on or about November 16, 2010.

8. Exhibit 6 is a true and accurate reproduction of documents filed by Geneva Aerospace in Trademark Application, Serial Number 78355947 for "Variable Autonomy Control System" that I downloaded from the USPTO Trademark Document Retrieval (TDR) Web site at http://tmportal.uspto.gov/external/portal/tow on or about November 17, 2010.

9. Exhibit 7 is a true and accurate reproduction of documents filed by Geneva Aerospace in Trademark Application, Serial Number 78355939 for "VACS" that I downloaded from the USPTO Trademark Document Retrieval (TDR) Web site at http://tmportal.uspto.gov/external/portal/tow on or about November 17, 2010.

10. Exhibit 8 is a true and accurate reproduction of the paper **Development and Testing of a Variable Autonomy Control System (VACS) for UAVs** by Dave Duggan of Geneva Aerospace and Luis A. Piñeiro of AFRL contained in the Proceedings AUVSI Symposium, 2002, that was given to me by AUVSI (Association of Unmanned Vehicles International) on November 18, 2010.

11. Exhibit 9 is a true and accurate reproduction of the document contained in Geneva Aerospace Provisional Application 60/480,192 **Small Business Innovation Research (SBIR) Program Projects Summary, Topic Number AF98-179**, that I downloaded from PAIR on November 22, 2010.

12. Exhibit 10 is a true and accurate reproduction of the Web page containing Geneva Phase I Contract information for AF98-179 that I downloaded from the Air Force SBIR Web site at http://www.afsbirsttr.com/TechMall/Default.aspx?kwa=AF98-179 on November 26, 2010.

13. Exhibit 11 is a true and accurate reproduction of the Information Disclosure Statement in the Duggan Provisional Application 60/480,192 that I downloaded from PAIR on November 22, 2010.

14. November 22, 2010 was the first day that Provisional Application 60/480,192 became available to the public on PAIR. Provisional Application 60/480,192 became available to the public on PAIR only as a result of my telephone conversations with Mr. Don Levin (Director of SEARCH AND INFORMATION RESOURCES ADMINISTRATION) and Mr. Richard Fernandez (of that same office) the previous week.

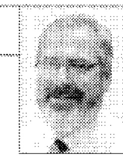
I hereby declare under the penalty of perjury that the foregoing is true and correct to the best of my knowledge and belief.

Dated: November 29, 2010

Jed Margolin

Jed Margolin

<u>Exhibit 1</u> – AWST Article **NASA Plans UAS Push**



BY GRAHAM WARWICK

Senior Editor-Technology
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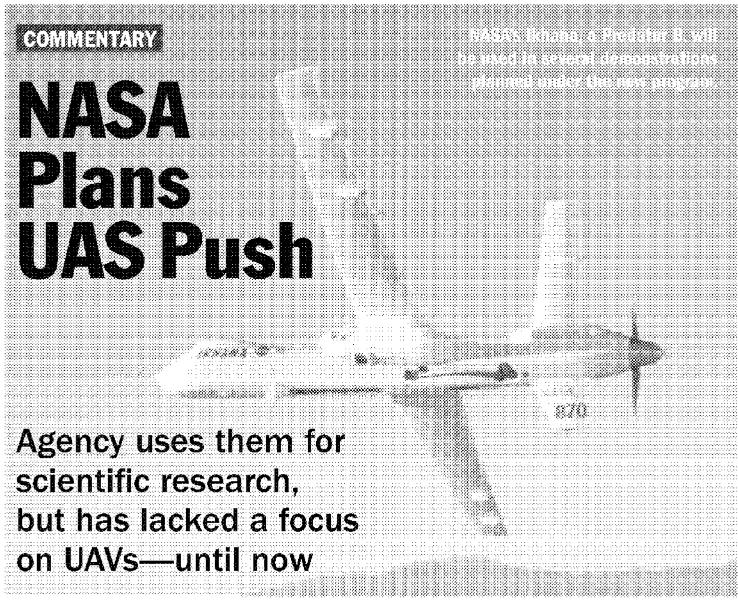
warwick@aviationweek.com



COMMENTARY

NASA Plans UAS Push

Agency uses them for scientific research, but has lacked a focus on UAVs—until now

NASA's Ikhana, a Predator B, will be used in several demonstrations planned under the new program.

NASA/JIM ROSS

NASA is seeking industry feedback on its plans for a new five-year, $150-million program to help integrate unmanned aircraft into civil airspace. The feedback is likely to be mixed, as the agency's last major unmanned aircraft research program was canceled before it got off the ground, despite industry backing.

Briefed to industry experts in early August, the Unmanned Air Systems (UAS) Integration in the National Airspace System (NAS) project is planned to begin in Fiscal 2011. It would be NASA's first major unmanned aircraft effort since the High-Altitude Long-Endurance Remotely Operated Aircraft (HALE ROA) project was killed in 2005.

The new program would focus on separation assurance and collision avoidance, pilot-aircraft interface, certification requirements and communications, involving a series of increasingly complex flight demonstrations. The main goal is to generate data to help the FAA and standards organizations develop guidelines and regulations for the design and operation of UASs in the NAS. The research is expected to have an impact in the 2015-25 timeframe.

NASA has tried to avoid duplication with, and identify gaps in, UAS civil-airspace integration efforts already underway, says Jeff Bauer, project planning lead. "Scope has been the biggest thing we have struggled with—what are the right things to do," he says. The result is a hodge-podge, lacking the singular vision of the HALE ROA project, which was the intended centerpiece of a government-industry plan to enable routine operations by long-endurance UAVs in airspace above 18,000 ft.

Some industry experts believe the new program is too near-term and that NASA should focus on longer-term challenges such as autonomy. Others think the program is "late to need" and that some of the data to be generated are required urgently to support efforts in progress to certify small unmanned aircraft and secure dedicated frequency spectrum for UAS command-and-control links.

NASA did not have free rein in scoping out the program as its direction from Congress and the Obama administration was to coordinate with the FAA and Defense and Homeland Security departments to address operational and safety issues with UAS integration into the NAS while avoiding duplication.

As a result, the separation assurance and collision-avoidance project will focus on real-time trajectory and contingency monitoring to provide an additional layer of safety for air traffic controllers and UAS operators. NASA will also develop mission planning tools to automate contingency procedures after communications or systems failures while minimizing the impact of UAS operations on air transport system capacity and delays.

The pilot-aircraft interface project will develop guidelines for designing or modifying ground control stations to be compliant with NAS requirements. This could involve adding audible, tactile and visual cues, and will culminate in a proof-of-concept demonstration using a Predator B ground station modified for NAS compliance.

Initially, the communications project will support work underway to secure dedicated "safety of flight" spectrum for UAS command-and-control links at the 2012 World Radiocommunication Conference. Subsequently, the project will develop and test prototypes of a data link radio that meets safety, security and scalability requirements.

Finally, NASA plans to provide the FAA with a methodology for developing airworthiness requirements for the certification of UAS. While some argue that manned aircraft certification rules should be the starting point, the agency believes the balance between probability of failure and severity of consequences used to define airworthiness requirements for passenger-carrying aircraft needs to be reassessed for unmanned aircraft. NASA also plans to assess UAS-specific hazards and risks and develop guidance for type design, focusing on the automation aspects.

Exhibit 2 – Duggan Filewrapper Documents

to support transition between the first and second modes of control.

31. A multi-modal variable autonomy control system, the system comprising:

a plurality of control mode components each corresponding to a different mode of control and being configured to respond to command inputs by generating directionally descriptive control commands; and

a unified autopilot component for processing said directionally descriptive control commands.

an vehicle control component for receiving processed commands from the unified autopilot system and actuating control devices accordingly.

32. The system of claim 31, wherein said plurality of control mode components are associated with more than three different modes of control.

33. The system of claim 31, wherein said plurality of control mode components are associated with both autonomous and user-input-based modes of control.

34. The system of claim 31, wherein said plurality of control modes are further configured to respond to

IFW

OIPE IAP74 NOV 21 2005 PATENT & TRADEMARK OFFICE

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First Named Inventor : David S. Duggan et al.	
Appln. No. : 10/871,612	
Filed : June 18, 2004	Group Art Unit: 3661
For : VEHICLE CONTROL SYSTEM INCLUDING RELATED METHODS AND COMPONENTS	Examiner:
Docket No.: G46.12-0001	

SUPPLEMENTAL INFORMATION DISCLOSURE STATEMENT

I HEREBY CERTIFY THAT THIS PAPER IS BEING SENT BY U.S. MAIL, FIRST CLASS, TO THE COMMISSIONER FOR PATENTS, P.O. BOX 1450, ALEXANDRIA, VA 22313-1450, THIS 19th DAY OF November 2005.

PATENT ATTORNEY

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

The patents or publications listed on the enclosed PTO Form-1449 are submitted pursuant to 37 C.F.R. § 1.97. Copies of the foreign references or "other art" references are included.

LIST REFERENCES NOT SUBMITTED

TIME OF FILING

The information disclosure statement is being filed:

1. X 1. Within three months of the filing date of a national application other that a Continued Prosecution Application (CPA);
2. Within three months of the date of entry of the National Stage international application;
3. Before the mailing date of a first Office Action on the merits; or
4. Before the mailing of a first Office Action after the filing of a Request for Continue Examination (RCE).

2. ___ after the time period specified in paragraph 1 above, but before the mailing date of a final action under 37 C.F.R. § 1.113 or notice of allowance under 37 C.F.R. § 1.311. Therefore, in accordance with 37 C.F.R. § 1.97(c), submitted herewith is:

(check either A or B below)

A. ___ a statement as specified in 37 C.F.R. § 1.97(e).

B. ___ the fee set forth in 37 C.F.R. § 1.17(p) for submission of an information disclosure statement under 37 C.F.R. § 1.97(c).

3. ___ after the mailing date of either a final action under 37 C.F.R. § 1.113 or a notice of allowance under 37 C.F.R. § 1.311, whichever occurs first, but before payment of the issue fee. Therefore, Applicant petitions for consideration and submits herewith:

A. a statement as specified in 37 C.F.R. § 1.97(e);

B. the petition fee set forth in 37 C.F.R. § 1.17(p).

STATEMENT

(only used if No. 2(A) or No. 3 above is checked)

The person(s) signing below certify

(check appropriate paragraph)

___ that each item of information contained in this Information Disclosure Statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of this statement. 37 C.F.R. § 1.97(e)(1).

OR

___ that no item of information contained in this Information Disclosure Statement was cited in a communication from a foreign patent office in a counterpart foreign application or, to the knowledge of the person signing the certification after making reasonable inquiry, was known to any individual designated in 37 C.F.R. § 1.56(c) more than three months prior to the filing of this statement. 37 C.F.R. § 1.97(e)(2).

METHOD OF PAYMENT

X No fee is required.

____Attached is a check in the amount of $_____.

The Director is authorized to charge any fee deficiency required by this paper or credit any overpayment to Deposit Account No. 23-1123.

Respectfully submitted,

WESTMAN, CHAMPLIN & KELLY, P.A.

By: ______________________

Christopher L. Holt, Reg. No. 45,844
Suite 1400 - International Centre
900 Second Avenue South
Minneapolis, Minnesota 55402-3319
Phone: (612) 334-3222
Fax: (612) 334-3312

CLH:rkp

Sheet 1 of 1

FORM PTO-1449	Atty. Docket No.: G46.12-0001	Appl. No.: 10/871,612
LIST OF PATENTS AND PUBLICATIONS FOR APPLICANT'S INFORMATION DISCLOSURE STATEMENT	First Named Inventor: David S. Duggan et al.	
	Filing Date: June 18, 2004	Group Art: 3661

U.S. PATENT DOCUMENTS

Examiner Initial		Document No.	Date	Name	Class	Sub Class	Filing Date If Appropriate
	AA	U.S. Patent Pub. No. US 2005-0256938 A1	11/2005	Margolin	709	218	
	AB	5,666,531	09/1997	Martin	395	620	
	AC	5,422,998	06/1995	Margolin	395	166	
	AD	5,553,229	09/1996	Margolin	395	166	
	AE	5,933,156	08/1999	Margolin	345	509	
	AF	5,566,073	10/1996	Margolin	364	449	
	AG	5,904,724	05/1999	Margolin	701	120	
	AH	5,974,423	10/1999	Margolin	707	104	
	AI	6,023,278	02/2000	Margolin	345	419	
	AJ	6,377,436	04/2002	Margolin	361	230	
	AK	6,177,943	01/2001	Margolin	345	419	
	AL	5,978,488	11/1999	Margolin	381	61	

FOREIGN PATENT DOCUMENTS

		Document No.	Date	Country	Class	Sub Class	Translation Yes	No
	AM							

OTHER ART (Including Author, Title, Date, Pertinent Pages, Etc.)

	AN	
	AO	
	AP	

EXAMINER:	DATE CONSIDERED:

EXAMINER: Initial if citation considered, whether or not citation is in conformance with MPEP 609; draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

Sheet 2 of 2

FORM PTO-1449	Atty. Docket No.: G46.12-0001	Appl. No.: 10/871,612
LIST OF PATENTS AND PUBLICATIONS FOR APPLICANT'S INFORMATION DISCLOSURE STATEMENT	First Named Inventor: **David S. Duggan et al.**	
	Filing Date: **June 18, 2004**	Group Art: **3661**

U.S. PATENT DOCUMENTS

Examiner Initial		Document No.	Date	Name	Class	Sub Class	Filing Date If Appropriate
	AQ	6,862,501	03/2005	He	701	3	
	AR	6,062,513	05/2000	Lambregts	244	175	
	AS	4,155,525	05/1979	Peter-Contesse	244	182	
	AT	6,304,819	10/2001	Agnew et al.	701	207	
	AU	6,064,939	05/2000	Nishida et al.	701	120	
	AV	6,498,984	12/2002	Agnew et al.	701	207	
	AW						

FOREIGN PATENT DOCUMENTS

		Document No.	Date	Country	Class	Sub Class	Translation Yes No
	AX						

OTHER ART (Including Author, Title, Date, Pertinent Pages, Etc.)

	AY	RIS Press Releases - http://www.landform.com/pages/PressReleases.htm. 4 pgs.
	AZ	Beringer, D.; "Applying Performance-Controlled Systems, Fuzzy Logic, and Fly-By-Wire Controls to General Aviation Office of Aerospace Medicine, May 2002, pgs. 1-8.
	BA	R. Parrish et al.; "Spatial Awareness Comparisons Between Large-Screen, Integrated Pictorial Displays and Conventional EFIS Displays During Simulated Landing Approaches," NASA Technical Paper 3467, CECOM Technical Report 94-E-1, October 1994, 1-22.
	BB	Office of the Secretary of Defense, Airspace Integration Plan for Unmanned Aviation November 2004.
	BC	Abernathy, M.; "Virtual Cockpit Window" for a Windowless Aerospacecraft. http://www.nasatech.com/Briefs/Jan03/MSC23096.html, Jan. 2003. 2 pgs.

EXAMINER:	DATE CONSIDERED:

EXAMINER: Initial if citation considered, whether or not citation is in conformance with MPEP 609; draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

Interview Summary	Application No.	Applicant(s)	
	10/871,612	DUGGAN ET AL.	
	Examiner	**Art Unit**	
	Gertrude Arthur-Jeanglaude	3661	

All participants (applicant, applicant's representative, PTO personnel):

(1) Gertrude Arthur-Jeanglaude. (3)_____.

(2) Christopher Holt (Reg # 45,844). (4)_____.

Date of Interview: 26 November 2007.

Type: a)☒ Telephonic b)☐ Video Conference
c)☐ Personal [copy given to: 1)☐ applicant 2)☐ applicant's representative]

Exhibit shown or demonstration conducted: d)☐ Yes e)☒ No.
If Yes, brief description: _____.

Claim(s) discussed: 31.

Identification of prior art discussed: none.

Agreement with respect to the claims f)☒ was reached. g)☐ was not reached. h)☐ N/A.

Substance of Interview including description of the general nature of what was agreed to if an agreement was reached, or any other comments: To amned claim 31 to correct typo errors.

(A fuller description, if necessary, and a copy of the amendments which the examiner agreed would render the claims allowable, if available, must be attached. Also, where no copy of the amendments that would render the claims allowable is available, a summary thereof must be attached.)

THE FORMAL WRITTEN REPLY TO THE LAST OFFICE ACTION MUST INCLUDE THE SUBSTANCE OF THE INTERVIEW. (See MPEP Section 713.04). If a reply to the last Office action has already been filed, APPLICANT IS GIVEN A NON-EXTENDABLE PERIOD OF THE LONGER OF ONE MONTH OR THIRTY DAYS FROM THIS INTERVIEW DATE, OR THE MAILING DATE OF THIS INTERVIEW SUMMARY FORM, WHICHEVER IS LATER, TO FILE A STATEMENT OF THE SUBSTANCE OF THE INTERVIEW. See Summary of Record of Interview requirements on reverse side or on attached sheet.

Examiner Note: You must sign this form unless it is an Attachment to a signed Office action.

Examiner's signature, if required

Exhibit 3 – Geneva License Agreement

1

Geneva Aerospace™
At the core of UAV control

Geneva Aerospace, Inc
4240 International Parkway, Suite 100
Carrollton, TX 75007
469-568-2376
Fax 469-568-2101

May 17th, 2006

SAMUELS, GREEN, STEEL & ADAMS, LLP
Mr. Scott Albrecht, Esq.
19800 MacArthur Blvd, Suite 1000
IRVINE, CA, 92612

SUBJECT: RPV NON-EXCLUSIVE LICENSE AGREEMENT

Dear Mr. Albrecht,

I am enclosing two (2) originals of a "RPV NON-EXCLUSIVE LICENSE AGREEMENT". Please, have both copies signed and dated. Retain one executed original for your files and return one executed copy to Mr. Alan Barker at the above address.

Best regards,

Corinne Leroux
Assistant

2

RPV NON-EXCLUSIVE LICENSE AGREEMENT

This Agreement is made this 01day of May, 2006 ("Effective Date") by and between Optima Technology Inc. (hereinafter referred to as "Licensor"), a Delaware corporation, Mr. Jed Margolin (hereinafter referred to as "Inventor"), an individual, both having a place of business at 2222 Michelson Drive, Suite 1830, Irvine, California 92612 USA, and Geneva Aerospace®, Inc., a Texas corporation (hereinafter referred to as "Licensee"), having its principal place of business at 4240 International Parkway, Suite 100, Carrollton, TX 75007, individually referred to as "Party" and collectively as the "Parties."

WITNESSED THAT

WHEREAS, as is demonstrated by the document(s) attached hereto as Exhibit A, Licensor has obtained from Inventor the right to provide a license under certain patents as herein identified; and

WHEREAS, Inventor is the named inventor in one or more of said patents; and

WHEREAS, Licensee desires to obtain, and Licensor is willing to grant Licensee, a non-exclusive license as hereafter defined and under the terms and provisions herein specified.

NOW, THEREFORE, in consideration of the promises and mutual agreements herein contained Licensor, Inventor and Licensee agree as follows:

TERMS

1. DEFINITIONS

1.1 The term "consist" limits and covers only the elements expressly recited. By contrast, the utilization of the terms "include," "such as," and "for example" are not limited and therefore cover more elements than those recited.

1.2 "Affiliate" shall mean any corporation or the like at least fifty percent (50%) of whose voting share capital is owned or directly or indirectly controlled by or under common control with a Party as of the Effective Date of this Agreement or at any time during the term of this Agreement and any other entity over which a Party exercises effective managerial control.

1.3 "Days" shall mean calendar days.

1.4 "RPV" shall mean "remotely piloted vehicle." A "remotely piloted aircraft" is an RPV. "UAV" shall mean "unmanned aerial vehicle." RPV is an older term for UAV. "UCAV" shall mean "Unmanned Combat Aerial Vehicle." UCAV is also sometimes defined as an "Uninhabited Combat Aerial Vehicle." UCAV is a UAV that is intended for use in combat. UCAS means "Unmanned Combat Air System."

1.5 "Synthetic Vision" is the current term for "Synthetic Environment" and is the three dimensional projected image data presented to the pilot or other observer.

1.6 "Patent Portfolio" shall mean the portfolio consisting of United States Patent Numbers 5,904,724 (Method and Apparatus for Remotely Piloting an Aircraft), 5,566,073 (Pilot Aid Using a Synthetic Environment), and those future United States patents that may be added in accordance with the covenants and warranties set forth in Section 8.1.

1.7 "Royalty Products" shall mean only the product identified as Licensee Part Number 606-0069-001 missionTEK Synthetic Image Module described as situational awareness aid for a UAV operator using missionTEK. This Part Number excludes the SDS Acuity IG software package hosted on a rack mount computer. This Part Number interfaces to mission TEK through an Ethernet connection and creates a synthetic image of a UAV that is driven by the current vehicle telemetry stream on the product order form attached hereto as Exhibit B. The other products and options identified in Exhibit B are specifically excluded from the definition of "Royalty Products." It is to be understood that Royalty Products shall include systems or components that are manufactured outside the United States, its territories, or possessions and which can reasonably be expected to be used or sold within the United States, its territories, or possessions and/or including and covering all countries on planet Earth and surrounding planets/systems, so long as those systems or components are also identified in Exhibit B as Licensee Part Number 606-0069-001 missionTEK Synthetic Image Module described as situational awareness aid for a UAV operator using missionTEK. This Part Number excludes the SDS Acuity IG software package hosted on a rack mount computer. This Part Number interfaces to mission TEK through an Ethernet connection and creates a synthetic image of a UAV that is driven by the current vehicle telemetry stream.

1.8 "Sale or Sold" shall mean selling, leasing, or otherwise transferring ownership, possession, or use to another party, of a Royalty Product (except as scrap), either directly or through a chain of distribution, and shall be deemed to have occurred upon invoicing of a Royalty Product to a third party, or if not invoiced, when ownership, possession, or use is transferred to a third party directly or indirectly.

1.9 "Claims" shall mean one or more patent claims identified within the body of a Patent (s).

1.10 "Claims in the Patent Portfolio" shall mean Claims identified within the body of a Patent(s) included in the Patent Portfolio (defined in Section 1.6 of this Agreement).

2. LICENSE GRANT

2.1 Subject to the terms and provisions of this Agreement, and to Licensee making the payments required under Section 4.1, Licensor and Inventor grants to Licensee a royalty bearing non-exclusive, personal, non-transferable, worldwide right and license under the Claims in the Patent Portfolio to test, make, have made, use, import, export, distribute, offer for sale, sell, lease, and/or otherwise dispose of products in, or for, the United States and its territories and possessions, subject to any applicable export laws and regulations of the United States.

2.2 Subject to the terms and provisions of this Agreement, and to Licensee making the payments required under Section 4.1, Licensor and Inventor grants to Licensee the right to extend to its direct and indirect distributors, suppliers, dealers, and customers its right, under the Claims in the Patent Portfolio, to test, make, have made, use, import, export, distribute, offer for sale, sell, lease, and/or otherwise dispose of products in, or for, the United States and its territories and possessions subject to any applicable exports laws and regulations of the United States.

2.3 Subject to execution of this agreement by the Parties, Licensor and Inventor release and forever discharge Licensee (and its direct and indirect distributors, suppliers, dealers and customers) from any and all claims, liens, demands, causes of action, obligations, losses, damages, and liabilities, known or unknown, suspected or unsuspected, liquidated or unliquidated, fixed or contingent, that they have had in the past or now have or may have in the future under any of the Claims in the Patent Portfolio based on or arising out of products Sold, prior to and including May 01, 2006 by Licensee in, or for, the United States and its territories and possessions.

2.4 Subject to the terms and provisions of this Agreement, and to Licensee making the payment required under Section 4.1 and during the term of the life of this Agreement, Licensor and Inventor further represent, covenant and agree that neither they nor any entity directly or indirectly controlled by either will bring suit or otherwise assert a claim for infringement against Licensee (or its direct and indirect distributors, suppliers, dealers or customers) before any court or administrative agency in any country of the world based on or arising out of products Sold by Licensee in, or for, the United States and its territories and possessions.

2.5 The release and covenant not to sue provided in Sections 2.3 and 2.4, as well as any other releases or covenants not to sue set out in this Agreement, shall bind any assignee or other person to whom the Assignor or Inventor may assign ownership or control of Claims in the Patent Portfolio.

2.6 Licensor and Inventor grants to Licensee the right to sublicense to an Affiliate of Licensee the rights granted to Licensee under this Agreement; provided that the

Affiliate is bound by the terms and provisions of this Agreement as if it were named in the place of Licensee, and provided that the Affiliate shall pay and account, directly or through Licensee, to the Licensor the royalties payable under this Agreement as a result of the activities of the Affiliate as if it were named in the place of Licensee. Any rights granted to an Affiliate shall terminate automatically and without notice on the date such Affiliate ceases to be an Affiliate; provided, however, that such termination shall not affect the rights granted to the Affiliate for acts occurring prior to the effective date of such termination. Upon written request from Licensor as to whether a particular entity or entities is an Affiliate, Licensee will answer such request in writing within thirty (30) Days from receipt of the request.

2.7 The rights, grants, covenants, and terms of Section 2.1, 2.2, 2.4, and 4.1 shall not apply to Royalty Products Sold by Licensee to a third party after Licensee was notified by Licensor that such third party has or had, directly or through others, asserted in any judicial proceeding or judicial document, at any time during the lifetime of this Agreement, that any of the Claims in the Patent Portfolio are invalid and/or not infringed.

2.8 The rights, grants, covenants, and terms of Sections 2.1, 2.2, 2.3, 2.4, and 4.1 shall not apply to Royalty Products Sold by Licensee to a third party for sale under a brand not owned or controlled by Licensee unless: (i) such third party has executed with Licensor a License Agreement; and/or (ii) Licensee pays the Royalty, under Sections 4.1 and 4.2, to Licensor for every Royalty Product Sold by such third party in, or for, the United States and its territories and possessions.

3. LIMITS ON SCOPE OF LICENSE GRANT

3.1 Any license grant or other authorization that may be provided by Licensor or Inventor to Licensee under this Agreement or to a third party does not provide, directly, by implication, or otherwise, any license grant, or authorization to Licensee to make, have made, use, import, export, distribute, offer for sale, sell, rent, or otherwise dispose of RPV systems for use by R/C hobbyists; and/or to make, have made, test, use, import, export, distribute, offer for sale, sell or lease, or otherwise dispose of equipment used to product or manufacture RPV systems for use by R/C hobbyists.

3.2 Any third party which acquires rights under this agreement is bound by the requirements of section 3.1.

4. ROYALTY AND PAYMENTS

4.1 In consideration for the licenses, covenants not to sue, and other rights granted by Licensor and Inventor to Licensee under this Agreement relative to Royalty Products Sold by Licensee in, or for, the United States and its territories and possessions and/or including and covering all countries on planet Earth and surrounding planets/systems after May, 01, 2006, Licensee agrees to pay Licensor a continuing "Royalty" throughout the term of this Agreement equal to five percent (5%) for each such Royalty Product.

4.2 [DELETED BY PARTIES DURING NEGOTIATION]

4.3 Only one Royalty shall be paid on any Royalty Product with respect to the Claims in the Patent Portfolio regardless as to whether the Royalty Product is encompassed by one or more of the Claims in the Patent Portfolio. Licensee shall not be required to make payments under Section 4.1 as to Royalty Products Sold by Licensee where the Royalty due has been paid to Licensor by a third party. Licensee shall not be required to make payments under Section 4.1 as to Royalty Products Sold by Licensee and subsequently found defective and returned to Licensee for full credit, and not thereafter Sold by Licensee in, or for, the United States and its territories and possession and/or including and covering all countries on planet Earth and surrounding planets/systems.

4.4 The Parties understand that there should be no taxes imposed by any foreign country on the income of Licensor paid under this Agreement. However, to the extent, if any, that such taxes are imposed for any reason: (i) such taxes shall be borne by Licensor; (ii) Licensee will deduct such tax from the amounts payable to Licensor and pay such tax to the appropriate authority in the name of and on behalf of Licensor; (iii) Licensee shall send to Licensor certificates of tax payment in due course after each payment of the tax; and (iv) Licensee agrees to submit and to file any document to the competent foreign revenue office, that is required to have such certificate issued.

4.5 If any other entity is granted a license under any of the Claims in the Patent Portfolio with respect to Royalty Products under any more favorable economic terms than those granted to Licensee under this Agreement, then Licensor shall disclose, in writing, to Licensee the terms and provisions of each such license within thirty (30) Days of its execution, and Licensee shall have the right, within ninety (90) Days of receipt of such disclosure, to substitute all of the terms and provisions in this Agreement with all of the terms and provisions of the subsequent license, retroactive to the date that the subsequent license agreement was executed.

5. REPORTS

5.1 Licensee shall keep sales records of all Royalty Products Sold by Licensee during the term of this Agreement in, or for, the United States and its territories and possessions and/or including and covering all countries on planet Earth and surrounding planets/systems. These sales records shall be of sufficient detail to permit verification in accordance with the accuracy and completeness of the information and the royalties required to be reported and paid under this

Agreement. Licensee shall keep such records for at least five (5) years after each due date for royalty payments under this Agreement.

5.2 Licensee shall send Licensor a written "Royalty Report", accompanied in the manner provided for in Section 5.7 by the proper amount then payable to Licensor as shown in such Royalty Report,:

(a) on or before the thirtieth (30^{th}) day after termination of this Agreement; and

(b) on or before the last day of the months of January, April, July and October of each year during the term of this Agreement. However, if less than one thousand Royalty Products are Sold by Licensee in, or for, the United States and its territories and possessions and/or including and covering all countries on planet Earth and surrounding planets/systems during a calendar year, then the four (4) quarterly reports and payments for the next calendar year immediately following may be combined in a single annual Royalty Report and payment made on or before the last day of January immediately following such next calendar year.

5.3 The Royalty Report shall be certified in its correctness by Licensee's representative responsible for paying such on Licensee's behalf in the normal course of Licensee's business, and providing information such as:

(a) the total number of Royalty Products, by product category, Sold by Licensee in; or for, the United States and its territories and possessions and/or including and covering all countries on planet Earth and surrounding planets/systems during the preceding calendar quarter;

(b) the royalty amount due for such calendar quarter; and

(c) the total number of Royalty Products, by product category, Sold by Licensee in, or for, the United States and its territories and possessions and/or including and covering all countries on planet Earth and surrounding planets/systems during such calendar quarter for which the Royalty due from Licensee was paid for by a third party and an identification of each such third party.

5.4 In the event that any Royalty Report and payment are not made by or on behalf of Licensee by the date provided under this Agreement, interest shall be payable on the past due amounts at the rate of the prime lending rate as published in the Wall Street Journal from time to time plus 2%, compounded semi-annually. This interest shall be calculated from the date payment was due to the payment date. This interest payment shall be in addition to any other remedy provided to Licensor by law or by this Agreement.

5.5 Licensor shall maintain Royalty Reports of Licensee as "Confidential Information" in accordance with Article 9 of this Agreement. Confidential Information shall also include any other information provided by Licensee to Licensor and which is designated in good faith as confidential by Licensee.

5.6 Licensor shall have the right, during reasonable business hours and at the reasonable convenience of Licensee, to have the correctness of any Royalty Report of Licensee audited, at licensor's expense, by a firm of independent public accountants, selected by Licensor, and reasonably acceptable to Licensee. The independent public accountants shall examine Licensee's records only on matters pertinent to this Agreement. Nor more than one such audit shall be performed per year, unless Licensee has underreported as provided in the following sentence. In the event it is determined by the independent public accountants, at any time, that Licensee has underreported in an amount in excess of five percent (5%) of the royalties properly due with respect to one or more Royalty Reports, then Licensee, in addition to any other remedy provided Licensor by law or by this Agreement, agrees and is bound to:

(a) Reimburse Licensor's full cost and expense associated with the audit; and

(b) Pay Licensor an amount equal to one hundred and twenty-five (125%) of the amount that Licensee has failed to report or pay, along with interest at the rate of the prime lending rate as published in the Wall Street Journal from time to time plus two percent (2%), compounded semi-annually, calculated from the date each royalty accrued to the date of payment under this Section.

Any payments due under this Section shall be due and payable within thirty (30) Days following notice from Licensor of such failure, breach or default.

5.7 All royalty payments under this Agreement shall be paid in United States currency, without deductions of taxes of any kind other than as provided for in Section 4.4, payable to Licensor c/o SAMUELS, GREEN, STEEL & ADAMS, LLP, Scott Albrecht, Esq.; at 19800 Macarthur Blvd., Suite 1000, Irvine, California 92612-2433, U.S.A. by wire transfer to:

SAMUELS, GREEN, STEEL & ADAMS, LLP
Scott Albrecht, Esq.; P.C. Client Trust

[Financial Information Redacted]

or to any other U.S.A. accounts, as instructed jointly and in writing by Licensor and Scott Albrecht, Esq.

5.8 In the event applicable exchange control regulations shall prevent remittance of United States currency payment hereunder by Licensee, Licensee agrees, at Licensor's option and in accordance with the requirement to make payments without deductions of taxes of any kind other than as provided for in Section 4.4, to deposit an equivalent amount in a currency as designated by Licensor, in a bank designated by Licensor for the account of Licensor, such equivalent amounts to be calculated using currency tables published in the Wall Street Journal.

6. TERM AND TERMINATION

6.1 This Agreement shall continue in full force and effect, unless sooner terminated by specific provisions in this Agreement, until the expiration date of the last remaining of the Claims in the Patent Portfolio, or until a final decree of invalidity from which no appeal or other judicial recourse can be, or is, taken of the last remaining of the Claims in the Patent Portfolio.

6.2 Licensee may terminate this Agreement at any time by sixty (60) Days written notice to Licensor.

6.3 Licensor may terminate this Agreement forthwith upon written notice to Licensee if:

(a) Licensee remains in default in making any payment or supplying a Royalty report or fails to comply with any other provision for a period of thirty (30) Days, in each case after written notice of such default or failure is given by Licensor to Licensee, unless a genuine and good faith dispute exists as to the amount due and any amounts not in dispute are timely paid;

(b) Licensee shall make an assignment for the benefit of creditors, or any order for the compulsory liquidation of Licensee shall be made by any court;

(c) Licensee shall be finally determined by a court of competent jurisdiction to have (i) willfully or deliberately violated any material provision of this Agreement; (ii) concealed from Licensor any failure to comply with this Agreement including, but not limited to, the deliberate or willful understatement of royalties payable or the express refusal to timely pay royalties; and/or (iii) acted in bad faith in breaching any material provision of this Agreement. In such an event, the termination shall be effective as of the date of notice given by Licensor; and

(d) Licensee and/or any of its Affiliates, during the term of the Agreement, directly or through others, assert in any judicial proceeding or judicial document that any of the Claims in the Patent Portfolio are invalid.

6.4 Any termination of this Agreement shall not relieve Licensee of its liability for any payments accrued or owing prior to the effective date of such termination, or for any payments on Royalty Products manufactured by Licensee, in whole or in part, and located in the United States and its territories and possessions and/or including and covering all countries on planet Earth and surrounding planets/systems, prior to the effective date of such termination and Sold after the termination date.

7. ASSIGNMENTS

7.1 This Agreement may be assigned by Licensor provided that the assignment does not operate to terminate, impair or in any way change any obligations or rights that Licensor currently has under this Agreement, or any of the obligations or rights that Licensee would have had, if the assignment has not occurred. In the event the assignment is to a competitor of Licensee, Licensor and Inventor will continue to receive Royalty Reports made by Licensee on a confidential basis and will not reveal the contents of the Royalty Reports to the assignee.

7.2 This Agreement shall inure to the benefit of, and be binding upon, the successors and assigns of the Parties, but no purported assignment or transfer by Licensee of this Agreement or any part thereof shall have any force or validity whatsoever unless and until approved in writing by Licensor, except an assignment to a direct or indirect wholly-owned subsidiary of Licensee, or to a buyer of all or substantially all of an entire business unit or product line of Licensee to which this license pertains. However, any purported conveyance or any attempt by Licensee to confer or extend the benefits and privileges of this Agreement upon or to any entity shall be void and ineffective if that entity: (I) shall have, directly or indirectly, rejected or declined to accept a license from Licensor upon like, similar or more favorable terms as embodiment herein; and/or (ii) directly or through others, asserted in any judicial proceeding or document that any of the Claims in the Patent Portfolio are invalid.

8. COVENNANTS, REPRESENTATIONS AND WARRANTIES

8.1 Licensor and Inventor warrant and covenant that: (i) if during the term of this Agreement, they own, control or acquire additional Claim(s), this Agreement will be supplemented to include such additional Claim(s) without the payment by Licensee of any royalties other than those required to be paid under this Agreement; (ii) they have the entire right, title and interest in and to the Claims in the Patent Portfolio; (iii) they have the right and authority to enter into this Agreement; (iv) they do not own or control any foreign issued patents or foreign pending patent applications; and (v) there are no liens, conveyances, mortgages, assignments, encumbrances or other agreements to which Licensor or Inventor are a party, or by which they are bound, that would prevent or impair the full exercise of all substantive rights granted to Licensee by Licensor pursuant to the terms and provisions of this Agreement.

8.2 Licensor and inventor make no representation or warranty that Royalty Products will not infringe, directly, contributorily or by inducement under the laws of the United States or any foreign country, any patent or other intellectual property right of a third party.

8.3 Any dispute arising under or relating to this Agreement or in any dispute arising with respect or related to the subject matter of the Claims in the Patent Portfolio, which cannot be resolved by negotiation in good faith between the parties hereto, shall be resolved by an action brought in, and the Parties and their Affiliates who have agreed to be bound by this Agreement consent to the jurisdiction and venue of a court in the State of Delaware, U.S.A. Without regard to those laws relating to conflict of laws and the parties to this agreement hereby submit to the jurisdiction of the courts in the State of Delaware, U.S.A. in connection with any disputes arising out of this Agreement.

8.4 Licensee hereby submits for itself and its property in any legal action or proceeding relating to this Agreement, or for recognition and any enforcement of any judgment in respect thereof, to the non-exclusive general jurisdiction and forum of the courts of the State of Delaware in the United States of America, the courts of the United States of America for the District of Delaware, and appellate courts from any thereof. Licensee agrees not to raise, and waives, any objections or defenses based upon venue or forum non conveniens, except that Licensor may seek temporary injunctive relief in any venue of its choosing.

8.5 Licensee hereby designates the following agent in the United States for any service of any summons, complaint or other process in connection with any litigation arising out of this Agreement and Licensee agrees and certifies that such agent shall have full authority to accept the same on behalf of Licensee:

Name: W. Alan Barker, Geneva Legal Counsel
Address: 4240 International Parkway
Suite 100
Carrollton, Texas 75007
Tel.: (469) 568-2376 x112
Fax: (469) 568-2100
Email: abarker@genevaaerospace.com

8.6 Licensee represents and warrants that Licensee assumes responsibility for obtaining all necessary official government approval, validation, and/or consent from the appropriate governmental authorities for the performance of this Agreement and for remittance of payment pursuant hereto and for registering or recording this Agreement as required; provided, however, that Licensee shall use its best efforts to provide that Licensor shall have the right to participate or be represented in any proceeding, hearing, negotiation or the like with governmental authorities relating to such approval, validation and/or consent.

8.7 Licensee and its Affiliates shall, upon request, grant to Licensor, Inventor, and/or their Affiliates a non-exclusive license to and release from any and all claims of infringement of any patents that are necessarily infringed when implementing the Intellectual Property or claiming technologies for which there is no realistic alternative in implementing the Intellectual Property and with respect to which Licensee has or may in the future obtain rights or controls, directly or indirectly, to grant such a license and release. Any such licenses and release shall be granted upon fair, reasonable, and non-discriminatory terms and provisions.

8.8 Every Party represents and warrants that in executing this Agreement, other than the promises, warranties and representations expressly made in this Agreement, it does not rely on any promises, inducements, or representations made by any Party or third party with respect to this Agreement or any other business dealings with any Party or third party, now or in the future.

8.9 Every Party represents and warrants that it is not presently the subject of a voluntary or involuntary petition in bankruptcy or the equivalent thereof, is not presently contemplating filing any such voluntary petition, and does not presently have reason to believe that such an involuntary petition will be filed against it.

8.10 Other than the express warranties of this Article, there are no other warranties, express or implied.

9. CONFIDENTIAL INFORMATION

9.1 For a period of five (5) years as measured from the first date of disclosure of Confidential Information pursuant to this Agreement, Licensor and Inventor agree to use reasonable care and discretion, at least commensurate with that degree of reasonable care they use to protect similar information of their own, to avoid disclosure, publication or dissemination of Confidential Information, outside of those employees, attorneys or consultants of Licensor, and independent public accountants selected by Licensor pursuant to Section 5.6, who have a need to know Confidential Information, and are bound by the terms of this Article to keep Confidential Information in confidence.

9.2 Disclosure by Licensor or Inventor of Confidential Information under Section 9.1 of this Agreement shall be permitted in the following circumstances; provided, that Licensor and Inventor shall have first given reasonable notice to Licensee that such disclosure is to be made:

(a) in response to an order of a court, government or governmental body;

(b) otherwise as required by law; or

(c) to the independent public accountants selected in accordance with Section 5.6 who agree in writing to maintain Confidential Information in confidence.

9.3 Notwithstanding any other provisions of this Agreement, the obligations specified in Section 9.1 of this Agreement will not apply to any Confidential Information that:

(a) is or become publicly available without breach of this Agreement;

(b) is released for disclosure by written consent of Licensee;

(c) can be shown by written documentation to have already been in Licensor's or Inventor's possession at the time of its receipt from Licensee; or

(d) is disclosed to Licensor or Inventor by a third party without Licensor's or Inventor's knowledge of any breach of any obligation or confidentiality owed to Licensee.

10. MISCELLANEOUS

10.1 All notices to, demands, consents, and communications that any Party may desire to give to the other, and/or may be required under this Agreement, must be in writing. The notice shall be effective upon receipt in the United States after having been sent by registered or certified mail or sent by facsimile transmission; and shall be effective upon receipt outside the United States after having been delivered prepaid to a reputable international delivery service or courier or sent by facsimile transmission; and addressed to the address designated below:

For notice to Licensor:

SAMUELS, GREEN, STEEL & ADAMS, LLP,
Mr. Mark Adams, Esq.
19800 MacArthur Blvd., Suite 1000
Irvine, CA 92612

For notice to Licensee:
W. Alan Barker, Geneva Legal Counsel
4240 International Parkway
Suite 100
Carrollton, Texas 75007
Tel: (469) 568-2376 x112
Fax: (469) 568-2100
Email: abarker@genevaaerospace.com

Or to such address that the Party to whom notices are to be sent may from time to time designate in writing.

10.2 No failure or delay to act upon any default or to exercise any right, power or remedy under this Agreement will operate as a waiver of any such default, right, power or remedy.

10.3 This Agreement constitutes the entire understanding of the Parties with respect to its subject matter and supersedes all prior oral or written negotiations, agreements and understandings. This Agreement may not be modified or amended except in writing duly signed by authorized persons on behalf of the Parties.

10.4 The validity, construction, interpretation and performance of this Agreement, and any disputes or legal actions arising under or from this Agreement, shall be governed by the laws and regulations of the United States of America as to patent law, and the State of Delaware as applied to contracts.

10.5 Each of the terms and provisions of this Agreement is material. Without such terms and provisions the Parties would not have entered into this Agreement. If any term or provision of this Agreement is, becomes, or is deemed invalid, illegal or unenforceable under the applicable laws or regulations in the United States or any of its jurisdictions including, for example, the State of Delaware, such term or provision may be amended, by mutual agreement between Licensor and Licensee, to the extent necessary to conform to applicable laws or regulations without materially altering the intention of the parties or, if it cannot be so amended by good-faith negotiations and agreement between Licensor and Licensee then this Agreement shall be terminated sixty (60) days following such term or provision becoming or being deemed invalid, illegal or unenforceable.

10.6 This Agreement does not constitute either Party the agent of the other Party for any purpose whatsoever, nor does either Party have the right or authority to assume, create or incur any liability of any kind, express or implied, against or in the name or on behalf of the other Party.

10.7 The English language form of this Agreement shall control and determine its interpretation.

IN WITNESS WHEREOF, the parties hereto have caused this RPV License Agreement to be executed by their respective duly authorized officers as of the Effective Date.

OPTIMA TECHNOLOGY INC.

Date: May 01, 2006

By: ______________________
Robert Adams
As CEO, Optima Technology Inc.

Date: May 25, 2006.

By: ______________________
Jed Margolin
Inventor

GENEVA AEROSPACE®, INC.

Date: May 17, 2006.

By: ______________________
David Felio
As CEO/President
Geneva Aerospace, Inc.

This Agreement shall not be effective unless an original or a fax copy of this signature page fully executing this Agreement is received by Licensor within twenty-one (21) Days of the Effective Date.

Exhibit A

Optima Technology
Proprietary & Confidential Information

[Redacted]

Geneva Aerospace
At the core of UAV control

Commercial Price List

Exhibit B

Geneva P/N	Name	Description	List Price
	Flight Controls		
606-0022-001	flightTEK for Fixed Wing No Navigator	flightTEK computer with internal GPS and fixed wing VACS software. No cabling or GPS antenna.	$ 11,900.00
606-0023-001	flightTEK for Airship No Navigator	flightTEK computer with internal GPS and airship VACS software. No cabling or GPS antenna.	$ 20,500.00
606-0022-002	flightTEK Extended Use	Same as above with the addition of a web interface that permits the customer to modify the autopilot gains.	$ 11,900.00
606-0023-002	flightTEK Airship Extended Use	Same as above with the addition of a web interface that permits the customer to modify the autopilot gains.	$ 20,500.00
606-0024-001	flightTEK Standard Cable Set	Standard cable set not including the GPS RF cable. Cable is based on Dakota configuration.	$ 2,900.00
606-0025-001	flightTEK PIL Cable Set	Standard bench cable that breaks out all of the flightTEK interfaces	$ 1,200.00
606-0026-001	flightTEK Custom Cable Set Design	Non-standard cable set design to interface to special payloads or other airborne components. Comes with a single cable set to aid in fit checks and integration.	$ 23,000.00
Defined at design	flightTEK Custom Cable Set	Single cable set designed to specifications from the custom cable set design effort	$ 3,100.00
606-0027-002	flightTEK GPS Antenna	Active GPS antenna and TBD ft. RF cable	$ 490.00
	flightTEK VACS Software Options		
820-0011-001	Navigator Software	15 state Kalman filter that provides the full navigation state.	$ 1,000.00
606-0068-001	SIL 6DOF SDK	Development environment that supports the extended use flightTEK. Allows the user to create a model of the aircraft and test the flightTEK gain settings against the airframe model. Includes a pre-compiled library for use on a ??? OS and Visual C++ compiler environment.	$ 15,000.00
606-0050-001	PIL/HIL 6DOF SDK System	Development environment that supports the extended use flightTEK. Allows the user to create a model of the aircraft and test the flightTEK gain settings against the airframe model in a real-time PIL/HIL environment. Includes a pre-compiled library for use on a Linux OS and a preloaded Boox PC.	$ 5,000.00
	flightTEK IMU/INS		
606-0028-001	Systron Donner CMIGITS III INS	Includes the CMIGITS hardware and the software interface driver	$ 30,850.00
606-0029-001	CMIGITS Mount w/ 12v/28v DC-DC converter	Standard Dakota mount with interface cable and 12v/28v DC-DC power converter	$ 2,000.00
606-0030-001	CMIGITS Mount (28v)	Standard Dakota mount with interface cable without power converter (28v)	$ 1,500.00
606-0031-001	Systron Donner MMQ IMU Assembly	Includes the MMQ hardware, LVDS board converter, TBD in. cable between MMQ and LVDS board, and the software interface driver	$ 7,200.00
606-0032-001	Crossbow IMU	Includes the Crossbow hardware and the software interface driver	$ 4,900.00
606-0033-001	Microstrain IMU	Includes Microstrain hardware and the software interface driver	$ 1,900.00
606-0065-001	Interface Panel	Includes ADS sensor, RC to autonomous flight switching, FTS interface	$ 7,000.00
606-0035-001	ADS Sensor - Setra	ADS sensor w/ tubing - Setra	$ 550.00
606-0035-002	ADS Sensor - All Sensors	ADS sensor w/ tubing - All Sensors	$ 550.00
	Data Link for Air Vehicles		
606-0036-001	linkTEK DV	Transmits data & video via 802.11b for LOS or via optional satcom link for BLOS. Video is transmitted as digital data compressed using JPEG2000 compression. 4 ethernet ports on an internal switch are provided. If flightTEK is used, one ethernet port will be used. 1 watt internal power amp for 802.11b is included.	$ 9,950.00
606-0036-002	linkTEK DV No Amp	Same as linkTEK DV but does not include internal 802.11b power amp.	$ 8,600.00
606-0037-001	linkTEK D	Same as linkTEK DV but does not include video.	$ 9,200.00
606-0037-002	linkTEK D No Amp	Same as linkTEK DV No Amp but does not include video.	$ 8,000.00
606-0038-001	SATCOM - 1	Satcom modem enclosure with a single GlobalStar modem, TBD in. of RF cable, 24 in. serial interface cable, and a single GlobalStar antenna.	$ 4,400.00
606-0038-002	SATCOM - 2	Satcom modem enclosure with two GlobalStar modems, TBD in. of RF cables, 24 in. serial interface cable, and two GlobalStar antennas.	$ 7,200.00
606-0041-001	linkTEK Developer Kit	Power cable, power supply, and RJ45 cable, and 3" rubber duck antenna.	$ 950.00
606-0039-001	Serial Datalink 225-400 MHz	Radio hardware with TBD in. RF cable and vehicle antenna	$ 5,200.00
606-0040-001	Serial Datalink 900 MHz	Radio hardware with TBD in. RF cable and vehicle antenna	$ 1,750.00
606-0042-001	Serial Datalink Developer Kit	Power cable, power supply, and RJ45 cable, and 3" rubber duck antenna.	$ 950.00
	Control Stations		
820-0012-001	missionTEK Software	Runs on Windows 2000, NT, or XP. Capable of commanding all available flight modes.	$ 15,000.00
606-0010-001	missionTEK Computer	Includes a Panasonic Toughbook, mouse, and joystick.	$ 4,500.00
606-0069-001	missionTEK Synthetic Image Module	This product is an interface module that enables missionTEK support unmanned vehicle operator situational awareness aids. The product provides an interface to the AAcuity® PC-IG System sold by SDS International. The product requires missionTEK to be connected to the PC-IG system through an Ethernet connection and provides the PC-IG system periodic vehicle data that is used to generate a synthetic image of the vehicle relative to a 3-D terrain environment.	$ 2,000.00
606-0037-003	linkTEK D - GCS	Same as linkTEK D for the air vehicle and includes power supply, power cable, interface cables, and 3" quarter wave rubber duck antenna.	$ 9,700.00
606-0037-004	linkTEK D No Amp - GCS	Same as linkTEK D - GCS except no 802.11b power amp.	$ 9,000.00
606-0038-003	SATCOM - 1 - GCS	Satcom modem enclosure with a single GlobalStar modem, TBD in. of RF cable, 24 in. serial interface cable, and a single GlobalStar antenna.	$ 5,200.00
606-0038-004	SATCOM - 2 - GCS	Same as SATCOM - 1 except an additional GlobalStar modem, RF cable, and antenna is included.	$ 8,600.00
606-0043-001	linkTEK Comm Kit	802.11b antenna, RF cables, antenna masts.	$ 1,250.00
606-0039-002	Serial Datalink 225-400 MHz - GCS	225-400 MHz radio hardware in ruggedized enclosure with ground power cord	$ 4,600.00
606-0040-002	Serial Datalink 900 MHz - GCS	900 MHz radio hardware in ruggedized enclosure with ground power cord	$ 2,000.00
501-xxxx-xxx	linkTek / Serial Datalink Interface Cable	Inerface cable required when using linkTEK to support multi-vehicle control	$ 130.00
606-0043-002	Serial Datalink Comm Kit	900 MHz Omni antenna, 3dB Omnidirectional UHF antenna, 30' RF cable, antenna masts, mast mounting kit, mast stand	$ 950.00
606-0051-001	Ground Control Station - Packaged Option	GCS Box with power supply and integrated with purchased Control Station Components	$ 1,900.00
	Flight Termination		
606-0044-001	safeTEK Air	Receiver, backup battery pack, TBD in. RF cable, and antenna	$ 4,500.00
602-0042-001	safeTEK Ground	Rack mount with ability to independently command 3 safeTEK air units. Comes with power cord.	$ 6,750.00
606-0043-003	safeTEK Ground Comm Kit	Antenna, RF cable, mast	$ 1,950.00

Exhibit 4 - Public Records from Palm Beach County, Florida

1

CFN 20060462327
OR BK 20706 PG 0325
RECORDED 08/08/2006 15:46:06
Palm Beach County, Florida
AMT 1,012,602.00
Doc Stamp 7,088.90
Sharon R. Bock, CLERK & COMPTROLLER
Pgs 0325 - 326; (2pgs)

RETURN TO:
NOVA TITLE COMPANY
1401 UNIVERSITY DR. SUITE 402
CORAL SPRINGS, FL 33071-8909
(954) 755-9889

W/C 84

SPECIAL WARRANTY DEED

THIS INDENTURE is made this 03 day of August, 2006, between **BOYNTON BEACH ASSOCIATES XVI, LLLP**, a Florida limited liability limited partnership ("Seller") whose post office address is 1600 Sawgrass Corporate Parkway, Suite 300, Sunrise, Florida 33323, and Jean Bruner Jeanglaude and Gertrude Arthur-Jeanglaude, husband and wife ("Buyer"), whose Social Security Numbers are ____________ and ____________, respectively, and whose post office address is 8671 Thornbrook Terrace Point, Boynton Beach, Florida 33437.

WITNESSETH, that Seller, for and in consideration of the sum of TEN AND NO/100 DOLLARS ($10.00) and other good and valuable consideration to Seller in hand paid by Buyer, the receipt and sufficiency of which are hereby acknowledged, has granted, bargained and sold, and hereby grants, bargains and sells to Buyer, and Buyer's heirs, successors and assigns forever, the following described land, with a Property Appraiser's Identification Number of **00 42 45 32 03 000 1170.**

> **Lot 117 , CANYON ISLES - PLAT ONE, according to the plat thereof, as recorded in Plat Book 105 at Page 1, of the Public Records of Palm Beach County, Florida.**

THIS CONVEYANCE AND TITLE TO SAID PROPERTY is subject to: (a) taxes and assessments for the present year and subsequent years, including, but not limited to, pending and certified county or municipal improvement liens; (b) restrictions, reservations, conditions, limitations, easements and other matters of record or imposed by governmental authorities having jurisdiction or control over the subject property, but this reference shall not operate to reimpose any of same; (c) all laws, ordinances, regulations, restrictions, prohibitions and other requirements imposed by governmental authorities, including, but not limited to, all applicable zoning, building, bulkhead, land use and environmental ordinances, rules and regulations, and rights or interests vested in the United States of America and/or the State of Florida; (d) those certain covenants, restrictions, agreements and lien rights set forth in **Exhibit "A"** attached hereto and by this reference made a part hereof; (e) the Declaration of Covenants, Restrictions and Easements for Canyon Isles, dated January 18, 2006 and recorded January 20, 2006 in Official Records Book 19820, at Page 216 of the Public Records of Palm Beach County, Florida, as amended and/or supplemented from time to time; (f) the plat of Canyon Isles – Plat One, as recorded in Plat Book 105, at Page 1 of the Public Records of Palm Beach County, Florida; (g) the plat of Canyon Isles – Plat Two, as recorded in Plat Book 105, at Page 40 of the Public Records of Palm Beach County, Florida; and (h) the plat of Canyon Isles – Plat Three, as recorded in Plat Book 106, at Page 61 of the Public Records of Palm Beach County, Florida.

SELLER does hereby specially warrant the title to said land, subject to the foregoing matters, and will defend same against the lawful claims of all persons claiming by, through or under Seller and no others.

IN WITNESS WHEREOF, Seller has hereunto set Seller's hand and seal the day and year first above written.

WITNESSES:

BOYNTON BEACH ASSOCIATES XVI, LLLP, a Florida limited liability limited partnership

By: Boynton Beach XVI Corporation, a Florida corporation, its general partner

By: N. Maria Menendez
N. Maria Menendez, Vice President

Print Name of Witness: Ebony D. A...

Print Name of Witness: Evelyn Duenas

STATE OF FLORIDA
COUNTY OF BROWARD

The foregoing instrument was acknowledged before me this 03 day of August, 2006, by N. Maria Menendez, as Vice President of Boynton Beach XVI Corporation, a Florida corporation, the general partner of Boynton Beach Associates XVI, LLLP, a Florida limited liability limited partnership, on behalf of said corporation and limited liability limited partnership. She is personally known to me.

Notary Public
My Commission Expires:

EVELYN DUENAS
Notary Public - State of Florida
My Commission Expires Aug 8, 2009
Commission # DD459453
Bonded By National Notary Assn.

This instrument prepared by:
HENRY W. JOHNSON, ESQ.
HUME & JOHNSON, P.A.
1401 University Drive, #301
Coral Springs, Florida 33071
(954) 755-9880

2

EXHIBIT "A"
COVENANTS, RESTRICTIONS, AGREEMENTS AND LIEN RIGHTS

The title to the property described in the Special Warranty Deed to which this **Exhibit "A"** is attached (the "Deed") shall be subject to and burdened by the covenants, restrictions, agreements and lien rights set forth below:

1. Capitalized Terms and Definitions. All initial capitalized terms used in this **Exhibit "A"** but not defined herein shall have the meanings given to such terms as set forth in the Deed. The following terms as used in this **Exhibit "A"** shall have the meanings given to such terms as set forth below.

"Gain" shall mean and refer to the amount, if any, by which: (i) the gross selling price of the Property (less and except: (y) the actual, documented costs of any physical improvements made by Buyer after the date of the Deed to the exterior of the home on the Property such as pools, patios, screen enclosures and extensions, and (z) the actual, documented closing costs required to be paid by Buyer in connection with the sale of the Property such as documentary stamp taxes, recording fees and/or brokerage commissions), exceeds (ii) the "Total Purchase Price" paid to Seller by Buyer pursuant to and as defined in the Purchase Contract executed by Seller and Buyer.

"Hardship Event" shall mean and refer to a sale, transfer, lease or sublet of the Property, as appropriate, following a divorce of the Buyers (if married to each other), death or serious disability of one or more of the Buyers, job transfer of one or more of the Buyers to a location greater than fifty (50) miles from the Property, or other reason acceptable to Seller in Seller's sole and absolute discretion, as evidenced by a written waiver of this provision given by Seller.

"Property" shall mean and refer to the property described in the Deed together with the improvements thereon.

"Transfer Advertisement or Agreement" shall mean and refer to any or all of the following: (i) any listing or advertisement for the sale or lease of the Property or any portion thereof made with a broker, in any multiple listing service, in any classified or other advertisement, or otherwise (including, without limitation, "by owner"), (ii) any agreement (verbal or written) for transfer of title to the Property to any third party, and/or (iii) any agreement (verbal or written) for the leasing and/or subletting of the Property or any portion thereof, notwithstanding anything to the contrary in the Declaration.

2. Sales/Transfers of the Property. In the event that Buyer sells or transfers title to the Property (directly or indirectly): (a) at any time within one (1) year following the date of the Deed, and/or (b) at any time thereafter if such sale or transfer results from a Transfer Advertisement or Agreement made or entered into within one (1) year following the date of the Deed, then except only in the event of a Hardship Event released by Seller as provided in Paragraph 4 below, Buyer shall pay to Seller from the proceeds of such sale or transfer, an amount equal to one-hundred percent (100%) of the Gain realized from such sale or transfer.

3. No Leasing of the Property. Notwithstanding anything to the contrary in the Declaration, for a period of one (1) year following the date of the Deed, except only in the event of a Hardship Event released by Seller as provided in paragraph 4 below, Buyer shall not lease and/or sublet the Property or any portion thereof. Any such lease and/or sublet shall be void and unenforceable. All other leases or sublets, including those resulting from such a Hardship Event, shall be subject to the terms and conditions of the Declaration.

4. Lien Rights; Releases. There is and shall be a lien against the Property to secure Buyer's obligations set forth in this **Exhibit "A"**, which lien may be foreclosed on by Seller if Buyer breaches any of its obligations hereunder. In the event of a proposed sale, transfer, lease or sublet of the Property due to a Hardship Event, Buyer must first provide to Seller evidence of such Hardship Event acceptable to Seller in Seller's sole and absolute discretion, and if acceptable to Seller, Seller shall deliver to Buyer a written acknowledgment of the Hardship Event and waiver of Seller's rights hereunder with respect only to such sale, transfer, lease or sublet. In addition, upon written request from Buyer to Seller and payment of the Gain due to Seller in connection with any sale or transfer of the Property as provided in this **Exhibit "A"**, then Seller shall provide to Buyer a written acknowledgment of such payment and release of Seller's lien rights with respect only to such sale or transfer provided that Buyer provides Seller with evidence satisfactory to Seller in Seller's sole and absolute discretion of the amount of the Gain due, including, without limitation closing or other settlement statements. Any release provided by Seller shall be specific only to the particular sale, transfer, lease or sublet described in the release and not to any subsequent sale, transfer, lease or sublet which shall remain subject to this **Exhibit "A"**.

5. Binding and Running with Title to the Property. The covenants, restrictions, agreements and lien rights set forth in this **Exhibit "A"** shall burden and run with title to the Property.

6. Remedies. In addition to its right of foreclosure, Seller shall have all remedies at law and/or in equity for a breach by Buyer under this **Exhibit "A"**. In the event that Seller prevails in any action (legal or otherwise) to enforce its rights and/or Buyer's obligations, Seller shall be entitled to recover all of its costs incurred including, without limitation, reasonable attorneys' fees, through and including all appellate levels. By acceptance of the Deed to the Property, Buyer, for itself, and its successors and assigns waives any homestead or other exemption now or hereafter existing or enacted under either Florida or federal law as same may relate to Seller's rights hereunder.

7. Subordination. This **Exhibit "A"** shall be subordinate to the right of any holder of an institutional first mortgage on the Property and shall not apply to any sales or leases by an institutional first mortgagee who acquires title to the Property by foreclosure or deed in lieu of foreclosure.

8. Miscellaneous. This **Exhibit "A"** shall be construed in accordance with the laws of the State of Florida and shall be binding on Buyer and Buyer's heirs, successors and assigns. In that regard, all references to Buyer in this **Exhibit "A"** shall also mean and refer to each and every of Buyer's heirs, successors and/or assigns. Should any term or provision of this **Exhibit "A"** be ruled to be illegal or otherwise invalid by a court of competent jurisdiction, such term or provision shall be given its nearest legal meaning or be construed as deleted as such court determines, and the same will not invalidate the remaining terms and provisions of this **Exhibit "A"**, which terms, provisions and portions of this Contract will remain in full force and effect. This **Exhibit "A"** may not be amended or modified except by an instrument in writing executed by Seller.

RETURN TO:
NOVA TITLE COMPANY
1401 UNIVERSITY DR. SUITE 402
CORAL SPRINGS, FL 33071-8909
(954) 755-9880

CFN 20060518682
OR BK 20826 PG 1476
RECORDED 09/08/2006 13:31:09
Palm Beach County, Florida
AMT 10.00
Doc Stamp 0.70
Sharon R. Bock, CLERK & COMPTROLLER
Pgs 1476 - 1477; (2pgs)

W/C 84

CORRECTIVE

SPECIAL WARRANTY DEED

THIS INDENTURE is made this 5 day of September, 2006, between **BOYNTON BEACH ASSOCIATES XVI, LLLP**, a Florida limited liability limited partnership ("Seller") whose post office address is 1600 Sawgrass Corporate Parkway, Suite 300, Sunrise, Florida 33323, and Jean Bruner Jeanglaude and Gertrude Arthur Jeanglaude, husband and wife ("Buyer"), whose Social Security Numbers are ____________ and ____________, respectively, and whose post office address is 8671 Thornbrook Terrace Point, Boynton Beach, Florida 33437.

WITNESSETH, that Seller, for and in consideration of the sum of TEN AND NO/100 DOLLARS ($10.00) and other good and valuable consideration to Seller in hand paid by Buyer, the receipt and sufficiency of which are hereby acknowledged, has granted, bargained and sold, and hereby grants, bargains and sells to Buyer, and Buyer's heirs, successors and assigns forever, the following described land, with a Property Appraiser's Identification Number of **00 42 45 32 03 000 1170.**

Lot 117 , CANYON ISLES - PLAT TWO, according to the plat thereof, as recorded in Plat Book 40 at Page 43, of the Public Records of Palm Beach County, Florida.

THIS CONVEYANCE AND TITLE TO SAID PROPERTY is subject to: (a) taxes and assessments for the present year and subsequent years, including, but not limited to, pending and certified county or municipal improvement liens; (b) restrictions, reservations, conditions, limitations, easements and other matters of record or imposed by governmental authorities having jurisdiction or control over the subject property, but this reference shall not operate to reimpose any of same; (c) all laws, ordinances, regulations, restrictions, prohibitions and other requirements imposed by governmental authorities, including, but not limited to, all applicable zoning, building, bulkhead, land use and environmental ordinances, rules and regulations, and rights or interests vested in the United States of America and/or the State of Florida; (d) those certain covenants, restrictions, agreements and lien rights set forth in **Exhibit "A"** attached hereto and by this reference made a part hereof; (e) the Declaration of Covenants, Restrictions and Easements for Canyon Isles, dated January 18, 2006 and recorded January 20, 2006 in Official Records Book 19820, at Page 216 of the Public Records of Palm Beach County, Florida, as amended and/or supplemented from time to time; (f) the plat of Canyon Isles – Plat One, as recorded in Plat Book 105, at Page 1 of the Public Records of Palm Beach County, Florida; (g) the plat of Canyon Isles – Plat Two, as recorded in Plat Book 105, at Page 40 of the Public Records of Palm Beach County, Florida; and (h) the plat of Canyon Isles – Plat Three, as recorded in Plat Book 106, at Page 61 of the Public Records of Palm Beach County, Florida.

SELLER does hereby specially warrant the title to said land, subject to the foregoing matters, and will defend same against the lawful claims of all persons claiming by, through or under Seller and no others.

IN WITNESS WHEREOF, Seller has hereunto set Seller's hand and seal the day and year first above written.

WITNESSES:

BOYNTON BEACH ASSOCIATES XVI, LLLP, a Florida limited liability limited partnership

By: Boynton Beach XVI Corporation, a Florida corporation, its general partner

By: N. Maria Menendez
N. Maria Menendez, Vice President

Kathleen Bronson
Print Name of Witness: Kathleen Bronson

Kathleen M Coffman
Print Name of Witness: Kathleen M Coffman

STATE OF FLORIDA
COUNTY OF BROWARD

The foregoing instrument was acknowledged before me this 5 day of September, 2006, by N. Maria Menendez, as Vice President of Boynton Beach XVI Corporation, a Florida corporation, the general partner of Boynton Beach Associates XVI, LLLP, a Florida limited liability limited partnership, on behalf of said corporation and limited liability limited partnership. She is personally known to me.

Kathleen M Coffman
Notary Public
My Commission Expires:

KATHLEEN M. COFFMAN
Notary Public - State of Florida
My Commission Expires Mar 18, 2009
Commission # DD 391078
Bonded By National Notary Assn.

This instrument prepared by:
HENRY W. JOHNSON, ESQ.
HUME & JOHNSON, P.A.
1401 University Drive, #301
Coral Springs, Florida 33071
(954) 755-9880

THIS DEED IS BEING RECORDED TO CORRECT THE LEGAL DESCRIPTION CONTAINED IN THE ORIGINAL DEED DATED 08/03/06 AND RECORDED 08/08/06 IN OFFICIAL RECORDS BOOK 20706 AT PAGE 325 OF THE PUBLIC RECORDS OF PALM BEACH COUNTY, FLORIDA

EXHIBIT "A"

COVENANTS, RESTRICTIONS, AGREEMENTS AND LIEN RIGHTS

The title to the property described in the Special Warranty Deed to which this **Exhibit "A"** is attached (the "Deed") shall be subject to and burdened by the covenants, restrictions, agreements and lien rights set forth below:

1. Capitalized Terms and Definitions. All initial capitalized terms used in this **Exhibit "A"** but not defined herein shall have the meanings given to such terms as set forth in the Deed. The following terms as used in this **Exhibit "A"** shall have the meanings given to such terms as set forth below.

"Gain" shall mean and refer to the amount, if any, by which: (i) the gross selling price of the Property (less and except: (y) the actual, documented costs of any physical improvements made by Buyer after the date of the Deed to the exterior of the home on the Property such as pools, patios, screen enclosures and extensions, and (z) the actual, documented closing costs required to be paid by Buyer in connection with the sale of the Property such as documentary stamp taxes, recording fees and/or brokerage commissions), exceeds (ii) the "Total Purchase Price" paid to Seller by Buyer pursuant to and as defined in the Purchase Contract executed by Seller and Buyer.

"Hardship Event" shall mean and refer to a sale, transfer, lease or sublet of the Property, as appropriate, following a divorce of the Buyers (if married to each other), death or serious disability of one or more of the Buyers, job transfer of one or more of the Buyers to a location greater than fifty (50) miles from the Property, or other reason acceptable to Seller in Seller's sole and absolute discretion, as evidenced by a written waiver of this provision given by Seller.

"Property" shall mean and refer to the property described in the Deed together with the improvements thereon.

"Transfer Advertisement or Agreement" shall mean and refer to any or all of the following: (i) any listing or advertisement for the sale or lease of the Property or any portion thereof made with a broker, in any multiple listing service, in any classified or other advertisement, or otherwise (including, without limitation, "by owner"), (ii) any agreement (verbal or written) for transfer of title to the Property to any third party, and/or (iii) any agreement (verbal or written) for the leasing and/or subletting of the Property or any portion thereof, notwithstanding anything to the contrary in the Declaration.

2. Sales/Transfers of the Property. In the event that Buyer sells or transfers title to the Property (directly or indirectly): (a) at any time within one (1) year following the date of the Deed, and/or (b) at any time thereafter if such sale or transfer results from a Transfer Advertisement or Agreement made or entered into within one (1) year following the date of the Deed, then except only in the event of a Hardship Event released by Seller as provided in Paragraph 4 below, Buyer shall pay to Seller from the proceeds of such sale or transfer, an amount equal to one-hundred percent (100%) of the Gain realized from such sale or transfer.

3. No Leasing of the Property. Notwithstanding anything to the contrary in the Declaration, for a period of one (1) year following the date of the Deed, except only in the event of a Hardship Event released by Seller as provided in paragraph 4 below, Buyer shall not lease and/or sublet the Property or any portion thereof. Any such lease and/or sublet shall be void and unenforceable. All other leases or sublets, including those resulting from such a Hardship Event, shall be subject to the terms and conditions of the Declaration.

4. Lien Rights; Releases. There is and shall be a lien against the Property to secure Buyer's obligations set forth in this **Exhibit "A"**, which lien may be foreclosed on by Seller if Buyer breaches any of its obligations hereunder. In the event of a proposed sale, transfer, lease or sublet of the Property due to a Hardship Event, Buyer must first provide to Seller evidence of such Hardship Event acceptable to Seller in Seller's sole and absolute discretion, and if acceptable to Seller, Seller shall deliver to Buyer a written acknowledgment of the Hardship Event and waiver of Seller's rights hereunder with respect only to such sale, transfer, lease or sublet. In addition, upon written request from Buyer to Seller and payment of the Gain due to Seller in connection with any sale or transfer of the Property as provided in this **Exhibit "A"**, then Seller shall provide to Buyer a written acknowledgment of such payment and release of Seller's lien rights with respect only to such sale or transfer provided that Buyer provides Seller with evidence satisfactory to Seller in Seller's sole and absolute discretion of the amount of the Gain due, including, without limitation closing or other settlement statements. Any release provided by Seller shall be specific only to the particular sale, transfer, lease or sublet described in the release and not to any subsequent sale, transfer, lease or sublet which shall remain subject to this **Exhibit "A"**.

5. Binding and Running with Title to the Property. The covenants, restrictions, agreements and lien rights set forth in this **Exhibit "A"** shall burden and run with title to the Property.

6. Remedies. In addition to its right of foreclosure, Seller shall have all remedies at law and/or in equity for a breach by Buyer under this **Exhibit "A"**. In the event that Seller prevails in any action (legal or otherwise) to enforce its rights and/or Buyer's obligations, Seller shall be entitled to recover all of its costs incurred including, without limitation, reasonable attorneys' fees, through and including all appellate levels. By acceptance of the Deed to the Property, Buyer, for itself, and its successors and assigns waives any homestead or other exemption now or hereafter existing or enacted under either Florida or federal law as same may relate to Seller's rights hereunder.

7. Subordination. This **Exhibit "A"** shall be subordinate to the right of any holder of an institutional first mortgage on the Property and shall not apply to any sales or leases by an institutional first mortgagee who acquires title to the Property by foreclosure or deed in lieu of foreclosure.

8. Miscellaneous. This **Exhibit "A"** shall be construed in accordance with the laws of the State of Florida and shall be binding on Buyer and Buyer's heirs, successors and assigns. In that regard, all references to Buyer in this **Exhibit "A"** shall also mean and refer to each and every of Buyer's heirs, successors and/or assigns. Should any term or provision of this **Exhibit "A"** be ruled to be illegal or otherwise invalid by a court of competent jurisdiction, such term or provision shall be given its nearest legal meaning or be construed as deleted as such court determines, and the same will not invalidate the remaining terms and provisions of this **Exhibit "A"**, which terms, provisions and portions of this Contract will remain in full force and effect. This **Exhibit "A"** may not be amended or modified except by an instrument in writing executed by Seller.

RETURN TO:
NOVA TITLE COMPANY
1401 UNIVERSITY DR. SUITE 402
CORAL SPRINGS, FL 33071-8909
(954) 755-9889

CFN 20060567208
OR BK 20927 PG 0647
RECORDED 10/04/2006 12:56:16
Palm Beach County, Florida
AMT 10.00
Doc Stamp 0.70
Sharon R. Bock, CLERK & COMPTROLLER
Pgs 0647 - 648; (2pgs)

W/C 84

CORRECTIVE

SPECIAL WARRANTY DEED

THIS INDENTURE is made this 25 day of September, 2006, between **BOYNTON BEACH ASSOCIATES XVI, LLLP**, a Florida limited liability limited partnership ("Seller") whose post office address is 1600 Sawgrass Corporate Parkway, Suite 300, Sunrise, Florida 33323, and Jean Bruner Jeanglaude and Gertrude Arthur Jeanglaude, husband and wife ("Buyer"), whose Social Security Numbers are ________ and ________, respectively, and whose post office address is 8671 Thornbrook Terrace Point, Boynton Beach, Florida 33437.

WITNESSETH, that Seller, for and in consideration of the sum of TEN AND NO/100 DOLLARS ($10.00) and other good and valuable consideration to Seller in hand paid by Buyer, the receipt and sufficiency of which are hereby acknowledged, has granted, bargained and sold, and hereby grants, bargains and sells to Buyer, and Buyer's heirs, successors and assigns forever, the following described land, with a Property Appraiser's Identification Number of **00 42 45 32 03 000 1170.**

Lot 117 , CANYON ISLES - PLAT TWO, according to the plat thereof, as recorded in Plat Book 105 at Page 40, of the Public Records of Palm Beach County, Florida.

THIS CONVEYANCE AND TITLE TO SAID PROPERTY is subject to: (a) taxes and assessments for the present year and subsequent years, including, but not limited to, pending and certified county or municipal improvement liens; (b) restrictions, reservations, conditions, limitations, easements and other matters of record or imposed by governmental authorities having jurisdiction or control over the subject property, but this reference shall not operate to reimpose any of same; (c) all laws, ordinances, regulations, restrictions, prohibitions and other requirements imposed by governmental authorities, including, but not limited to, all applicable zoning, building, bulkhead, land use and environmental ordinances, rules and regulations, and rights or interests vested in the United States of America and/or the State of Florida; (d) those certain covenants, restrictions, agreements and lien rights set forth in **Exhibit "A"** attached hereto and by this reference made a part hereof; (e) the Declaration of Covenants, Restrictions and Easements for Canyon Isles, dated January 18, 2006 and recorded January 20, 2006 in Official Records Book 19820, at Page 216 of the Public Records of Palm Beach County, Florida, as amended and/or supplemented from time to time; (f) the plat of Canyon Isles – Plat One, as recorded in Plat Book 105, at Page 1 of the Public Records of Palm Beach County, Florida; (g) the plat of Canyon Isles – Plat Two, as recorded in Plat Book 105, at Page 40 of the Public Records of Palm Beach County, Florida; and (h) the plat of Canyon Isles – Plat Three, as recorded in Plat Book 106, at Page 61 of the Public Records of Palm Beach County, Florida.

SELLER does hereby specially warrant the title to said land, subject to the foregoing matters, and will defend same against the lawful claims of all persons claiming by, through or under Seller and no others.

IN WITNESS WHEREOF, Seller has hereunto set Seller's hand and seal the day and year first above written.

WITNESSES:

BOYNTON BEACH ASSOCIATES XVI, LLLP, a Florida limited liability limited partnership

By: Boynton Beach XVI Corporation, a Florida corporation, its general partner

By: N. Maria Menendez
N. Maria Menendez, Vice President

Print Name of Witness: Gloria Ortiz

Kathleen M Coffman
Print Name of Witness: Kathleen M Coffman

STATE OF FLORIDA
COUNTY OF BROWARD

The foregoing instrument was acknowledged before me this 25 day of September, 2006, by N. Maria Ménendez, as Vice President of Boynton Beach XVI Corporation, a Florida corporation, the general partner of Boynton Beach Associates XVI, LLLP, a Florida limited liability limited partnership, on behalf of said corporation and limited liability limited partnership. She is personally known to me.

Kathleen M Coffman
Notary Public
My Commission Expires:

KATHLEEN M. COFFMAN
Notary Public - State of Florida
My Commission Expires Mar 18, 2009
Commission # DD 391078
Bonded By National Notary Assn.

This instrument prepared by:
HENRY W. JOHNSON, ESQ.
HUME & JOHNSON, P.A.
1401 University Drive, #301
Coral Springs, Florida 33071
(954) 755-9880

THIS DEED IS BEING RECORDED TO CORRECT TEH LEGAL DESCRIPTION CONTAINED IN THE CORRECTIVE DEED DATED SEPTEMBER 5, 2006 AND RECORDED SEPTEMBER 8, 2006 in ORBOOK 20826 AT PAGE 1476 OF THE PUBLIC RECORDS OF PALM BEACH COUNTY, FLORIDA

EXHIBIT "A"

COVENANTS, RESTRICTIONS, AGREEMENTS AND LIEN RIGHTS

The title to the property described in the Special Warranty Deed to which this **Exhibit "A"** is attached (the "Deed") shall be subject to and burdened by the covenants, restrictions, agreements and lien rights set forth below:

1. Capitalized Terms and Definitions. All initial capitalized terms used in this **Exhibit "A"** but not defined herein shall have the meanings given to such terms as set forth in the Deed. The following terms as used in this **Exhibit "A"** shall have the meanings given to such terms as set forth below.

"Gain" shall mean and refer to the amount, if any, by which: (i) the gross selling price of the Property (less and except: (y) the actual, documented costs of any physical improvements made by Buyer after the date of the Deed to the exterior of the home on the Property such as pools, patios, screen enclosures and extensions, and (z) the actual, documented closing costs required to be paid by Buyer in connection with the sale of the Property such as documentary stamp taxes, recording fees and/or brokerage commissions), exceeds (ii) the "Total Purchase Price" paid to Seller by Buyer pursuant to and as defined in the Purchase Contract executed by Seller and Buyer.

"Hardship Event" shall mean and refer to a sale, transfer, lease or sublet of the Property, as appropriate, following a divorce of the Buyers (if married to each other), death or serious disability of one or more of the Buyers, job transfer of one or more of the Buyers to a location greater than fifty (50) miles from the Property, or other reason acceptable to Seller in Seller's sole and absolute discretion, as evidenced by a written waiver of this provision given by Seller.

"Property" shall mean and refer to the property described in the Deed together with the improvements thereon.

"Transfer Advertisement or Agreement" shall mean and refer to any or all of the following: (i) any listing or advertisement for the sale or lease of the Property or any portion thereof made with a broker, in any multiple listing service, in any classified or other advertisement, or otherwise (including, without limitation, "by owner"), (ii) any agreement (verbal or written) for transfer of title to the Property to any third party, and/or (iii) any agreement (verbal or written) for the leasing and/or subletting of the Property or any portion thereof, notwithstanding anything to the contrary in the Declaration.

2. Sales/Transfers of the Property. In the event that Buyer sells or transfers title to the Property (directly or indirectly): (a) at any time within one (1) year following the date of the Deed, and/or (b) at any time thereafter if such sale or transfer results from a Transfer Advertisement or Agreement made or entered into within one (1) year following the date of the Deed, then except only in the event of a Hardship Event released by Seller as provided in Paragraph 4 below, Buyer shall pay to Seller from the proceeds of such sale or transfer, an amount equal to one-hundred percent (100%) of the Gain realized from such sale or transfer.

3. No Leasing of the Property. Notwithstanding anything to the contrary in the Declaration, for a period of one (1) year following the date of the Deed, except only in the event of a Hardship Event released by Seller as provided in paragraph 4 below, Buyer shall not lease and/or sublet the Property or any portion thereof. Any such lease and/or sublet shall be void and unenforceable. All other leases or sublets, including those resulting from such a Hardship Event, shall be subject to the terms and conditions of the Declaration.

4. Lien Rights; Releases. There is and shall be a lien against the Property to secure Buyer's obligations set forth in this **Exhibit "A"**, which lien may be foreclosed on by Seller if Buyer breaches any of its obligations hereunder. In the event of a proposed sale, transfer, lease or sublet of the Property due to a Hardship Event, Buyer must first provide to Seller evidence of such Hardship Event acceptable to Seller in Seller's sole and absolute discretion, and if acceptable to Seller, Seller shall deliver to Buyer a written acknowledgment of the Hardship Event and waiver of Seller's rights hereunder with respect only to such sale, transfer, lease or sublet. In addition, upon written request from Buyer to Seller and payment of the Gain due to Seller in connection with any sale or transfer of the Property as provided in this **Exhibit "A"**, then Seller shall provide to Buyer a written acknowledgment of such payment and release of Seller's lien rights with respect only to such sale or transfer provided that Buyer provides Seller with evidence satisfactory to Seller in Seller's sole and absolute discretion of the amount of the Gain due, including, without limitation closing or other settlement statements. Any release provided by Seller shall be specific only to the particular sale, transfer, lease or sublet described in the release and not to any subsequent sale, transfer, lease or sublet which shall remain subject to this **Exhibit "A"**.

5. Binding and Running with Title to the Property. The covenants, restrictions, agreements and lien rights set forth in this **Exhibit "A"** shall burden and run with title to the Property.

6. Remedies. In addition to its right of foreclosure, Seller shall have all remedies at law and/or in equity for a breach by Buyer under this **Exhibit "A"**. In the event that Seller prevails in any action (legal or otherwise) to enforce its rights and/or Buyer's obligations, Seller shall be entitled to recover all of its costs incurred including, without limitation, reasonable attorneys' fees, through and including all appellate levels. By acceptance of the Deed to the Property, Buyer, for itself, and its successors and assigns waives any homestead or other exemption now or hereafter existing or enacted under either Florida or federal law as same may relate to Seller's rights hereunder.

7. Subordination. This **Exhibit "A"** shall be subordinate to the right of any holder of an institutional first mortgage on the Property and shall not apply to any sales or leases by an institutional first mortgagee who acquires title to the Property by foreclosure or deed in lieu of foreclosure.

8. Miscellaneous. This **Exhibit "A"** shall be construed in accordance with the laws of the State of Florida and shall be binding on Buyer and Buyer's heirs, successors and assigns. In that regard, all references to Buyer in this **Exhibit "A"** shall also mean and refer to each and every of Buyer's heirs, successors and/or assigns. Should any term or provision of this **Exhibit "A"** be ruled to be illegal or otherwise invalid by a court of competent jurisdiction, such term or provision shall be given its nearest legal meaning or be construed as deleted as such court determines, and the same will not invalidate the remaining terms and provisions of this **Exhibit "A"**, which terms, provisions and portions of this Contract will remain in full force and effect. This **Exhibit "A"** may not be amended or modified except by an instrument in writing executed by Seller.

RETURN TO
NOVA TITLE COMPANY
1401 UNIVERSITY DR SUITE 402
CORAL SPRINGS, FL 33071-8908
(954) 755-8800

This instrument prepared by:
John Hume, Esq.
Hume & Johnson P.A.
1401 University Drive, Suite 402
Coral Springs, Florida 33071

CFN 20060567209
OR BK 20927 PG 0649
RECORDED 10/04/2006 12:56:16
Palm Beach County, Florida
Sharon R. Bock, CLERK & COMPTROLLER
Pg 0649; (1pg)

W/C 84

CORRECTION AND RATIFICATION AGREEMENT

AGREEMENT made this 26 day of 09/06, by JEAN BRUNER JEANGLAUDE AND GERTRUDE ARTHUR JEANGLAUDE, husband and wife ("Borrowers"), whose post office address is 8671 Thornbrook Terrace Point, BOYNTON BEACH, FLORIDA 33437.

Recitals:

A. Borrowers are the owners of the real property located at , 8671 Thornbrook Terrace Point Boynton Beach, Florida 33437 more particularly described as follows: Lot 117, CANYON ISLES PLAT TWO, according to the plat thereof, as recorded in Plat Book 105 at Page 40 of the Public Records of Palm Beach County, Florida

B. Borrowers acquired title to the property by Warranty Deed dated September 5, 2006 and recorded September 8, 2006 in Official Records Book 20826 at Page 1476 of the Public Records of Palm Beach County, Florida.

C. In conjunction with their purchase of the property, Borrowers encumbered the property with a mortgage in favor of GL FINANCIAL SERVICES, LLC., which mortgage secured a loan in the amount of $650,000.00. The mortgage was dated August 3, 2006 and recorded August 8, 2006 in Official Records Book 20706 at Page 0327 of the Public Records of Palm Beach County, Florida.

D. RECORDED WITH INCORRECT LEGAL DESCRIPTION

THEREFORE, in consideration of the original mortgage loan and for other good and valuable considerations, the receipt of which is hereby acknowledged, Borrowers agree as follows:

1. Recitals. The above recitals are true and correct.

2. Correction. ***(INCORRECT LEGAL DESCRIPTION)***:

3. Ratification. Except as otherwise modified herein, all of the original terms and provisions of the mortgage are hereby ratified and confirmed and incorporated herein by reference.

Witnesses:

Ella Katz
Ella Katz
PRINTED NAME OF WITNESS

Jean Bruner Jeanglaude
JEAN BRUNER JEANGLAUDE

Megan Redford
PRINTED NAME OF WITNESS

Gertrude Arthur Jeanglaude
GERTRUDE ARTHUR JEANGLAUDE

STATE OF FLORIDA

COUNTY OF BROWARD

The foregoing instrument was acknowledged before me this 26 day of September, 2006 by JEAN BRUNER JEANGLAUDE AND GERTRUDE ARTHUR JEANGLAUDE, who are personally known to me or produced drivers license as identification.

Notary Public, State of Florida

My commission expires:

Maureen E. Roxberry
Commission #DD299658
Expires: Mar 11, 2008
Bonded Thru
Atlantic Bonding Co., Inc.

RETURN TO:
1401 UNIVERSITY DRIVE, SUITE 402
CORAL SPRINGS, FL 33071-8900
(954) 755-9500

This instrument prepared by:
John Hume, Esq.
Hume & Johnson P.A.
1401 University Drive, Suite 402
Coral Springs, Florida 33071

CFN 20060567210
OR BK 20927 PG 0650
RECORDED 10/04/2006 12:56:16
Palm Beach County, Florida
Sharon R. Bock, CLERK & COMPTROLLER
Pg 0650; (1pg)

W/C 84

CORRECTION AND RATIFICATION AGREEMENT

AGREEMENT made this 26 day of 09/06 by JEAN BRUNER JEANGLAUDE AND GERTRUDE ARTHUR JEANGLAUDE, husband and wife ("Borrowers"), whose post office address is 8671 Thornbrook Terrace Point, BOYNTON BEACH, FLORIDA 33437.

Recitals:

A. Borrowers are the owners of the real property located at , 8671 Thornbrook Terrace Point Boynton Beach, Florida 33437 more particularly described as follows: Lot 117, CANYON ISLES PLAT TWO, according to the plat thereof, as recorded in Plat Book 105 at Page 40 of the Public Records of Palm Beach County, Florida

B. Borrowers acquired title to the property by Warranty Deed dated September 5, 2006 and recorded September 8, 2006 in Official Records Book 20826 at Page 1476 of the Public Records of Palm Beach County, Florida.

C. In conjunction with their purchase of the property, Borrowers encumbered the property with a mortgage in favor of GL FINANCIAL SERVICES, LLC., which mortgage secured a loan in the amount of $141,120.00. The mortgage was dated August 3, 2006 and recorded August 8, 2006 in Official Records Book 20706 at Page 0344 of the Public Records of Palm Beach County, Florida.

D. RECORDED WITH INCORRECT LEGAL DESCRIPTION

THEREFORE, in consideration of the original mortgage loan and for other good and valuable considerations, the receipt of which is hereby acknowledged, Borrowers agree as follows:

1. Recitals. The above recitals are true and correct.

2. Correction. *(INCORRECT LEGAL DESCRIPTION)*:

3. Ratification. Except as otherwise modified herein, all of the original terms and provisions of the mortgage are hereby ratified and confirmed and incorporated herein by reference.

Witnesses:

Ella Katz
Ella Katz
PRINTED NAME OF WITNESS

Jean Bruner Jeanglaude
JEAN BRUNER JEANGLAUDE

Megan R. Ford
PRINTED NAME OF WITNESS

Gertrude Arthur Jeanglaude
GERTRUDE ARTHUR JEANGLAUDE

STATE OF FLORIDA

COUNTY OF BROWARD

The foregoing instrument was acknowledged before me this 26th day of September, 2006 by JEAN BRUNER JEANGLAUDE AND GERTRUDE ARTHUR JEANGLAUDE, who are personally known to me or produced drivers license as identification.

Notary Public, State of Florida

My commission expires:

Maureen E. Roxberry
Commission #DD299658
Expires: Mar 11, 2008
Bonded Thru
Atlantic Bonding Co., Inc.

(2)

After Recording Return To:
COUNTRYWIDE HOME LOANS, INC.
MS SV-79 DOCUMENT PROCESSING
P.O.Box 10423
Van Nuys, CA 91410-0423
This document was prepared by:
YVETTE ZAPATA
GL FINANCIAL SERVICES, LLC.

210 N. UNIVERSITY DR STE 601
CORAL SPRINGS, FL 33071

RETURN TO:
NOVA TITLE COMP
1401 UNIVERSITY DR. S
CORAL SPRINGS, FL 3307
(954) 755-9889

W/C 84

CFN 20060462328
OR BK 20706 PG 0327
RECORDED 08/08/2006 15:46:06
Palm Beach County, Florida
AMT 650,000.00
Deed Doc 2,275.00
Intang 1,300.00
Sharon R. Bock, CLERK & COMPTROLLER
Pgs 0327 - 343; (17pgs)

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00013884537607006
[Doc ID #]

MORTGAGE

MIN 1000157-0006863972-9

DEFINITIONS

Words used in multiple sections of this document are defined below and other words are defined in Sections 3, 11, 13, 18, 20 and 21. Certain rules regarding the usage of words used in this document are also provided in Section 16.

(A) "Security Instrument" means this document, which is dated AUGUST 03, 2006 , together with all Riders to this document.

(B) "Borrower" is
JEAN B JEANGLAUDE, AND GERTRUDE ARTHUR-JEANGLAUDE, HUSBAND AND WIFE

Borrower is the mortgagor under this Security Instrument.

(C) "MERS" is Mortgage Electronic Registration Systems, Inc. MERS is a separate corporation that is acting solely as a nominee for Lender and Lender's successors and assigns. **MERS is the mortgagee under this Security Instrument.** MERS is organized and existing under the laws of Delaware, and has an address and telephone number of P.O. Box 2026, Flint, MI 48501-2026, tel. (888) 679-MERS.

(D) "Lender" is
GL FINANCIAL SERVICES, LLC.
Lender is a BANK
organized and existing under the laws of FLORIDA .
Lender's address is
210 N. UNIVERSITY DR STE 601, CORAL SPRINGS, FL 33071 .

(E) "Note" means the promissory note signed by Borrower and dated AUGUST 03, 2006 . The Note states that Borrower owes Lender
SIX HUNDRED FIFTY THOUSAND and 00/100
Dollars (U.S. $ 650,000.00) plus interest. Borrower has promised to pay this debt in regular Periodic Payments and to pay the debt in full not later than SEPTEMBER 01, 2036 .

(F) "Property" means the property that is described below under the heading "Transfer of Rights in the Property."

DOC ID #: 00013884537607006

(G) "Loan" means the debt evidenced by the Note, plus interest, any prepayment charges and late charges due under the Note, and all sums due under this Security Instrument, plus interest.
(H) "Riders" means all Riders to this Security Instrument that are executed by Borrower. The following Riders are to be executed by Borrower [check box as applicable]:

[ ] Adjustable Rate Rider	[ ] Condominium Rider	[X] Second Home Rider
[ ] Balloon Rider	[X] Planned Unit Development Rider	[ ] 1-4 Family Rider
[ ] VA Rider	[ ] Biweekly Payment Rider	[ ] Other(s) [specify]

(I) "Applicable Law" means all controlling applicable federal, state and local statutes, regulations, ordinances and administrative rules and orders (that have the effect of law) as well as all applicable final, non-appealable judicial opinions.
(J) "Community Association Dues, Fees, and Assessments" means all dues, fees, assessments and other charges that are imposed on Borrower or the Property by a condominium association, homeowners association or similar organization.
(K) "Electronic Funds Transfer" means any transfer of funds, other than a transaction originated by check, draft, or similar paper instrument, which is initiated through an electronic terminal, telephonic instrument, computer, or magnetic tape so as to order, instruct, or authorize a financial institution to debit or credit an account. Such term includes, but is not limited to, point-of-sale transfers, automated teller machine transactions, transfers initiated by telephone, wire transfers, and automated clearinghouse transfers.
(L) "Escrow Items" means those items that are described in Section 3.
(M) "Miscellaneous Proceeds" means any compensation, settlement, award of damages, or proceeds paid by any third party (other than insurance proceeds paid under the coverages described in Section 5) for: (i) damage to, or destruction of, the Property; (ii) condemnation or other taking of all or any part of the Property; (iii) conveyance in lieu of condemnation; or (iv) misrepresentations of, or omissions as to, the value and/or condition of the Property.
(N) "Mortgage Insurance" means insurance protecting Lender against the nonpayment of, or default on, the Loan.
(O) "Periodic Payment" means the regularly scheduled amount due for (i) principal and interest under the Note, plus (ii) any amounts under Section 3 of this Security Instrument.
(P) "RESPA" means the Real Estate Settlement Procedures Act (12 U.S.C. Section 2601 et seq.) and its implementing regulation, Regulation X (24 C.F.R. Part 3500), as they might be amended from time to time, or any additional or successor legislation or regulation that governs the same subject matter. As used in this Security Instrument, "RESPA" refers to all requirements and restrictions that are imposed in regard to a "federally related mortgage loan" even if the Loan does not qualify as a "federally related mortgage loan" under RESPA.
(Q) "Successor in Interest of Borrower" means any party that has taken title to the Property, whether or not that party has assumed Borrower's obligations under the Note and/or this Security Instrument.

TRANSFER OF RIGHTS IN THE PROPERTY
This Security Instrument secures to Lender: (i) the repayment of the Loan, and all renewals, extensions and modifications of the Note; and (ii) the performance of Borrower's covenants and agreements under this Security Instrument and the Note. For this purpose, Borrower does hereby mortgage, grant and convey to MERS (solely as nominee for Lender and Lender's successors and assigns) and to the successors and assigns of MERS, the following described property located in the
COUNTY of PALM BEACH :
[Type of Recording Jurisdiction] [Name of Recording Jurisdiction]

SEE EXHIBIT "A" ATTACHED HERETO AND MADE A PART HEREOF.

DOC ID #: 00013884537607006

Parcel ID Number: which currently has the address of
8671 THORNBROOK TERRACE POINT, Boynton Beach ,
[Street/City]
Florida 33437-4882 ("Property Address"):
[Zip Code]

TOGETHER WITH all the improvements now or hereafter erected on the property, and all easements, appurtenances, and fixtures now or hereafter a part of the property. All replacements and additions shall also be covered by this Security Instrument. All of the foregoing is referred to in this Security Instrument as the "Property." Borrower understands and agrees that MERS holds only legal title to the interests granted by Borrower in this Security Instrument, but, if necessary to comply with law or custom, MERS (as nominee for Lender and Lender's successors and assigns) has the right: to exercise any or all of those interests, including, but not limited to, the right to foreclose and sell the Property; and to take any action required of Lender including, but not limited to, releasing and canceling this Security Instrument.

BORROWER COVENANTS that Borrower is lawfully seised of the estate hereby conveyed and has the right to mortgage, grant and convey the Property and that the Property is unencumbered, except for encumbrances of record. Borrower warrants and will defend generally the title to the Property against all claims and demands, subject to any encumbrances of record.

THIS SECURITY INSTRUMENT combines uniform covenants for national use and non-uniform covenants with limited variations by jurisdiction to constitute a uniform security instrument covering real property.

UNIFORM COVENANTS. Borrower and Lender covenant and agree as follows:

1. Payment of Principal, Interest, Escrow Items, Prepayment Charges, and Late Charges. Borrower shall pay when due the principal of, and interest on, the debt evidenced by the Note and any prepayment charges and late charges due under the Note. Borrower shall also pay funds for Escrow Items pursuant to Section 3. Payments due under the Note and this Security Instrument shall be made in U.S. currency. However, if any check or other instrument received by Lender as payment under the Note or this Security Instrument is returned to Lender unpaid, Lender may require that any or all subsequent payments due under the Note and this Security Instrument be made in one or more of the following forms, as selected by Lender: (a) cash; (b) money order; (c) certified check, bank check, treasurer's check or cashier's check, provided any such check is drawn upon an institution whose deposits are insured by a federal agency, instrumentality, or entity; or (d) Electronic Funds Transfer.

Payments are deemed received by Lender when received at the location designated in the Note or at such other location as may be designated by Lender in accordance with the notice provisions in Section 15. Lender may return any payment or partial payment if the payment or partial payments are insufficient to bring the Loan current. Lender may accept any payment or partial payment insufficient to bring the Loan current, without waiver of any rights hereunder or prejudice to its rights to refuse such payment or partial payments in the future, but Lender is not obligated to apply such payments at the time such payments are accepted. If each Periodic Payment is applied as of its scheduled due date, then Lender need not pay interest on unapplied funds. Lender may hold such unapplied funds until Borrower makes payment to bring the Loan current. If Borrower does not do so within a reasonable period of time, Lender shall either apply such funds or return them to Borrower. If not applied earlier, such funds will be applied to the outstanding principal balance under the Note immediately prior to foreclosure. No offset or claim which Borrower might have now or in the future against Lender shall relieve Borrower from making payments due under the Note and this Security Instrument or performing the covenants and agreements secured by this Security Instrument.

2. Application of Payments or Proceeds. Except as otherwise described in this Section 2, all payments accepted and applied by Lender shall be applied in the following order of priority: (a) interest due under the Note; (b) principal due under the Note; (c) amounts due under Section 3. Such payments shall be applied to each Periodic Payment in the order in which it became due. Any remaining amounts shall be applied first to late charges, second to any other amounts due under this Security Instrument, and then to reduce the principal balance of the Note.

If Lender receives a payment from Borrower for a delinquent Periodic Payment which includes a sufficient amount to pay any late charge due, the payment may be applied to the delinquent payment and the late charge. If more than one Periodic Payment is outstanding, Lender may apply any payment received from Borrower to the repayment of the Periodic Payments if, and to the extent that, each payment can be paid in full. To the extent that any excess exists after the payment is applied to the full payment of one or more Periodic Payments, such excess may be applied to any late charges due. Voluntary prepayments shall be applied first to any prepayment charges and then as described in the Note.

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Any application of payments, insurance proceeds, or Miscellaneous Proceeds to principal due under the Note shall not extend or postpone the due date, or change the amount, of the Periodic Payments.

3. Funds for Escrow Items. Borrower shall pay to Lender on the day Periodic Payments are due under the Note, until the Note is paid in full, a sum (the "Funds") to provide for payment of amounts due for: (a) taxes and assessments and other items which can attain priority over this Security Instrument as a lien or encumbrance on the Property; (b) leasehold payments or ground rents on the Property, if any; (c) premiums for any and all insurance required by Lender under Section 5; and (d) Mortgage Insurance premiums, if any, or any sums payable by Borrower to Lender in lieu of the payment of Mortgage Insurance premiums in accordance with the provisions of Section 10. These items are called "Escrow Items." At origination or at any time during the term of the Loan, Lender may require that Community Association Dues, Fees, and Assessments, if any, be escrowed by Borrower, and such dues, fees and assessments shall be an Escrow Item. Borrower shall promptly furnish to Lender all notices of amounts to be paid under this Section. Borrower shall pay Lender the Funds for Escrow Items unless Lender waives Borrower's obligation to pay the Funds for any or all Escrow Items. Lender may waive Borrower's obligation to pay to Lender Funds for any or all Escrow Items at any time. Any such waiver may only be in writing. In the event of such waiver, Borrower shall pay directly, when and where payable, the amounts due for any Escrow Items for which payment of Funds has been waived by Lender and, if Lender requires, shall furnish to Lender receipts evidencing such payment within such time period as Lender may require. Borrower's obligation to make such payments and to provide receipts shall for all purposes be deemed to be a covenant and agreement contained in this Security Instrument, as the phrase "covenant and agreement" is used in Section 9. If Borrower is obligated to pay Escrow Items directly, pursuant to a waiver, and Borrower fails to pay the amount due for an Escrow Item, Lender may exercise its rights under Section 9 and pay such amount and Borrower shall then be obligated under Section 9 to repay to Lender any such amount. Lender may revoke the waiver as to any or all Escrow Items at any time by a notice given in accordance with Section 15 and, upon such revocation, Borrower shall pay to Lender all Funds, and in such amounts, that are then required under this Section 3.

Lender may, at any time, collect and hold Funds in an amount (a) sufficient to permit Lender to apply the Funds at the time specified under RESPA, and (b) not to exceed the maximum amount a lender can require under RESPA. Lender shall estimate the amount of Funds due on the basis of current data and reasonable estimates of expenditures of future Escrow Items or otherwise in accordance with Applicable Law.

The Funds shall be held in an institution whose deposits are insured by a federal agency, instrumentality, or entity (including Lender, if Lender is an institution whose deposits are so insured) or in any Federal Home Loan Bank. Lender shall apply the Funds to pay the Escrow Items no later than the time specified under RESPA. Lender shall not charge Borrower for holding and applying the Funds, annually analyzing the escrow account, or verifying the Escrow Items, unless Lender pays Borrower interest on the Funds and Applicable Law permits Lender to make such a charge. Unless an agreement is made in writing or Applicable Law requires interest to be paid on the Funds, Lender shall not be required to pay Borrower any interest or earnings on the Funds. Borrower and Lender can agree in writing, however, that interest shall be paid on the Funds. Lender shall give to Borrower, without charge, an annual accounting of the Funds as required by RESPA.

If there is a surplus of Funds held in escrow, as defined under RESPA, Lender shall account to Borrower for the excess funds in accordance with RESPA. If there is a shortage of Funds held in escrow, as defined under RESPA, Lender shall notify Borrower as required by RESPA, and Borrower shall pay to Lender the amount necessary to make up the shortage in accordance with RESPA, but in no more than 12 monthly payments. If there is a deficiency of Funds held in escrow, as defined under RESPA, Lender shall notify Borrower as required by RESPA, and Borrower shall pay to Lender the amount necessary to make up the deficiency in accordance with RESPA, but in no more than 12 monthly payments.

Upon payment in full of all sums secured by this Security Instrument, Lender shall promptly refund to Borrower any Funds held by Lender.

4. Charges; Liens. Borrower shall pay all taxes, assessments, charges, fines, and impositions attributable to the Property which can attain priority over this Security Instrument, leasehold payments or ground rents on the Property, if any, and Community Association Dues, Fees, and Assessments, if any. To the extent that these items are Escrow Items, Borrower shall pay them in the manner provided in Section 3.

Borrower shall promptly discharge any lien which has priority over this Security Instrument unless Borrower: (a) agrees in writing to the payment of the obligation secured by the lien in a manner acceptable to Lender, but only so long as Borrower is performing such agreement; (b) contests the lien in good faith by, or defends against enforcement of the lien in, legal proceedings which in Lender's opinion operate to prevent the enforcement of the lien while those proceedings are pending, but only until such proceedings are concluded; or (c) secures from the holder of the lien an agreement satisfactory to Lender subordinating the lien to this Security Instrument. If Lender determines that any part of the Property is subject to a lien which can attain priority over this Security Instrument, Lender may give Borrower a notice identifying the lien. Within 10 days of the date on which that notice is given, Borrower shall satisfy the lien or take one or more of the actions set forth above in this Section 4.

Lender may require Borrower to pay a one-time charge for a real estate tax verification and/or reporting service used by Lender in connection with this Loan.

5. **Property Insurance.** Borrower shall keep the improvements now existing or hereafter erected on the Property insured against loss by fire, hazards included within the term "extended coverage," and any other hazards including, but not limited to, earthquakes and floods, for which Lender requires insurance. This insurance shall be maintained in the amounts (including deductible levels) and for the periods that Lender requires. What Lender requires pursuant to the preceding sentences can change during the term of the Loan. The insurance carrier providing the insurance shall be chosen by Borrower subject to Lender's right to disapprove Borrower's choice, which right shall not be exercised unreasonably. Lender may require Borrower to pay, in connection with this Loan, either: (a) a one-time charge for flood zone determination, certification and tracking services; or (b) a one-time charge for flood zone determination and certification services and subsequent charges each time remappings or similar changes occur which reasonably might affect such determination or certification. Borrower shall also be responsible for the payment of any fees imposed by the Federal Emergency Management Agency in connection with the review of any flood zone determination resulting from an objection by Borrower.

If Borrower fails to maintain any of the coverages described above, Lender may obtain insurance coverage, at Lender's option and Borrower's expense. Lender is under no obligation to purchase any particular type or amount of coverage. Therefore, such coverage shall cover Lender, but might or might not protect Borrower, Borrower's equity in the Property, or the contents of the Property, against any risk, hazard or liability and might provide greater or lesser coverage than was previously in effect. Borrower acknowledges that the cost of the insurance coverage so obtained might significantly exceed the cost of insurance that Borrower could have obtained. Any amounts disbursed by Lender under this Section 5 shall become additional debt of Borrower secured by this Security Instrument. These amounts shall bear interest at the Note rate from the date of disbursement and shall be payable, with such interest, upon notice from Lender to Borrower requesting payment.

All insurance policies required by Lender and renewals of such policies shall be subject to Lender's right to disapprove such policies, shall include a standard mortgage clause, and shall name Lender as mortgagee and/or as an additional loss payee. Lender shall have the right to hold the policies and renewal certificates. If Lender requires, Borrower shall promptly give to Lender all receipts of paid premiums and renewal notices. If Borrower obtains any form of insurance coverage, not otherwise required by Lender, for damage to, or destruction of, the Property, such policy shall include a standard mortgage clause and shall name Lender as mortgagee and/or as an additional loss payee.

In the event of loss, Borrower shall give prompt notice to the insurance carrier and Lender. Lender may make proof of loss if not made promptly by Borrower. Unless Lender and Borrower otherwise agree in writing, any insurance proceeds, whether or not the underlying insurance was required by Lender, shall be applied to restoration or repair of the Property, if the restoration or repair is economically feasible and Lender's security is not lessened. During such repair and restoration period, Lender shall have the right to hold such insurance proceeds until Lender has had an opportunity to inspect such Property to ensure the work has been completed to Lender's satisfaction, provided that such inspection shall be undertaken promptly. Lender may disburse proceeds for the repairs and restoration in a single payment or in a series of progress payments as the work is completed. Unless an agreement is made in writing or Applicable Law requires interest to be paid on such insurance proceeds, Lender shall not be required to pay Borrower any interest or earnings on such proceeds. Fees for public adjusters, or other third parties, retained by Borrower shall not be paid out of the insurance proceeds and shall be the sole obligation of Borrower. If the restoration or repair is not economically feasible or Lender's security would be lessened, the insurance proceeds shall be applied to the sums secured by this Security Instrument, whether or not then due, with the excess, if any, paid to Borrower. Such insurance proceeds shall be applied in the order provided for in Section 2.

If Borrower abandons the Property, Lender may file, negotiate and settle any available insurance claim and related matters. If Borrower does not respond within 30 days to a notice from Lender that the insurance carrier has offered to settle a claim, then Lender may negotiate and settle the claim. The 30-day period will begin when the notice is given. In either event, or if Lender acquires the Property under Section 22 or otherwise, Borrower hereby assigns to Lender (a) Borrower's rights to any insurance proceeds in an amount not to exceed the amounts unpaid under the Note or this Security Instrument, and (b) any other of Borrower's rights (other than the right to any refund of unearned premiums paid by Borrower) under all insurance policies covering the Property, insofar as such rights are applicable to the coverage of the Property. Lender may use the insurance proceeds either to repair or restore the Property or to pay amounts unpaid under the Note or this Security Instrument, whether or not then due.

6. Occupancy. Borrower shall occupy, establish, and use the Property as Borrower's principal residence within 60 days after the execution of this Security Instrument and shall continue to occupy the Property as Borrower's principal residence for at least one year after the date of occupancy, unless Lender otherwise agrees in writing, which consent shall not be unreasonably withheld, or unless extenuating circumstances exist which are beyond Borrower's control.

7. Preservation, Maintenance and Protection of the Property; Inspections. Borrower shall not destroy, damage or impair the Property, allow the Property to deteriorate or commit waste on the Property. Whether or not Borrower is residing in the Property, Borrower shall maintain the Property in order to prevent the Property from deteriorating or decreasing in value due to its condition. Unless it is determined pursuant to Section 5 that repair or restoration is not economically feasible, Borrower shall promptly repair the Property if damaged to avoid further deterioration or damage. If insurance or condemnation proceeds are paid in connection with damage to, or the taking of, the Property, Borrower shall be responsible for repairing or restoring the Property only if Lender has released proceeds for such purposes. Lender may disburse proceeds for the repairs and restoration in a single payment or in a series of progress payments as the work is completed. If the insurance or condemnation proceeds are not sufficient to repair or restore the Property, Borrower is not relieved of Borrower's obligation for the completion of such repair or restoration.

Lender or its agent may make reasonable entries upon and inspections of the Property. If it has reasonable cause, Lender may inspect the interior of the improvements on the Property. Lender shall give Borrower notice at the time of or prior to such an interior inspection specifying such reasonable cause.

8. Borrower's Loan Application. Borrower shall be in default if, during the Loan application process, Borrower or any persons or entities acting at the direction of Borrower or with Borrower's knowledge or consent gave materially false, misleading, or inaccurate information or statements to Lender (or failed to provide Lender with material information) in connection with the Loan. Material representations include, but are not limited to, representations concerning Borrower's occupancy of the Property as Borrower's principal residence.

9. Protection of Lender's Interest in the Property and Rights Under this Security Instrument. If (a) Borrower fails to perform the covenants and agreements contained in this Security Instrument, (b) there is a legal proceeding that might significantly affect Lender's interest in the Property and/or rights under this Security Instrument (such as a proceeding in bankruptcy, probate, for condemnation or forfeiture, for enforcement of a lien which may attain priority over this Security Instrument or to enforce laws or regulations), or (c) Borrower has abandoned the Property, then Lender may do and pay for whatever is reasonable or appropriate to protect Lender's interest in the Property and rights under this Security Instrument, including protecting and/or assessing the value of the Property, and securing and/or repairing the Property. Lender's actions can include, but are not limited to: (a) paying any sums secured by a lien which has priority over this Security Instrument; (b) appearing in court; and (c) paying reasonable attorneys' fees to protect its interest in the Property and/or rights under this Security Instrument, including its secured position in a bankruptcy proceeding. Securing the Property includes, but is not limited to, entering the Property to make repairs, change locks, replace or board up doors and windows, drain water from pipes, eliminate building or other code violations or dangerous conditions, and have utilities turned on or off. Although Lender may take action under this Section 9, Lender does not have to do so and is not under any duty or obligation to do so. It is agreed that Lender incurs no liability for not taking any or all actions authorized under this Section 9.

Any amounts disbursed by Lender under this Section 9 shall become additional debt of Borrower secured by this Security Instrument. These amounts shall bear interest at the Note rate from the date of disbursement and shall be payable, with such interest, upon notice from Lender to Borrower requesting payment.

If this Security Instrument is on a leasehold, Borrower shall comply with all the provisions of the lease. If Borrower acquires fee title to the Property, the leasehold and the fee title shall not merge unless Lender agrees to the merger in writing.

10. Mortgage Insurance. If Lender required Mortgage Insurance as a condition of making the Loan, Borrower shall pay the premiums required to maintain the Mortgage Insurance in effect. If, for any reason, the Mortgage Insurance coverage required by Lender ceases to be available from the mortgage insurer that previously provided such insurance and Borrower was required to make separately designated payments toward the premiums for Mortgage Insurance, Borrower shall pay the premiums required to obtain coverage substantially equivalent to the Mortgage Insurance previously in effect, at a cost substantially equivalent to the cost to Borrower of the Mortgage Insurance previously in effect, from an alternate mortgage insurer selected by Lender. If substantially equivalent Mortgage Insurance coverage is not available, Borrower shall continue to pay to Lender the amount of the separately designated payments that were due when the insurance coverage ceased to be in effect. Lender will accept, use and retain these payments as a non-refundable loss reserve in lieu of Mortgage Insurance. Such loss reserve shall be non-refundable, notwithstanding the fact that the Loan is ultimately paid in full, and Lender shall not be required to pay Borrower any interest or earnings on such loss reserve. Lender can no longer require loss reserve payments if Mortgage Insurance coverage (in the

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amount and for the period that Lender requires) provided by an insurer selected by Lender again becomes available, is obtained, and Lender requires separately designated payments toward the premiums for Mortgage Insurance. If Lender required Mortgage Insurance as a condition of making the Loan and Borrower was required to make separately designated payments toward the premiums for Mortgage Insurance, Borrower shall pay the premiums required to maintain Mortgage Insurance in effect, or to provide a non-refundable loss reserve, until Lender's requirement for Mortgage Insurance ends in accordance with any written agreement between Borrower and Lender providing for such termination or until termination is required by Applicable Law. Nothing in this Section 10 affects Borrower's obligation to pay interest at the rate provided in the Note.

Mortgage Insurance reimburses Lender (or any entity that purchases the Note) for certain losses it may incur if Borrower does not repay the Loan as agreed. Borrower is not a party to the Mortgage Insurance.

Mortgage insurers evaluate their total risk on all such insurance in force from time to time, and may enter into agreements with other parties that share or modify their risk, or reduce losses. These agreements are on terms and conditions that are satisfactory to the mortgage insurer and the other party (or parties) to these agreements. These agreements may require the mortgage insurer to make payments using any source of funds that the mortgage insurer may have available (which may include funds obtained from Mortgage Insurance premiums).

As a result of these agreements, Lender, any purchaser of the Note, another insurer, any reinsurer, any other entity, or any affiliate of any of the foregoing, may receive (directly or indirectly) amounts that derive from (or might be characterized as) a portion of Borrower's payments for Mortgage Insurance, in exchange for sharing or modifying the mortgage insurer's risk, or reducing losses. If such agreement provides that an affiliate of Lender takes a share of the insurer's risk in exchange for a share of the premiums paid to the insurer, the arrangement is often termed "captive reinsurance." Further:

(a) Any such agreements will not affect the amounts that Borrower has agreed to pay for Mortgage Insurance, or any other terms of the Loan. Such agreements will not increase the amount Borrower will owe for Mortgage Insurance, and they will not entitle Borrower to any refund.

(b) Any such agreements will not affect the rights Borrower has - if any - with respect to the Mortgage Insurance under the Homeowners Protection Act of 1998 or any other law. These rights may include the right to receive certain disclosures, to request and obtain cancellation of the Mortgage Insurance, to have the Mortgage Insurance terminated automatically, and/or to receive a refund of any Mortgage Insurance premiums that were unearned at the time of such cancellation or termination.

11. Assignment of Miscellaneous Proceeds; Forfeiture. All Miscellaneous Proceeds are hereby assigned to and shall be paid to Lender.

If the Property is damaged, such Miscellaneous Proceeds shall be applied to restoration or repair of the Property, if the restoration or repair is economically feasible and Lender's security is not lessened. During such repair and restoration period, Lender shall have the right to hold such Miscellaneous Proceeds until Lender has had an opportunity to inspect such Property to ensure the work has been completed to Lender's satisfaction, provided that such inspection shall be undertaken promptly. Lender may pay for the repairs and restoration in a single disbursement or in a series of progress payments as the work is completed. Unless an agreement is made in writing or Applicable Law requires interest to be paid on such Miscellaneous Proceeds, Lender shall not be required to pay Borrower any interest or earnings on such Miscellaneous Proceeds. If the restoration or repair is not economically feasible or Lender's security would be lessened, the Miscellaneous Proceeds shall be applied to the sums secured by this Security Instrument, whether or not then due, with the excess, if any, paid to Borrower. Such Miscellaneous Proceeds shall be applied in the order provided for in Section 2.

In the event of a total taking, destruction, or loss in value of the Property, the Miscellaneous Proceeds shall be applied to the sums secured by this Security Instrument, whether or not then due, with the excess, if any, paid to Borrower.

In the event of a partial taking, destruction, or loss in value of the Property in which the fair market value of the Property immediately before the partial taking, destruction, or loss in value is equal to or greater than the amount of the sums secured by this Security Instrument immediately before the partial taking, destruction, or loss in value, unless Borrower and Lender otherwise agree in writing, the sums secured by this Security Instrument shall be reduced by the amount of the Miscellaneous Proceeds multiplied by the following fraction: (a) the total amount of the sums secured immediately before the partial taking, destruction, or loss in value divided by (b) the fair market value of the Property immediately before the partial taking, destruction, or loss in value. Any balance shall be paid to Borrower.

In the event of a partial taking, destruction, or loss in value of the Property in which the fair market value of the Property immediately before the partial taking, destruction, or loss in value is less than the amount of the sums secured immediately before the partial taking, destruction, or loss in value, unless Borrower and Lender otherwise agree in writing, the Miscellaneous Proceeds shall be applied to the sums secured by this Security Instrument whether or not the sums are then due.

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If the Property is abandoned by Borrower, or if, after notice by Lender to Borrower that the Opposing Party (as defined in the next sentence) offers to make an award to settle a claim for damages, Borrower fails to respond to Lender within 30 days after the date the notice is given, Lender is authorized to collect and apply the Miscellaneous Proceeds either to restoration or repair of the Property or to the sums secured by this Security Instrument, whether or not then due. "Opposing Party" means the third party that owes Borrower Miscellaneous Proceeds or the party against whom Borrower has a right of action in regard to Miscellaneous Proceeds.

Borrower shall be in default if any action or proceeding, whether civil or criminal, is begun that, in Lender's judgment, could result in forfeiture of the Property or other material impairment of Lender's interest in the Property or rights under this Security Instrument. Borrower can cure such a default and, if acceleration has occurred, reinstate as provided in Section 19, by causing the action or proceeding to be dismissed with a ruling that, in Lender's judgment, precludes forfeiture of the Property or other material impairment of Lender's interest in the Property or rights under this Security Instrument. The proceeds of any award or claim for damages that are attributable to the impairment of Lender's interest in the Property are hereby assigned and shall be paid to Lender.

All Miscellaneous Proceeds that are not applied to restoration or repair of the Property shall be applied in the order provided for in Section 2.

12. Borrower Not Released; Forbearance By Lender Not a Waiver. Extension of the time for payment or modification of amortization of the sums secured by this Security Instrument granted by Lender to Borrower or any Successor in Interest of Borrower shall not operate to release the liability of Borrower or any Successors in Interest of Borrower. Lender shall not be required to commence proceedings against any Successor in Interest of Borrower or to refuse to extend time for payment or otherwise modify amortization of the sums secured by this Security Instrument by reason of any demand made by the original Borrower or any Successors in Interest of Borrower. Any forbearance by Lender in exercising any right or remedy including, without limitation, Lender's acceptance of payments from third persons, entities or Successors in Interest of Borrower or in amounts less than the amount then due, shall not be a waiver of or preclude the exercise of any right or remedy.

13. Joint and Several Liability; Co-signers; Successors and Assigns Bound. Borrower covenants and agrees that Borrower's obligations and liability shall be joint and several. However, any Borrower who co-signs this Security Instrument but does not execute the Note (a "co-signer"): (a) is co-signing this Security Instrument only to mortgage, grant and convey the co-signer's interest in the Property under the terms of this Security Instrument; (b) is not personally obligated to pay the sums secured by this Security Instrument; and (c) agrees that Lender and any other Borrower can agree to extend, modify, forbear or make any accommodations with regard to the terms of this Security Instrument or the Note without the co-signer's consent.

Subject to the provisions of Section 18, any Successor in Interest of Borrower who assumes Borrower's obligations under this Security Instrument in writing, and is approved by Lender, shall obtain all of Borrower's rights and benefits under this Security Instrument. Borrower shall not be released from Borrower's obligations and liability under this Security Instrument unless Lender agrees to such release in writing. The covenants and agreements of this Security Instrument shall bind (except as provided in Section 20) and benefit the successors and assigns of Lender.

14. Loan Charges. Lender may charge Borrower fees for services performed in connection with Borrower's default, for the purpose of protecting Lender's interest in the Property and rights under this Security Instrument, including, but not limited to, attorneys' fees, property inspection and valuation fees. In regard to any other fees, the absence of express authority in this Security Instrument to charge a specific fee to Borrower shall not be construed as a prohibition on the charging of such fee. Lender may not charge fees that are expressly prohibited by this Security Instrument or by Applicable Law.

If the Loan is subject to a law which sets maximum loan charges, and that law is finally interpreted so that the interest or other loan charges collected or to be collected in connection with the Loan exceed the permitted limits, then: (a) any such loan charge shall be reduced by the amount necessary to reduce the charge to the permitted limit; and (b) any sums already collected from Borrower which exceeded permitted limits will be refunded to Borrower. Lender may choose to make this refund by reducing the principal owed under the Note or by making a direct payment to Borrower. If a refund reduces principal, the reduction will be treated as a partial prepayment without any prepayment charge (whether or not a prepayment charge is provided for under the Note). Borrower's acceptance of any such refund made by direct payment to Borrower will constitute a waiver of any right of action Borrower might have arising out of such overcharge.

15. Notices. All notices given by Borrower or Lender in connection with this Security Instrument must be in writing. Any notice to Borrower in connection with this Security Instrument shall be deemed to have been given to Borrower when mailed by first class mail or when actually delivered to Borrower's notice address if sent by other means. Notice to any one Borrower shall constitute notice to all Borrowers unless Applicable Law expressly requires otherwise. The notice address shall be the Property Address unless

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Borrower has designated a substitute notice address by notice to Lender. Borrower shall promptly notify Lender of Borrower's change of address. If Lender specifies a procedure for reporting Borrower's change of address, then Borrower shall only report a change of address through that specified procedure. There may be only one designated notice address under this Security Instrument at any one time. Any notice to Lender shall be given by delivering it or by mailing it by first class mail to Lender's address stated herein unless Lender has designated another address by notice to Borrower. Any notice in connection with this Security Instrument shall not be deemed to have been given to Lender until actually received by Lender. If any notice required by this Security Instrument is also required under Applicable Law, the Applicable Law requirement will satisfy the corresponding requirement under this Security Instrument.

16. Governing Law; Severability; Rules of Construction. This Security Instrument shall be governed by federal law and the law of the jurisdiction in which the Property is located. All rights and obligations contained in this Security Instrument are subject to any requirements and limitations of Applicable Law. Applicable Law might explicitly or implicitly allow the parties to agree by contract or it might be silent, but such silence shall not be construed as a prohibition against agreement by contract. In the event that any provision or clause of this Security Instrument or the Note conflicts with Applicable Law, such conflict shall not affect other provisions of this Security Instrument or the Note which can be given effect without the conflicting provision.

As used in this Security Instrument: (a) words of the masculine gender shall mean and include corresponding neuter words or words of the feminine gender; (b) words in the singular shall mean and include the plural and vice versa; and (c) the word "may" gives sole discretion without any obligation to take any action.

17. Borrower's Copy. Borrower shall be given one copy of the Note and of this Security Instrument.

18. Transfer of the Property or a Beneficial Interest in Borrower. As used in this Section 18, "Interest in the Property" means any legal or beneficial interest in the Property, including, but not limited to, those beneficial interests transferred in a bond for deed, contract for deed, installment sales contract or escrow agreement, the intent of which is the transfer of title by Borrower at a future date to a purchaser.

If all or any part of the Property or any Interest in the Property is sold or transferred (or if Borrower is not a natural person and a beneficial interest in Borrower is sold or transferred) without Lender's prior written consent, Lender may require immediate payment in full of all sums secured by this Security Instrument. However, this option shall not be exercised by Lender if such exercise is prohibited by Applicable Law.

If Lender exercises this option, Lender shall give Borrower notice of acceleration. The notice shall provide a period of not less than 30 days from the date the notice is given in accordance with Section 15 within which Borrower must pay all sums secured by this Security Instrument. If Borrower fails to pay these sums prior to the expiration of this period, Lender may invoke any remedies permitted by this Security Instrument without further notice or demand on Borrower.

19. Borrower's Right to Reinstate After Acceleration. If Borrower meets certain conditions, Borrower shall have the right to have enforcement of this Security Instrument discontinued at any time prior to the earliest of: (a) five days before sale of the Property pursuant to any power of sale contained in this Security Instrument; (b) such other period as Applicable Law might specify for the termination of Borrower's right to reinstate; or (c) entry of a judgment enforcing this Security Instrument. Those conditions are that Borrower: (a) pays Lender all sums which then would be due under this Security Instrument and the Note as if no acceleration had occurred; (b) cures any default of any other covenants or agreements; (c) pays all expenses incurred in enforcing this Security Instrument, including, but not limited to, reasonable attorneys' fees, property inspection and valuation fees, and other fees incurred for the purpose of protecting Lender's interest in the Property and rights under this Security Instrument; and (d) takes such action as Lender may reasonably require to assure that Lender's interest in the Property and rights under this Security Instrument, and Borrower's obligation to pay the sums secured by this Security Instrument, shall continue unchanged. Lender may require that Borrower pay such reinstatement sums and expenses in one or more of the following forms, as selected by Lender: (a) cash; (b) money order; (c) certified check, bank check, treasurer's check or cashier's check, provided any such check is drawn upon an institution whose deposits are insured by a federal agency, instrumentality or entity; or (d) Electronic Funds Transfer. Upon reinstatement by Borrower, this Security Instrument and obligations secured hereby shall remain fully effective as if no acceleration had occurred. However, this right to reinstate shall not apply in the case of acceleration under Section 18.

20. Sale of Note; Change of Loan Servicer; Notice of Grievance. The Note or a partial interest in the Note (together with this Security Instrument) can be sold one or more times without prior notice to Borrower. A sale might result in a change in the entity (known as the "Loan Servicer") that collects Periodic Payments due under the Note and this Security Instrument and performs other mortgage loan servicing obligations under the Note, this Security Instrument, and Applicable Law. There also might be one or more changes of the Loan Servicer unrelated to a sale of the Note. If there is a change of the Loan Servicer, Borrower will be given written notice of the change which will state the name and address of the new Loan Servicer, the address to which payments should be made and any other information RESPA requires in connection with a notice of transfer of servicing. If the Note is sold and thereafter the Loan is serviced by a Loan Servicer other than the purchaser of the Note, the mortgage loan servicing obligations to Borrower will remain with the Loan Servicer or be transferred to a successor Loan Servicer and are not assumed by the Note purchaser unless otherwise provided by the Note purchaser.

Neither Borrower nor Lender may commence, join, or be joined to any judicial action (as either an individual litigant or the member of a class) that arises from the other party's actions pursuant to this Security Instrument or that alleges that the other party has breached any provision of, or any duty owed by reason of, this Security Instrument, until such Borrower or Lender has notified the other party (with such notice given in compliance with the requirements of Section 15) of such alleged breach and afforded the other party hereto a reasonable period after the giving of such notice to take corrective action. If Applicable Law provides a time period which must elapse before certain action can be taken, that time period will be deemed to be reasonable for purposes of this paragraph. The notice of acceleration and opportunity to cure given to Borrower pursuant to Section 22 and the notice of acceleration given to Borrower pursuant to Section 18 shall be deemed to satisfy the notice and opportunity to take corrective action provisions of this Section 20.

21. Hazardous Substances. As used in this Section 21: (a) "Hazardous Substances" are those substances defined as toxic or hazardous substances, pollutants, or wastes by Environmental Law and the following substances: gasoline, kerosene, other flammable or toxic petroleum products, toxic pesticides and herbicides, volatile solvents, materials containing asbestos or formaldehyde, and radioactive materials; (b) "Environmental Law" means federal laws and laws of the jurisdiction where the Property is located that relate to health, safety or environmental protection; (c) "Environmental Cleanup" includes any response action, remedial action, or removal action, as defined in Environmental Law; and (d) an "Environmental Condition" means a condition that can cause, contribute to, or otherwise trigger an Environmental Cleanup.

Borrower shall not cause or permit the presence, use, disposal, storage, or release of any Hazardous Substances, or threaten to release any Hazardous Substances, on or in the Property. Borrower shall not do, nor allow anyone else to do, anything affecting the Property (a) that is in violation of any Environmental Law, (b) which creates an Environmental Condition, or (c) which, due to the presence, use, or release of a Hazardous Substance, creates a condition that adversely affects the value of the Property. The preceding two sentences shall not apply to the presence, use, or storage on the Property of small quantities of Hazardous Substances that are generally recognized to be appropriate to normal residential uses and to maintenance of the Property (including, but not limited to, hazardous substances in consumer products).

Borrower shall promptly give Lender written notice of (a) any investigation, claim, demand, lawsuit or other action by any governmental or regulatory agency or private party involving the Property and any Hazardous Substance or Environmental Law of which Borrower has actual knowledge, (b) any Environmental Condition, including but not limited to, any spilling, leaking, discharge, release or threat of release of any Hazardous Substance, and (c) any condition caused by the presence, use or release of a Hazardous Substance which adversely affects the value of the Property. If Borrower learns, or is notified by any governmental or regulatory authority, or any private party, that any removal or other remediation of any Hazardous Substance affecting the Property is necessary, Borrower shall promptly take all necessary remedial actions in accordance with Environmental Law. Nothing herein shall create any obligation on Lender for an Environmental Cleanup.

NON-UNIFORM COVENANTS. Borrower and Lender further covenant and agree as follows:

22. Acceleration; Remedies. Lender shall give notice to Borrower prior to acceleration following Borrower's breach of any covenant or agreement in this Security Instrument (but not prior to acceleration under Section 18 unless Applicable Law provides otherwise). The notice shall specify: (a) the default; (b) the action required to cure the default; (c) a date, not less than 30 days from the date the notice is given to Borrower, by which the default must be cured; and (d) that failure to cure the default on or before the date specified in the notice may result in acceleration of the sums secured by this Security Instrument, foreclosure by judicial proceeding and sale of the Property. The notice shall further inform Borrower of the right to reinstate after acceleration and the right to assert in the foreclosure proceeding the non-existence of a default or any other defense of Borrower to acceleration and foreclosure. If the default is not cured on or before the date specified in the notice, Lender at its option may require immediate payment in full of all sums secured by this Security Instrument without further demand and may foreclose this Security Instrument by judicial proceeding. Lender shall be entitled to collect all expenses incurred in pursuing the remedies provided in this Section 22, including, but not limited to, reasonable attorneys' fees and costs of title evidence.

23. Release. Upon payment of all sums secured by this Security Instrument, Lender shall release this Security Instrument. Borrower shall pay any recordation costs. Lender may charge Borrower a fee for releasing this Security Instrument, but only if the fee is paid to a third party for services rendered and the charging of the fee is permitted under Applicable Law.

DOC ID #: 00013884537607006

24. Attorneys' Fees. As used in this Security Instrument and the Note, attorneys' fees shall include those awarded by an appellate court and any attorneys' fees incurred in a bankruptcy proceeding.

25. Jury Trial Waiver. The Borrower hereby waives any right to a trial by jury in any action, proceeding, claim, or counterclaim, whether in contract or tort, at law or in equity, arising out of or in any way related to this Security Instrument or the Note.

BY SIGNING BELOW, Borrower accepts and agrees to the terms and covenants contained in this Security Instrument and in any Rider executed by Borrower and recorded with it.

Signed, sealed and delivered in the presence of:

Jean Bruner Jeanglaude (Seal)
JEAN B. JEANGLAUDE -Borrower
11 HEMMING DR
STAFFORD, VA 22554 (Address)

Gertrude Arthur Jeanglaude (Seal)
GERTRUDE ARTHUR-JEANGLAUDE -Borrower
11 HEMMING DR
STAFFORD, VA 22554 (Address)

_______________ (Seal)
-Borrower
(Address)

_______________ (Seal)
-Borrower
(Address)

VA.
STATE OF [redacted], [redacted] 3rd County ss: Fairfax

The foregoing instrument was acknowledged before me this August 3, 2006 by JEAN B JEANGLAUDE AND GERTRUDE ARTHUR JEANGLAUDE

who is personally known to me or who has produced driver's licenses as identification.

Notary Public 3/3/07

Prepared by: YVETTE ZAPATA

GL FINANCIAL SERVICES, LLC.

210 N. UNIVERSITY DR STE 601
CORAL SPRINGS, FL 33071
Phone: (954)825-4300
Brk Fax No.: (954)825-4320

DATE: 08/03/2006
CASE #:
DOC ID #: 00013884537607006
BORROWER: JEAN B. JEANGLAUDE
PROPERTY ADDRESS: 8671 THORNBROOK TERRACE POINT
Boynton Beach, FL 33437-4882

LEGAL DESCRIPTION EXHIBIT A

Lot 117, CANYON ISLES PLAT ONE, according to the plat thereof, as recorded in Plat Book 105 at Page 1 of the Public Records of Palm Beach County, Florida

FHA/VA/CONV
Legal Description Exhibit A
2C404-XX (04/03)(d)

23991

13884537600000 2006A

PLANNED UNIT DEVELOPMENT RIDER

After Recording Return To:
COUNTRYWIDE HOME LOANS, INC.
MS SV-79 DOCUMENT PROCESSING
P.O.Box 10423
Van Nuys, CA 91410-0423

Prepared By:
YVETTE ZAPATA
GL FINANCIAL SERVICES, LLC.

210 N. UNIVERSITY DR STE 601
CORAL SPRINGS, FL 33071

00013884537607006
[Doc ID #]

THIS PLANNED UNIT DEVELOPMENT RIDER is made this THIRD day of AUGUST, 2006 , and is incorporated into and shall be deemed to amend and supplement the, Mortgage, Deed of Trust, or Security Deed (the "Security Instrument") of the same date, given by the undersigned (the "Borrower") to secure Borrower's Note to
GL FINANCIAL SERVICES, LLC.

(the "Lender") of the same date and covering the Property described in the Security Instrument and located at:

8671 THORNBROOK TERRACE POINT
Boynton Beach, FL 33437-4882
[Property Address]

The Property includes, but is not limited to, a parcel of land improved with a dwelling, together with

DOC ID #: 00013884537607006

other such parcels and certain common areas and facilities, as described in
THE COVENANTS, CONDITIONS, AND RESTRICTIONS FILED OF RECORD
THAT AFFECT THE PROPERTY ORB 19820, PG 216

(the "Declaration"). The Property is a part of a planned unit development known as
CANYON ISLES

[Name of Planned Unit Development]

(the "PUD"). The Property also includes Borrower's interest in the homeowners association or equivalent entity owning or managing the common areas and facilities of the PUD (the "Owners Association") and the uses, benefits and proceeds of Borrower's interest.

PUD COVENANTS. In addition to the covenants and agreements made in the Security Instrument, Borrower and Lender further covenant and agree as follows:

A. PUD Obligations. Borrower shall perform all of Borrower's obligations under the PUD's Constituent Documents. The "Constituent Documents" are the (i) Declaration; (ii) articles of incorporation, trust instrument or any equivalent document which creates the Owners Association; and (iii) any by-laws or other rules or regulations of the Owners Association. Borrower shall promptly pay, when due, all dues and assessments imposed pursuant to the Constituent Documents.

B. Property Insurance. So long as the Owners Association maintains, with a generally accepted insurance carrier, a "master" or "blanket" policy insuring the Property which is satisfactory to Lender and which provides insurance coverage in the amounts (including deductible levels), for the periods, and against loss by fire, hazards included within the term "extended coverage," and any other hazards, including, but not limited to, earthquakes and floods, for which Lender requires insurance, then: (i) Lender waives the provision in Section 3 for the Periodic Payment to Lender of the yearly premium installments for property insurance on the Property; and (ii) Borrower's obligation under Section 5 to maintain property insurance coverage on the Property is deemed satisfied to the extent that the required coverage is provided by the Owners Association policy.

What Lender requires as a condition of this waiver can change during the term of the loan.

Borrower shall give Lender prompt notice of any lapse in required property insurance coverage provided by the master or blanket policy.

In the event of a distribution of property insurance proceeds in lieu of restoration or repair following a loss to the Property, or to common areas and facilities of the PUD, any proceeds payable to Borrower are hereby assigned and shall be paid to Lender. Lender shall apply the proceeds to the sums secured by the Security Instrument, whether or not then due, with the excess, if any, paid to Borrower.

C. Public Liability Insurance. Borrower shall take such actions as may be reasonable to insure that the Owners Association maintains a public liability insurance policy acceptable in form, amount, and extent of coverage to Lender.

D. Condemnation. The proceeds of any award or claim for damages, direct or consequential, payable to Borrower in connection with any condemnation or other taking of all or any part of the Property or the common areas and facilities of the PUD, or for any conveyance in lieu of condemnation, are hereby assigned and shall be paid to Lender. Such proceeds shall be applied by Lender to the sums secured by the Security Instrument as provided in Section 11.

E. Lender's Prior Consent. Borrower shall not, except after notice to Lender and with Lender's prior written consent, either partition or subdivide the Property or consent to: (i) the abandonment or termination of the PUD, except for abandonment or termination required by law in the case of substantial destruction by fire or other casualty or in the case of a taking by condemnation or eminent domain; (ii) any amendment to any provision of the "Constituent Documents" if the provision is for the

Initials: GAJ

DOC ID #: 00013884537607006

express benefit of Lender; (iii) termination of professional management and assumption of self-management of the Owners Association; or (iv) any action which would have the effect of rendering the public liability insurance coverage maintained by the Owners Association unacceptable to Lender.

F. Remedies. If Borrower does not pay PUD dues and assessments when due, then Lender may pay them. Any amounts disbursed by Lender under this paragraph F shall become additional debt of Borrower secured by the Security Instrument. Unless Borrower and Lender agree to other terms of payment, these amounts shall bear interest from the date of disbursement at the Note rate and shall be payable, with interest, upon notice from Lender to Borrower requesting payment.

BY SIGNING BELOW, Borrower accepts and agrees to the terms and provisions contained in this PUD Rider.

Jean Bruner JeanClaude (Seal)
JEAN B. JEANGLAUDE - Borrower
11 HEMMING DR
STAFFORD, VA 22554

Gertrude Arthur-Jeanglaude (Seal)
GERTRUDE ARTHUR-JEANGLAUDE - Borrower
11 HEMMING DR
STAFFORD, VA 22554

_______________ (Seal)
- Borrower

_______________ (Seal)
- Borrower

SECOND HOME RIDER

After Recording Return To:
COUNTRYWIDE HOME LOANS, INC.
MS SV-79 DOCUMENT PROCESSING
P.O.Box 10423
Van Nuys, CA 91410-0423

Prepared By:
YVETTE ZAPATA
GL FINANCIAL SERVICES, LLC.

210 N. UNIVERSITY DR STE 601
CORAL SPRINGS, FL 33071

00013884537607006
[Doc ID #]

THIS SECOND HOME RIDER is made this THIRD day of AUGUST, 2006 , and is incorporated into and shall be deemed to amend and supplement the Mortgage, Deed of Trust, or Security Deed (the "Security Instrument") of the same date given by the undersigned (the "Borrower" whether there are one or more persons undersigned) to secure Borrower's Note to GL FINANCIAL SERVICES, LLC.

(the "Lender") of the same date and covering the Property described in the Security Instrument (the "Property"), which is located at:

8671 THORNBROOK TERRACE POINT
Boynton Beach, FL 33437-4882
[Property Address]

MULTISTATE SECOND HOME RIDER - Single Family - **Fannie Mae/Freddie Mac UNIFORM INSTRUMENT** Page 1 of 2 Initials: ____
VMP-365R (0405) **CHL (06/04)(d)** **Form 3890 1/01**
VMP Mortgage Solutions, Inc. (800)521-7291

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13884537600000002365R

DOC ID #: 00013884537607006

In addition to the covenants and agreements made in the Security Instrument, Borrower and Lender further covenant and agree that Sections 6 and 8 of the Security Instrument are deleted and are replaced by the following:

6. Occupancy. Borrower shall occupy, and shall only use, the Property as Borrower's second home. Borrower shall keep the Property available for Borrower's exclusive use and enjoyment at all times, and shall not subject the Property to any timesharing or other shared ownership arrangement or to any rental pool or agreement that requires Borrower either to rent the Property or give a management firm or any other person any control over the occupancy or use of the Property.

8. Borrower's Loan Application. Borrower shall be in default if, during the Loan application process, Borrower or any persons or entities acting at the direction of Borrower or with Borrower's knowledge or consent gave materially false, misleading, or inaccurate information or statements to Lender (or failed to provide Lender with material information) in connection with the Loan. Material representations include, but are not limited to, representations concerning Borrower's occupancy of the Property as Borrower's second home.

BY SIGNING BELOW, Borrower accepts and agrees to the terms and provisions contained in this Second Home Rider.

Jean Bruner JeanClaude (Seal)
JEAN B. JEANCLAUDE - Borrower
11 HEMMING DR
STAFFORD, VA 22554

Gertrude Arthur-Jeanglaude (Seal)
GERTRUDE ARTHUR-JEANGLAUDE - Borrower
11 HEMMING DR
STAFFORD, VA 22554

_______________ (Seal)
- Borrower

_______________ (Seal)
- Borrower

(3)

CFN 20060462329
OR BK 20706 PG 0344
RECORDED 08/08/2006 15:46:06
Palm Beach County, Florida
AMT 141,120.00
Deed Doc 494.20
Intang 282.24
Sharon R. Bock, CLERK & COMPTROLLER
Pgs 0344 - 354; (11pgs)

After Recording Return To:
COUNTRYWIDE HOME LOANS, INC
MS SV-79 DOCUMENT PROCESSING
P.O.Box 10423
Van Nuys, CA 91410-0423
This document was prepared by:
YVETTE ZAPATA
GL FINANCIAL SERVICES, LLC.

NOVA TITLE COMPANY
1401 UNIVERSITY DR. SUITE 402
CORAL SPRINGS, FL 33071
(954) 755-9889

W/C 84

210 N. UNIVERSITY DR STE 601
CORAL SPRINGS, FL 33071

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[Doc ID #]

MORTGAGE
(Line of Credit)

MIN 1000157-0007101590-9

THIS MORTGAGE, dated AUGUST 03, 2006 , is between
JEAN B JEANGLAUDE, AND GERTRUDE ARTHUR-JEANGLAUDE, HUSBAND AND WIFE

residing at
11 HEMMING DR ,
the person or persons signing as "Mortgagor(s)" below and hereinafter referred to as "we," "our," or "us" and MORTGAGE ELECTRONIC REGISTRATION SYSTEMS, INC., ("MERS") a Delaware corporation with an address of P.O. Box 2026, Flint, MI 48501-2026, tel. (888) 679-MERS acting solely as nominee for
GL FINANCIAL SERVICES, LLC.
("Lender" or "you") and its successors and assigns. **MERS is the "Mortgagee" under this Mortgage.**

MORTGAGED PREMISES: In consideration of the loan hereinafter described, we hereby mortgage, grant and convey to MERS (solely as nominee for Lender and Lender's successors and assigns) and to the successors and assigns of MERS, the premises located at:

8671 THORNBROOK TERRACE POINT
Street

BOYNTON BEACH — Municipality
PALM BEACH — County

FL 33437 (the "Premises").
State ZIP

and further described as:

SEE EXHIBIT "A" ATTACHED HERETO AND MADE A PART HEREOF.

INITIAL HERE

Initials: JBJG GAJ

23991

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DOC ID #: 00013884536807006

The Premises includes all buildings and other improvements now or in the future on the Premises and all rights and interests which derive from our ownership, use or possession of the Premises and all appurtenances thereto.

WE UNDERSTAND and agree that MERS is a separate corporation acting solely as nominee for Lender and Lender's successors and assigns, and holds only legal title to the interests granted by us in this Mortgage, but, if necessary to comply with law or custom, MERS (as nominee for Lender and Lender's successors and assigns) has the right: to exercise any or all of those interests, including, but not limited to, the right to foreclose and sell the Property, and to take any action required of Lender including, but not limited to, releasing or canceling this Mortgage

LOAN: This Mortgage will secure Lender's loan to us in the principal amount of $ 141,120.00 or so much thereof as may be advanced and readvanced from time to time to JEAN B. JEANGLAUDE ,
GERTRUDE ARTHUR-JEANGLAUDE ,
,and
,
the Borrower(s) under the Home Equity Credit Line Agreement And Disclosure Statement (the "Note") dated 08/03/2006 , plus interest and costs, late charges and all other charges related to the loan, all of which sums are repayable according to the Note. This Mortgage will also secure the performance of all of the promises and agreements made by us and each Borrower and Co-Signer in the Note, all of our promises and agreements in this Mortgage, any extensions, renewals, amendments, supplements and other modifications of the Note, and any amounts advanced by you under the terms of the section of this Mortgage entitled "Our Authority To You." Loans under the Note may be made, repaid and remade from time to time in accordance with the terms of the Note and subject to the Credit Limit set forth in the Note.

OWNERSHIP: We are the sole owner(s) of the Premises. We have the legal right to mortgage the Premises to you.

OUR IMPORTANT OBLIGATIONS:

(a) TAXES: We will pay all real estate taxes, assessments, water charges and sewer rents relating to the Premises when they become due. We will not claim any credit on, or make deduction from, the loan under the Note because we pay these taxes and charges. We will provide Lender with proof of payment upon request.

(b) MAINTENANCE: We will maintain the building(s) on the Premises in good condition. We will not make major changes in the building(s) except for normal repairs. We will not tear down any of the building(s) on the Premises without first getting Lender's consent. We will not use the Premises illegally. If this Mortgage is on a unit in a condominium or a planned unit development, we shall perform all of our obligations under the declaration or covenants creating or governing the condominium or planned unit development, the by-laws and regulations of the condominium or planned unit development and constituent documents.

(c) INSURANCE: We will keep the building(s) on the Premises insured at all time against loss, by fire, flood and any other hazards Lender may specify. We may choose the insurance company, but our choice is subject to Lender's reasonable approval. The policies must be for at least the amounts and the time periods that Lender specifies. We will deliver to Lender upon Lender's request the policies of other proof of the insurance. The policies must name Lender as "mortgagee" and "loss-payee" so that Lender will receive payment on all insurance claims, to the extent of this Mortgage, before we do. The insurance policies must also provide that Lender be given not less than 10 days prior written notice of any cancellation or reduction in coverage, for any reason. Upon request, we shall deliver the policies, certificates or other evidence of insurance to Lender. In the event of loss or damage to the Premises, we will immediately notify Lender in writing and file a proof of loss with the insurer. Lender may file a proof of loss on our behalf if we fail or refuse to do so. Lender may also sign our name to any check, draft or other order for the payment of insurance proceeds in the event of loss or damage to the Premises. If Lender receives payment of a claim, Lender will have the right to choose to use the money either to repair the Premises or to reduce the amount owing on the Note.

(d) CONDEMNATION: We assign to Lender the proceeds of any award or claim for damages, direct or consequential, in connection with any condemnation or other taking of the Premises, or part thereof, or for conveyance in lieu of condemnation, all of which shall be paid to Lender, subject to the terms of any Prior Mortgage.

JBJ GAJ
Initials: ______

DOC ID #: 00013884536807006

(e) SECURITY INTEREST: We will join with you in signing and filing documents and, at our expense, in doing whatever you believe is necessary to perfect and continue the perfection of your lien and security interest in the Premises. It is agreed that the Lender shall be subrogated to the claims and liens of all parties whose claims or liens are discharged or paid with the proceeds of the Agreement secured hereby.

(f) OUR AUTHORITY TO YOU: If we fail to perform our obligations under this Mortgage, Lender may, if Lender chooses, perform our obligations and pay such costs and expenses. Lender will add the amounts Lender advances to the sums owing on the Note, on which Lender will charge interest at the interest rate set forth in the Note. If, for example, we fail to honor our promises to maintain insurance in effect, or to pay filing fees, taxes or the costs necessary to keep the Premises in good condition and repair or to perform any of our agreements with Lender, Lender may, if Lender chooses, advance any sums to satisfy any of our agreements with Lender or MERS and charge us interest on such advances at the interest rate set forth in the Note. This Mortgage secures all such advances. Lender's payments on our behalf will not cure our failure to perform our promises in this Mortgage. Any replacement insurance that Lender obtains to cover loss or damages to the Premises may be limited to the amount owing on the Note plus the amount of any Prior Mortgages.

(g) PRIOR MORTGAGE: If the provisions of this paragraph are completed, this Mortgage is subject and subordinate to a prior mortgage dated 08/03/2006 and given by us to AWL , as mortgagee, in the original amount of $ 650,000.00 (the "Prior Mortgage"). We shall not increase, amend or modify the Prior Mortgage without your prior written consent and shall upon receipt of any written notice from the holder of the Prior Mortgage promptly deliver a copy of such notice to you. We shall pay and perform all of our obligations under the Prior Mortgage as and when required under the Prior Mortgage.

(h) HAZARDOUS SUBSTANCES: We shall not cause or permit the presence, use, disposal, storage, or release of any Hazardous Substances on or in the Premises. We shall not do, nor allow anyone else to do, anything affecting the Premises that is in violation of any Environmental Law. The preceding two sentences shall not apply to the presence, use, or storage on the Premises of small quantities of Hazardous Substances that are generally recognized to be appropriate to normal residential uses and to maintenance of the Premises. As used in this paragraph, "Hazardous Substances" are those substances defined as toxic or hazardous substances by Environmental Law and the following substances: gasoline, kerosene, other flammable or toxic petroleum products, toxic pesticides and herbicides, volatile solvents, materials containing asbestos or formaldehyde, and radioactive materials. As used in this paragraph, "Environmental Law" means federal laws and laws of the jurisdiction where the Premises are located that relate to health, safety or environmental protection.

(i) SALE OF PREMISES: We will not sell, transfer ownership of, mortgage or otherwise dispose of our interest in the Premises, in whole or in part, or permit any other lien or claim against the Premises without Lender's prior written consent.

(j) INSPECTION: We will permit Lender to inspect the Premises at any reasonable time.

NO LOSS OF RIGHTS: The Note and this Mortgage may be negotiated or assigned without releasing us or the Premises. Lender may ad or release any person or property obligated under the Note and this Mortgage with losing rights in the Premises.

DEFAULT: Except as may be prohibited by applicable law, and subject to any advance notice and cure period if required by applicable law, if any event or condition of default as described in the Note occurs, Lender may foreclose upon this Mortgage. This means that Lender may arrange for the Premises to be sold, as provided by law, in order to pay off what we owe on the Note and under this Mortgage. If the money Lender receive from the sale is not enough to pay off what we owe, we will still owe the difference which Lender may seek to collect from us in accordance with applicable law. In addition, Lender may, in accordance with applicable law, (i) enter on and take possession of the Premises; (ii) collect the rental payments, including over-due rental payments, directly from tenants; (iii) manage the Premises; and (iv) sign, cancel and change leases. We agree that the interest rate set forth in the Note will continue before and after a default, entry of a judgment and foreclosure. In addition, Lender shall be entitled to collect all reasonable fees and costs actually incurred by Lender in proceeding to foreclosure, including, but not limited to, reasonable attorneys fees and costs of documentary evidence, abstracts and title reports.

ASSIGNMENT OF RENTS; APPOINTMENT OF RECEIVER: As additional security, we assign to you the rents of the Premises. You or a receiver appointed by the courts shall be entitled to enter upon, take possession of and manage the Premises and collect the rents of the Premises including those past due.

DOC ID #: 00013884536807006

WAIVERS: To the extent permitted by applicable law, we waive and release any error or defects in proceedings to enforce this Mortgage and hereby waive the benefit of any present or future laws providing for stay of execution, extension of time, exemption from attachment, levy and sale and homestead exemption.

BINDING EFFECT: Each of us shall be fully responsible for all of the promises and agreements in this Mortgage. Until the Note has been paid in full and the obligation to make further advances under the Note has been terminated, the provisions of this Mortgage will be binding on us, our legal representatives, our heirs and all future owners of the Premises. This Mortgage is for MERS and Lender's benefit and for the benefit of anyone to whom it may be assigned. Upon payment in full of all amounts owing under the Note and this Mortgage and provided any obligation to make further advances under the Note has terminated, this Mortgage and your rights in the Premises shall end.

NOTICE: Except for any notice required under applicable law to be given in another manner, (a) any notice to us provided for in this Deed of Trust shall be given by delivering it or by mailing such notice by regular first class mail addressed to us at the last address appearing in your records or at such other address as we may designate by notice to you as provided herein, and (b) any notice to you shall be given by certified mail, return receipt requested, to your address at
For MERS:
P.O. Box 2026, Flint, MI 48501-2026
For Lender:
210 N. UNIVERSITY DR STE 601, CORAL SPRINGS, FL 33071
or to such other address as you may designate by notice to us. Any notice provided for in this Mortgage shall be deemed to have been given to us or you when given in the manner designated herein.

RELEASE: Upon payment of all sums secured by this Mortgage and provided the obligation to make further advances under the Note has terminated, you shall discharge this Mortgage without charge to us, except that we shall pay any fees for recording of a satisfaction of this Mortgage.

GENERAL: You can waive or delay enforcing any of your rights under this Mortgage without losing them. Any waiver by you of any provisions of this Mortgage will not be a waiver of that or any other provision on any other occasion.

Initials: GAJ

DOC ID #: 00013884536807006

THIS MORTGAGE has been signed by each of us under seal on the date first above written.

WITNESS:

____

____

________________________ (SEAL)
Mortgagor: JEAN B. JEANGLAUDE
11 HEMMING DR
STAFFORD, VA 22554

________________________ (SEAL)
Mortgagor: GERTRUDE ARTHUR-JEANGLAUDE
11 HEMMING DR
STAFFORD, VA 22554

________________________ (SEAL)
Mortgagor:

________________________ (SEAL)
Mortgagor:

STATE OF Va. [redacted], County ss: Fairfax

The foregoing instrument was acknowledged before me this August 3, 2006 by JEAN B. JEANGLAUDE AND GERTRUDE ARTHUR JEANGLAUDE

who is personally known to me or who has produced driver's licenses as identification.

Notary Public Comm expires 8/31/07

Prepared by: YVETTE ZAPATA

GL FINANCIAL SERVICES, LLC.

210 N. UNIVERSITY DR STE 601
CORAL SPRINGS, FL 33071
Phone: (954)825-4300
Brk Fax No.: (954)825-4320

DATE: 08/03/2006
CASE #:
DOC ID #: 00013884536807006
BORROWER: JEAN B. JEANGLAUDE
PROPERTY ADDRESS: 8671 THORNBROOK TERRACE POINT
BOYNTON BEACH, FL 33437

LEGAL DESCRIPTION EXHIBIT A

Lot 117, CANYON ISLES PLAT ONE, according to teh plat thereof, as recorded in Plat Book 105 at Page 1 of the Public Records of Palm Beach County, Florida

FHA/VA/CONV
Legal Description Exhibit A
2C404-XX (04/03)(d)

23991

13884536800000020993

PLANNED UNIT DEVELOPMENT RIDER

After Recording Return To:
COUNTRYWIDE HOME LOANS, INC.
MS SV-79 DOCUMENT PROCESSING
P.O.Box 10423
Van Nuys, CA 91410-0423

Prepared By:
YVETTE ZAPATA
GL FINANCIAL SERVICES, LLC.

210 N. UNIVERSITY DR STE 601
CORAL SPRINGS, FL 33071

00013884536807006
[Doc ID #]

THIS PLANNED UNIT DEVELOPMENT RIDER is made this THIRD day of AUGUST, 2006, and is incorporated into and shall be deemed to amend and supplement the, Mortgage, Deed of Trust, or Security Deed (the "Security Instrument") of the same date, given by the undersigned (the "Borrower") to secure Borrower's Note to
GL FINANCIAL SERVICES, LLC.

(the "Lender") of the same date and covering the Property described in the Security Instrument and located at:

8671 THORNBROOK TERRACE POINT
BOYNTON BEACH, FL 33437
[Property Address]

The Property includes, but is not limited to, a parcel of land improved with a dwelling, together with

DOC ID #: 00013884536807006

other such parcels and certain common areas and facilities, as described in
THE COVENANTS, CONDITIONS, AND RESTRICTIONS FILED OF RECORD
THAT AFFECT THE PROPERTY ORB 19820, PG 216

(the "Declaration"). The Property is a part of a planned unit development known as
CANYON ISLES

[Name of Planned Unit Development]

(the "PUD"). The Property also includes Borrower's interest in the homeowners association or equivalent entity owning or managing the common areas and facilities of the PUD (the "Owners Association") and the uses, benefits and proceeds of Borrower's interest.

PUD COVENANTS. In addition to the covenants and agreements made in the Security Instrument, Borrower and Lender further covenant and agree as follows:

A. PUD Obligations. Borrower shall perform all of Borrower's obligations under the PUD's Constituent Documents. The "Constituent Documents" are the (i) Declaration; (ii) articles of incorporation, trust instrument or any equivalent document which creates the Owners Association; and (iii) any by-laws or other rules or regulations of the Owners Association. Borrower shall promptly pay, when due, all dues and assessments imposed pursuant to the Constituent Documents.

B. Property Insurance. So long as the Owners Association maintains, with a generally accepted insurance carrier, a "master" or "blanket" policy insuring the Property which is satisfactory to Lender and which provides insurance coverage in the amounts (including deductible levels), for the periods, and against loss by fire, hazards included within the term "extended coverage," and any other hazards, including, but not limited to, earthquakes and floods, for which Lender requires insurance, then: (i) Lender waives the provision in Section 3 for the Periodic Payment to Lender of the yearly premium installments for property insurance on the Property; and (ii) Borrower's obligation under Section 5 to maintain property insurance coverage on the Property is deemed satisfied to the extent that the required coverage is provided by the Owners Association policy.

What Lender requires as a condition of this waiver can change during the term of the loan.

Borrower shall give Lender prompt notice of any lapse in required property insurance coverage provided by the master or blanket policy.

In the event of a distribution of property insurance proceeds in lieu of restoration or repair following a loss to the Property, or to common areas and facilities of the PUD, any proceeds payable to Borrower are hereby assigned and shall be paid to Lender. Lender shall apply the proceeds to the sums secured by the Security Instrument, whether or not then due, with the excess, if any, paid to Borrower.

C. Public Liability Insurance. Borrower shall take such actions as may be reasonable to insure that the Owners Association maintains a public liability insurance policy acceptable in form, amount, and extent of coverage to Lender.

D. Condemnation. The proceeds of any award or claim for damages, direct or consequential, payable to Borrower in connection with any condemnation or other taking of all or any part of the Property or the common areas and facilities of the PUD, or for any conveyance in lieu of condemnation, are hereby assigned and shall be paid to Lender. Such proceeds shall be applied by Lender to the sums secured by the Security Instrument as provided in Section 11.

E. Lender's Prior Consent. Borrower shall not, except after notice to Lender and with Lender's prior written consent, either partition or subdivide the Property or consent to: (i) the abandonment or termination of the PUD, except for abandonment or termination required by law in the case of substantial destruction by fire or other casualty or in the case of a taking by condemnation or eminent domain; (ii) any amendment to any provision of the "Constituent Documents" if the provision is for the

Initials: JJ GAJ

DOC ID #: 00013884536807006

express benefit of Lender; (iii) termination of professional management and assumption of self-management of the Owners Association; or (iv) any action which would have the effect of rendering the public liability insurance coverage maintained by the Owners Association unacceptable to Lender.

F. Remedies. If Borrower does not pay PUD dues and assessments when due, then Lender may pay them. Any amounts disbursed by Lender under this paragraph F shall become additional debt of Borrower secured by the Security Instrument. Unless Borrower and Lender agree to other terms of payment, these amounts shall bear interest from the date of disbursement at the Note rate and shall be payable, with interest, upon notice from Lender to Borrower requesting payment.

BY SIGNING BELOW, Borrower accepts and agrees to the terms and provisions contained in this PUD Rider.

Jean Briner Jeanglaude (Seal)
JEAN B. JEANGLAUDE - Borrower
11 HEMMING DR
STAFFORD, VA 22554

Gertrude Arthur-Jeanglaude (Seal)
GERTRUDE ARTHUR JEANGLAUDE - Borrower
11 HEMMING DR
STAFFORD, VA 22554

(Seal)
- Borrower

(Seal)
- Borrower

SECOND HOME RIDER

After Recording Return To:
COUNTRYWIDE HOME LOANS, INC.
MS SV-79 DOCUMENT PROCESSING
P.O.Box 10423
Van Nuys, CA 91410-0423

Prepared By:
YVETTE ZAPATA
GL FINANCIAL SERVICES, LLC.

210 N. UNIVERSITY DR STE 601
CORAL SPRINGS, FL 33071

00013884536807006
[Doc ID #]

THIS SECOND HOME RIDER is made this THIRD day of AUGUST, 2006 , and is incorporated into and shall be deemed to amend and supplement the Mortgage, Deed of Trust, or Security Deed (the "Security Instrument") of the same date given by the undersigned (the "Borrower" whether there are one or more persons undersigned) to secure Borrower's Note to GL FINANCIAL SERVICES, LLC.

(the "Lender") of the same date and covering the Property described in the Security Instrument (the "Property"), which is located at:

8671 THORNBROOK TERRACE POINT
BOYNTON BEACH, FL 33437
[Property Address]

MULTISTATE SECOND HOME RIDER - Single Family - **Fannie Mae/Freddie Mac UNIFORM INSTRUMENT** Page 1 of 2 Initials: GAJ
-365R (0405) CHL (06/04)(d) **Form 3890 1/01**
VMP Mortgage Solutions, Inc. (800)521-7291

* 2 3 9 9 1 *

* 1 3 8 8 4 5 3 6 8 0 0 0 0 0 2 3 6 5 R *

DOC ID #: 00013884536807006

In addition to the covenants and agreements made in the Security Instrument, Borrower and Lender further covenant and agree that Sections 6 and 8 of the Security Instrument are deleted and are replaced by the following:

6. Occupancy. Borrower shall occupy, and shall only use, the Property as Borrower's second home. Borrower shall keep the Property available for Borrower's exclusive use and enjoyment at all times, and shall not subject the Property to any timesharing or other shared ownership arrangement or to any rental pool or agreement that requires Borrower either to rent the Property or give a management firm or any other person any control over the occupancy or use of the Property.

8. Borrower's Loan Application. Borrower shall be in default if, during the Loan application process, Borrower or any persons or entities acting at the direction of Borrower or with Borrower's knowledge or consent gave materially false, misleading, or inaccurate information or statements to Lender (or failed to provide Lender with material information) in connection with the Loan. Material representations include, but are not limited to, representations concerning Borrower's occupancy of the Property as Borrower's second home.

BY SIGNING BELOW, Borrower accepts and agrees to the terms and provisions contained in this Second Home Rider.

Jean Bruner Jeanglaude (Seal)
JEAN B. JEANGLAUDE - Borrower
11 HEMMING DR
STAFFORD, VA 22554

Gertrude Arthur-Jeanglaude (Seal)
GERTRUDE ARTHUR-JEANGLAUDE - Borrower
11 HEMMING DR
STAFFORD, VA 22554

_______________ (Seal)
- Borrower

_______________ (Seal)
- Borrower

Document Prepared By:
Stephan L. Galiano
ReconTrust Company, N.A.
1330 W. Southern Ave.
MS: TPSA-88
Tempe, AZ 85282-4545
(800) 540-2684

CFN 20070183108
OR BK 21628 PG 0225
RECORDED 04/16/2007 15:01:26
Palm Beach County, Florida
Sharon R. Bock, CLERK & COMPTROLLER
Pg 0225; (1pg)

When recorded return to:
JEAN B JEANGLAUDE, GERTRUDE ARTHUR-JEANGLAUDE
11 Hemming Dr.
Stafford, VA 22554

DOCID#00013884537620O5N

SATISFACTION OF MORTGAGE

KNOW ALL MEN BY THESE PRESENTS: Mortgage Electronic Registration Systems, Inc. the owner and holder of a certain mortgage deed executed by
JEAN B JEANGLAUDE, GERTRUDE ARTHUR-JEANGLAUDE
to Mortgage Electronic Registration Systems, Inc. bearing date 08/03/2006, recorded on 08/08/2006 in Official Records Book OR 20706, Page 0327 , Instrument # 20060462328 in the office of the Clerk of the Circuit Court of PALM BEACH County State of Florida, securing a certain note in the principal sum of $650,000.00 Dollars, and certain promises and obligations set forth in said mortgage deed, upon the property situated in said State and County hereby acknowledge full payment and satisfaction of said note and mortgage deed, and surrenders the same as canceled, and hereby directs the Clerk of the said Circuit Court to cancel the same of record.

(CORPORATE SEAL)

IN WITNESS WHEREOF the said Corporation has caused these presents to be executed in its name, and its corporate seal to be hereunto affixed, by its proper officers thereunto duly authorized, the 04 day of April, 2007.

Mortgage Electronic Registration Systems, Inc.

ATTEST:
Melissa Van Blarcom
Assistant Secretary

Signed and delivered in the presence of:

Alexandria Redfin
Witness

By
Stacey Shirra
Assistant Secretary

STATE OF ARIZONA
COUNTY OF MARICOPA

On 04/04/2007, before me, Christine Jones, Notary Public, personally appeared Stacey Shirra personally known to me (or proved to me on the basis of satisfactory evidence) to be the person whose name is subscribed to the within instrument and acknowledged to me that he/she executed the same in his/her authorized capacity, and that by his/her signature on the instrument the person, or the entity upon behalf of which the person acted, executed the instrument.

Witness my hand and official seal.

Christine Jones, Notary Public
Expires: 12/21/2009

OFFICIAL SEAL
CHRISTINE JONES
NOTARY PUBLIC - ARIZONA
MARICOPA COUNTY
My Comm. Expires Dec. 21, 2009

MORTGAGE ELECTRONIC REGISTRATION SYSTEMS
CORPORATE SEAL
1999
DELAWARE

Document Prepared By:
Steven U. Galiano
ReconTrust Company, N.A.
1330 W. Southern Ave.
MS: TPSA-88
Tempe, AZ 85282-4545
(800) 540-2684

CFN 20070185466
OR BK 21632 PG 1381
RECORDED 04/17/2007 14:52:07
Palm Beach County, Florida
Sharon R. Bock, CLERK & COMPTROLLER
Pg 1381; (1pg)

When recorded return to:
JEAN B JEANGLAUDE, GERTRUDE ARTHUR-JEANGLAU
11 HEMMING DRIVE
STAFFORD, VA 22554

DOCID#0001388453682005N

SATISFACTION OF MORTGAGE

KNOW ALL MEN BY THESE PRESENTS: Mortgage Electronic Registration Systems, Inc. the owner and holder of a certain mortgage deed executed by
JEAN B JEANGLAUDE, GERTRUDE ARTHUR-JEANGLAU
to Mortgage Electronic Registration Systems, Inc. bearing date 08/03/2006, recorded on 08/08/2006 in Official Records Book 20706, Page 0344 , Instrument # 20060462329 in the office of the Clerk of the Circuit Court of PALM BEACH County State of Florida, securing a certain note in the principal sum of $141,120.00 Dollars, and certain promises and obligations set forth in said mortgage deed, upon the property situated in said State and County hereby acknowledge full payment and satisfaction of said note and mortgage deed, and surrenders the same as canceled, and hereby directs the Clerk of the said Circuit Court to cancel the same of record.

(CORPORATE SEAL)

IN WITNESS WHEREOF the said Corporation has caused these presents to be executed in its name, and its corporate seal to be hereunto affixed, by its proper officers thereunto duly authorized, the 03 day of April, 2007.

Mortgage Electronic Registration Systems, Inc.

ATTEST: ______________________
Roxanne Bermea
Assistant Secretary

Signed and delivered in the presence of:

MCastro
Monica Castro
Witness

By ______________________
Peter Lopez
Assistant Secretary

STATE OF ARIZONA
COUNTY OF MARICOPA

On 04/03/2007, before me, Mary H. Doyle, Notary Public, personally appeared Peter Lopez personally known to me (or proved to me on the basis of satisfactory evidence) to be the person whose name is subscribed to the within instrument and acknowledged to me that he/she executed the same in his/her authorized capacity, and that by his/her signature on the instrument the person, or the entity upon behalf of which the person acted, executed the instrument.

Witness my hand and official seal.

Mary H. Doyle, Notary Public
Expires: 08/18/2009

OFFICIAL SEAL
MARY H. DOYLE
NOTARY PUBLIC - ARIZONA
MARICOPA COUNTY
My Comm. Expires Aug. 18, 2009

MORTGAGE ELECTRONIC REGISTRATION SYSTEMS
CORPORATE SEAL
1999
DELAWARE

Recording Requested by &
When Recorded Return To:
US Recordings, Inc.
PO Box 19989
Louisville, KY 40259

CFN 20070188785
OR BK 21639 PG 1219
RECORDED 04/19/2007 08:35:21
Palm Beach County, Florida
AMT 807,000.00
Deed Doc 2,824.50
Intang 1,614.00
Sharon R. Bock, CLERK & COMPTROLLER
Pgs 1219 - 1236; (18pgs)

This document was prepared by:
HEATHER MCLAUGHLIN
COUNTRYWIDE HOME LOANS, INC.

2380 PERFORMANCE DR MSRGV
C93I
RICHARDSON
TX 75082

[Space Above This Line For Recording Data]

38332630 ~~165970934~~ 00016597093403007
[Escrow/Closing #] [Doc ID #]

MORTGAGE

MIN 1000157 0007938670 7

T007-040958
DMR/NREIS

DEFINITIONS

Words used in multiple sections of this document are defined below and other words are defined in Sections 3, 11, 13, 18, 20 and 21. Certain rules regarding the usage of words used in this document are also provided in Section 16.

(A) "Security Instrument" means this document, which is dated MARCH 30, 2007, together with all Riders to this document.
(B) "Borrower" is
JEAN BRUNER JEANGLAUDE, AND GERTRUDE ARTHUR-JEANGLAUDE, HUSBAND AND WIFE

Borrower is the mortgagor under this Security Instrument.
(C) "MERS" is Mortgage Electronic Registration Systems, Inc. MERS is a separate corporation that is acting solely as a nominee for Lender and Lender's successors and assigns. **MERS is the mortgagee under this Security Instrument.** MERS is organized and existing under the laws of Delaware, and has an address and telephone number of P.O. Box 2026, Flint, MI 48501-2026, tel. (888) 679-MERS.
(D) "Lender" is
COUNTRYWIDE HOME LOANS, INC.
Lender is a CORPORATION
organized and existing under the laws of NEW YORK
Lender's address is
4500 Park Granada MSN# SVB-314, Calabasas, CA 91302-1613
(E) "Note" means the promissory note signed by Borrower and dated MARCH 30, 2007. The Note states that Borrower owes Lender
EIGHT HUNDRED SEVEN THOUSAND and 00/100
Dollars (U.S. $ 807,000.00) plus interest. Borrower has promised to pay this debt in regular Periodic Payments and to pay the debt in full not later than APRIL 01, 2037.
(F) "Property" means the property that is described below under the heading "Transfer of Rights in the Property."

FLORIDA-Single Family-Fannie Mae/Freddie Mac UNIFORM INSTRUMENT WITH MERS
Page 1 of 11
VMP-6A(FL) (0005) CHL (08/05)(d) VMP Mortgage Solutions, Inc. (800)521-7291 Form 3010 1/01
CONV/VA

23991 *16597093400000 2006A*

DOC ID #: 00016597093403007

(G) "Loan" means the debt evidenced by the Note, plus interest, any prepayment charges and late charges due under the Note, and all sums due under this Security Instrument, plus interest.
(H) "Riders" means all Riders to this Security Instrument that are executed by Borrower. The following Riders are to be executed by Borrower [check box as applicable]:

☐ Adjustable Rate Rider	☐ Condominium Rider	☐ Second Home Rider
☐ Balloon Rider	☒ Planned Unit Development Rider	☒ 1-4 Family Rider
☐ VA Rider	☐ Biweekly Payment Rider	☐ Other(s) [specify]

(I) "Applicable Law" means all controlling applicable federal, state and local statutes, regulations, ordinances and administrative rules and orders (that have the effect of law) as well as all applicable final, non-appealable judicial opinions.
(J) "Community Association Dues, Fees, and Assessments" means all dues, fees, assessments and other charges that are imposed on Borrower or the Property by a condominium association, homeowners association or similar organization.
(K) "Electronic Funds Transfer" means any transfer of funds, other than a transaction originated by check, draft, or similar paper instrument, which is initiated through an electronic terminal, telephonic instrument, computer, or magnetic tape so as to order, instruct, or authorize a financial institution to debit or credit an account. Such term includes, but is not limited to, point-of-sale transfers, automated teller machine transactions, transfers initiated by telephone, wire transfers, and automated clearinghouse transfers.
(L) "Escrow Items" means those items that are described in Section 3.
(M) "Miscellaneous Proceeds" means any compensation, settlement, award of damages, or proceeds paid by any third party (other than insurance proceeds paid under the coverages described in Section 5) for: (i) damage to, or destruction of, the Property; (ii) condemnation or other taking of all or any part of the Property; (iii) conveyance in lieu of condemnation; or (iv) misrepresentations of, or omissions as to, the value and/or condition of the Property.
(N) "Mortgage Insurance" means insurance protecting Lender against the nonpayment of, or default on, the Loan.
(O) "Periodic Payment" means the regularly scheduled amount due for (i) principal and interest under the Note, plus (ii) any amounts under Section 3 of this Security Instrument.
(P) "RESPA" means the Real Estate Settlement Procedures Act (12 U.S.C. Section 2601 et seq.) and its implementing regulation, Regulation X (24 C.F.R. Part 3500), as they might be amended from time to time, or any additional or successor legislation or regulation that governs the same subject matter. As used in this Security Instrument, "RESPA" refers to all requirements and restrictions that are imposed in regard to a "federally related mortgage loan" even if the Loan does not qualify as a "federally related mortgage loan" under RESPA.
(Q) "Successor in Interest of Borrower" means any party that has taken title to the Property, whether or not that party has assumed Borrower's obligations under the Note and/or this Security Instrument.

TRANSFER OF RIGHTS IN THE PROPERTY
This Security Instrument secures to Lender: (i) the repayment of the Loan, and all renewals, extensions and modifications of the Note; and (ii) the performance of Borrower's covenants and agreements under this Security Instrument and the Note. For this purpose, Borrower does hereby mortgage, grant and convey to MERS (solely as nominee for Lender and Lender's successors and assigns) and to the successors and assigns of MERS, the following described property located in the
COUNTY of PALM BEACH :
[Type of Recording Jurisdiction] [Name of Recording Jurisdiction]
SEE EXHIBIT "A" ATTACHED HERETO AND MADE A PART HEREOF.

MJF GRS

00-42-45-32-03-000-1170 DOC ID #: 00016597093403007
Parcel ID Number: which currently has the address of
8671 THORNBROOK TERRACE PT, BOYNTON BEACH ,
[Street/City]
Florida 33437-4882 ("Property Address"):
[Zip Code]

TOGETHER WITH all the improvements now or hereafter erected on the property, and all easements, appurtenances, and fixtures now or hereafter a part of the property. All replacements and additions shall also be covered by this Security Instrument. All of the foregoing is referred to in this Security Instrument as the "Property." Borrower understands and agrees that MERS holds only legal title to the interests granted by Borrower in this Security Instrument, but, if necessary to comply with law or custom, MERS (as nominee for Lender and Lender's successors and assigns) has the right: to exercise any or all of those interests, including, but not limited to, the right to foreclose and sell the Property; and to take any action required of Lender including, but not limited to, releasing and canceling this Security Instrument.

BORROWER COVENANTS that Borrower is lawfully seised of the estate hereby conveyed and has the right to mortgage, grant and convey the Property and that the Property is unencumbered, except for encumbrances of record. Borrower warrants and will defend generally the title to the Property against all claims and demands, subject to any encumbrances of record.

THIS SECURITY INSTRUMENT combines uniform covenants for national use and non-uniform covenants with limited variations by jurisdiction to constitute a uniform security instrument covering real property.

UNIFORM COVENANTS. Borrower and Lender covenant and agree as follows:

1. Payment of Principal, Interest, Escrow Items, Prepayment Charges, and Late Charges. Borrower shall pay when due the principal of, and interest on, the debt evidenced by the Note and any prepayment charges and late charges due under the Note. Borrower shall also pay funds for Escrow Items pursuant to Section 3. Payments due under the Note and this Security Instrument shall be made in U.S. currency. However, if any check or other instrument received by Lender as payment under the Note or this Security Instrument is returned to Lender unpaid, Lender may require that any or all subsequent payments due under the Note and this Security Instrument be made in one or more of the following forms, as selected by Lender: (a) cash; (b) money order; (c) certified check, bank check, treasurer's check or cashier's check, provided any such check is drawn upon an institution whose deposits are insured by a federal agency, instrumentality, or entity; or (d) Electronic Funds Transfer.

Payments are deemed received by Lender when received at the location designated in the Note or at such other location as may be designated by Lender in accordance with the notice provisions in Section 15. Lender may return any payment or partial payment if the payment or partial payments are insufficient to bring the Loan current. Lender may accept any payment or partial payment insufficient to bring the Loan current, without waiver of any rights hereunder or prejudice to its rights to refuse such payment or partial payments in the future, but Lender is not obligated to apply such payments at the time such payments are accepted. If each Periodic Payment is applied as of its scheduled due date, then Lender need not pay interest on unapplied funds. Lender may hold such unapplied funds until Borrower makes payment to bring the Loan current. If Borrower does not do so within a reasonable period of time, Lender shall either apply such funds or return them to Borrower. If not applied earlier, such funds will be applied to the outstanding principal balance under the Note immediately prior to foreclosure. No offset or claim which Borrower might have now or in the future against Lender shall relieve Borrower from making payments due under the Note and this Security Instrument or performing the covenants and agreements secured by this Security Instrument.

2. Application of Payments or Proceeds. Except as otherwise described in this Section 2, all payments accepted and applied by Lender shall be applied in the following order of priority: (a) interest due under the Note; (b) principal due under the Note; (c) amounts due under Section 3. Such payments shall be applied to each Periodic Payment in the order in which it became due. Any remaining amounts shall be applied first to late charges, second to any other amounts due under this Security Instrument, and then to reduce the principal balance of the Note.

If Lender receives a payment from Borrower for a delinquent Periodic Payment which includes a sufficient amount to pay any late charge due, the payment may be applied to the delinquent payment and the late charge. If more than one Periodic Payment is outstanding, Lender may apply any payment received from Borrower to the repayment of the Periodic Payments if, and to the extent that, each payment can be paid in full. To the extent that any excess exists after the payment is applied to the full payment of one or more Periodic Payments, such excess may be applied to any late charges due. Voluntary prepayments shall be applied first to any prepayment charges and then as described in the Note.

JMJ GAJ

DOC ID #: 00016597093403007

Any application of payments, insurance proceeds, or Miscellaneous Proceeds to principal due under the Note shall not extend or postpone the due date, or change the amount, of the Periodic Payments.

3. Funds for Escrow Items. Borrower shall pay to Lender on the day Periodic Payments are due under the Note, until the Note is paid in full, a sum (the "Funds") to provide for payment of amounts due for: (a) taxes and assessments and other items which can attain priority over this Security Instrument as a lien or encumbrance on the Property; (b) leasehold payments or ground rents on the Property, if any; (c) premiums for any and all insurance required by Lender under Section 5; and (d) Mortgage Insurance premiums, if any, or any sums payable by Borrower to Lender in lieu of the payment of Mortgage Insurance premiums in accordance with the provisions of Section 10. These items are called "Escrow Items." At origination or at any time during the term of the Loan, Lender may require that Community Association Dues, Fees, and Assessments, if any, be escrowed by Borrower, and such dues, fees and assessments shall be an Escrow Item. Borrower shall promptly furnish to Lender all notices of amounts to be paid under this Section. Borrower shall pay Lender the Funds for Escrow Items unless Lender waives Borrower's obligation to pay the Funds for any or all Escrow Items. Lender may waive Borrower's obligation to pay to Lender Funds for any or all Escrow Items at any time. Any such waiver may only be in writing. In the event of such waiver, Borrower shall pay directly, when and where payable, the amounts due for any Escrow Items for which payment of Funds has been waived by Lender and, if Lender requires, shall furnish to Lender receipts evidencing such payment within such time period as Lender may require. Borrower's obligation to make such payments and to provide receipts shall for all purposes be deemed to be a covenant and agreement contained in this Security Instrument, as the phrase "covenant and agreement" is used in Section 9. If Borrower is obligated to pay Escrow Items directly, pursuant to a waiver, and Borrower fails to pay the amount due for an Escrow Item, Lender may exercise its rights under Section 9 and pay such amount and Borrower shall then be obligated under Section 9 to repay to Lender any such amount. Lender may revoke the waiver as to any or all Escrow Items at any time by a notice given in accordance with Section 15 and, upon such revocation, Borrower shall pay to Lender all Funds, and in such amounts, that are then required under this Section 3.

Lender may, at any time, collect and hold Funds in an amount (a) sufficient to permit Lender to apply the Funds at the time specified under RESPA, and (b) not to exceed the maximum amount a lender can require under RESPA. Lender shall estimate the amount of Funds due on the basis of current data and reasonable estimates of expenditures of future Escrow Items or otherwise in accordance with Applicable Law.

The Funds shall be held in an institution whose deposits are insured by a federal agency, instrumentality, or entity (including Lender, if Lender is an institution whose deposits are so insured) or in any Federal Home Loan Bank. Lender shall apply the Funds to pay the Escrow Items no later than the time specified under RESPA. Lender shall not charge Borrower for holding and applying the Funds, annually analyzing the escrow account, or verifying the Escrow Items, unless Lender pays Borrower interest on the Funds and Applicable Law permits Lender to make such a charge. Unless an agreement is made in writing or Applicable Law requires interest to be paid on the Funds, Lender shall not be required to pay Borrower any interest or earnings on the Funds. Borrower and Lender can agree in writing, however, that interest shall be paid on the Funds. Lender shall give to Borrower, without charge, an annual accounting of the Funds as required by RESPA.

If there is a surplus of Funds held in escrow, as defined under RESPA, Lender shall account to Borrower for the excess funds in accordance with RESPA. If there is a shortage of Funds held in escrow, as defined under RESPA, Lender shall notify Borrower as required by RESPA, and Borrower shall pay to Lender the amount necessary to make up the shortage in accordance with RESPA, but in no more than 12 monthly payments. If there is a deficiency of Funds held in escrow, as defined under RESPA, Lender shall notify Borrower as required by RESPA, and Borrower shall pay to Lender the amount necessary to make up the deficiency in accordance with RESPA, but in no more than 12 monthly payments.

Upon payment in full of all sums secured by this Security Instrument, Lender shall promptly refund to Borrower any Funds held by Lender.

4. Charges; Liens. Borrower shall pay all taxes, assessments, charges, fines, and impositions attributable to the Property which can attain priority over this Security Instrument, leasehold payments or ground rents on the Property, if any, and Community Association Dues, Fees, and Assessments, if any. To the extent that these items are Escrow Items, Borrower shall pay them in the manner provided in Section 3.

Borrower shall promptly discharge any lien which has priority over this Security Instrument unless Borrower: (a) agrees in writing to the payment of the obligation secured by the lien in a manner acceptable to Lender, but only so long as Borrower is performing such agreement; (b) contests the lien in good faith by, or defends against enforcement of the lien in, legal proceedings which in Lender's opinion operate to prevent the enforcement of the lien while those proceedings are pending, but only until such proceedings are concluded; or (c) secures from the holder of the lien an agreement satisfactory to Lender subordinating the lien to this Security Instrument. If Lender determines that any part of the Property is subject to a lien which can attain priority over this Security Instrument, Lender may give Borrower a notice identifying the lien. Within 10 days of the date on which that notice is given, Borrower shall satisfy the lien or take one or more of the actions set forth above in this Section 4.

JAJ GAJ

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Lender may require Borrower to pay a one-time charge for a real estate tax verification and/or reporting service used by Lender in connection with this Loan.

5. **Property Insurance.** Borrower shall keep the improvements now existing or hereafter erected on the Property insured against loss by fire, hazards included within the term "extended coverage," and any other hazards including, but not limited to, earthquakes and floods, for which Lender requires insurance. This insurance shall be maintained in the amounts (including deductible levels) and for the periods that Lender requires. What Lender requires pursuant to the preceding sentences can change during the term of the Loan. The insurance carrier providing the insurance shall be chosen by Borrower subject to Lender's right to disapprove Borrower's choice, which right shall not be exercised unreasonably. Lender may require Borrower to pay, in connection with this Loan, either: (a) a one-time charge for flood zone determination, certification and tracking services; or (b) a one-time charge for flood zone determination and certification services and subsequent charges each time remappings or similar changes occur which reasonably might affect such determination or certification. Borrower shall also be responsible for the payment of any fees imposed by the Federal Emergency Management Agency in connection with the review of any flood zone determination resulting from an objection by Borrower.

If Borrower fails to maintain any of the coverages described above, Lender may obtain insurance coverage, at Lender's option and Borrower's expense. Lender is under no obligation to purchase any particular type or amount of coverage. Therefore, such coverage shall cover Lender, but might or might not protect Borrower, Borrower's equity in the Property, or the contents of the Property, against any risk, hazard or liability and might provide greater or lesser coverage than was previously in effect. Borrower acknowledges that the cost of the insurance coverage so obtained might significantly exceed the cost of insurance that Borrower could have obtained. Any amounts disbursed by Lender under this Section 5 shall become additional debt of Borrower secured by this Security Instrument. These amounts shall bear interest at the Note rate from the date of disbursement and shall be payable, with such interest, upon notice from Lender to Borrower requesting payment.

All insurance policies required by Lender and renewals of such policies shall be subject to Lender's right to disapprove such policies, shall include a standard mortgage clause, and shall name Lender as mortgagee and/or as an additional loss payee. Lender shall have the right to hold the policies and renewal certificates. If Lender requires, Borrower shall promptly give to Lender all receipts of paid premiums and renewal notices. If Borrower obtains any form of insurance coverage, not otherwise required by Lender, for damage to, or destruction of, the Property, such policy shall include a standard mortgage clause and shall name Lender as mortgagee and/or as an additional loss payee.

In the event of loss, Borrower shall give prompt notice to the insurance carrier and Lender. Lender may make proof of loss if not made promptly by Borrower. Unless Lender and Borrower otherwise agree in writing, any insurance proceeds, whether or not the underlying insurance was required by Lender, shall be applied to restoration or repair of the Property, if the restoration or repair is economically feasible and Lender's security is not lessened. During such repair and restoration period, Lender shall have the right to hold such insurance proceeds until Lender has had an opportunity to inspect such Property to ensure the work has been completed to Lender's satisfaction, provided that such inspection shall be undertaken promptly. Lender may disburse proceeds for the repairs and restoration in a single payment or in a series of progress payments as the work is completed. Unless an agreement is made in writing or Applicable Law requires interest to be paid on such insurance proceeds, Lender shall not be required to pay Borrower any interest or earnings on such proceeds. Fees for public adjusters, or other third parties, retained by Borrower shall not be paid out of the insurance proceeds and shall be the sole obligation of Borrower. If the restoration or repair is not economically feasible or Lender's security would be lessened, the insurance proceeds shall be applied to the sums secured by this Security Instrument, whether or not then due, with the excess, if any, paid to Borrower. Such insurance proceeds shall be applied in the order provided for in Section 2.

If Borrower abandons the Property, Lender may file, negotiate and settle any available insurance claim and related matters. If Borrower does not respond within 30 days to a notice from Lender that the insurance carrier has offered to settle a claim, then Lender may negotiate and settle the claim. The 30-day period will begin when the notice is given. In either event, or if Lender acquires the Property under Section 22 or otherwise, Borrower hereby assigns to Lender (a) Borrower's rights to any insurance proceeds in an amount not to exceed the amounts unpaid under the Note or this Security Instrument, and (b) any other of Borrower's rights (other than the right to any refund of unearned premiums paid by Borrower) under all insurance policies covering the Property, insofar as such rights are applicable to the coverage of the Property. Lender may use the insurance proceeds either to repair or restore the Property or to pay amounts unpaid under the Note or this Security Instrument, whether or not then due.

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6. Occupancy. Borrower shall occupy, establish, and use the Property as Borrower's principal residence within 60 days after the execution of this Security Instrument and shall continue to occupy the Property as Borrower's principal residence for at least one year after the date of occupancy, unless Lender otherwise agrees in writing, which consent shall not be unreasonably withheld, or unless extenuating circumstances exist which are beyond Borrower's control.

7. Preservation, Maintenance and Protection of the Property; Inspections. Borrower shall not destroy, damage or impair the Property, allow the Property to deteriorate or commit waste on the Property. Whether or not Borrower is residing in the Property, Borrower shall maintain the Property in order to prevent the Property from deteriorating or decreasing in value due to its condition. Unless it is determined pursuant to Section 5 that repair or restoration is not economically feasible, Borrower shall promptly repair the Property if damaged to avoid further deterioration or damage. If insurance or condemnation proceeds are paid in connection with damage to, or the taking of, the Property, Borrower shall be responsible for repairing or restoring the Property only if Lender has released proceeds for such purposes. Lender may disburse proceeds for the repairs and restoration in a single payment or in a series of progress payments as the work is completed. If the insurance or condemnation proceeds are not sufficient to repair or restore the Property, Borrower is not relieved of Borrower's obligation for the completion of such repair or restoration.

Lender or its agent may make reasonable entries upon and inspections of the Property. If it has reasonable cause, Lender may inspect the interior of the improvements on the Property. Lender shall give Borrower notice at the time of or prior to such an interior inspection specifying such reasonable cause.

8. Borrower's Loan Application. Borrower shall be in default if, during the Loan application process, Borrower or any persons or entities acting at the direction of Borrower or with Borrower's knowledge or consent gave materially false, misleading, or inaccurate information or statements to Lender (or failed to provide Lender with material information) in connection with the Loan. Material representations include, but are not limited to, representations concerning Borrower's occupancy of the Property as Borrower's principal residence.

9. Protection of Lender's Interest in the Property and Rights Under this Security Instrument. If (a) Borrower fails to perform the covenants and agreements contained in this Security Instrument, (b) there is a legal proceeding that might significantly affect Lender's interest in the Property and/or rights under this Security Instrument (such as a proceeding in bankruptcy, probate, for condemnation or forfeiture, for enforcement of a lien which may attain priority over this Security Instrument or to enforce laws or regulations), or (c) Borrower has abandoned the Property, then Lender may do and pay for whatever is reasonable or appropriate to protect Lender's interest in the Property and rights under this Security Instrument, including protecting and/or assessing the value of the Property, and securing and/or repairing the Property. Lender's actions can include, but are not limited to: (a) paying any sums secured by a lien which has priority over this Security Instrument; (b) appearing in court; and (c) paying reasonable attorneys' fees to protect its interest in the Property and/or rights under this Security Instrument, including its secured position in a bankruptcy proceeding. Securing the Property includes, but is not limited to, entering the Property to make repairs, change locks, replace or board up doors and windows, drain water from pipes, eliminate building or other code violations or dangerous conditions, and have utilities turned on or off. Although Lender may take action under this Section 9, Lender does not have to do so and is not under any duty or obligation to do so. It is agreed that Lender incurs no liability for not taking any or all actions authorized under this Section 9.

Any amounts disbursed by Lender under this Section 9 shall become additional debt of Borrower secured by this Security Instrument. These amounts shall bear interest at the Note rate from the date of disbursement and shall be payable, with such interest, upon notice from Lender to Borrower requesting payment.

If this Security Instrument is on a leasehold, Borrower shall comply with all the provisions of the lease. If Borrower acquires fee title to the Property, the leasehold and the fee title shall not merge unless Lender agrees to the merger in writing.

10. Mortgage Insurance. If Lender required Mortgage Insurance as a condition of making the Loan, Borrower shall pay the premiums required to maintain the Mortgage Insurance in effect. If, for any reason, the Mortgage Insurance coverage required by Lender ceases to be available from the mortgage insurer that previously provided such insurance and Borrower was required to make separately designated payments toward the premiums for Mortgage Insurance, Borrower shall pay the premiums required to obtain coverage substantially equivalent to the Mortgage Insurance previously in effect, at a cost substantially equivalent to the cost to Borrower of the Mortgage Insurance previously in effect, from an alternate mortgage insurer selected by Lender. If substantially equivalent Mortgage Insurance coverage is not available, Borrower shall continue to pay to Lender the amount of the separately designated payments that were due when the insurance coverage ceased to be in effect. Lender will accept, use and retain these payments as a non-refundable loss reserve in lieu of Mortgage Insurance. Such loss reserve shall be non-refundable, notwithstanding the fact that the Loan is ultimately paid in full, and Lender shall not be required to pay Borrower any interest or earnings on such loss reserve. Lender can no longer require loss reserve payments if Mortgage Insurance coverage (in the

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amount and for the period that Lender requires) provided by an insurer selected by Lender again becomes available, is obtained, and Lender requires separately designated payments toward the premiums for Mortgage Insurance. If Lender required Mortgage Insurance as a condition of making the Loan and Borrower was required to make separately designated payments toward the premiums for Mortgage Insurance, Borrower shall pay the premiums required to maintain Mortgage Insurance in effect, or to provide a non-refundable loss reserve, until Lender's requirement for Mortgage Insurance ends in accordance with any written agreement between Borrower and Lender providing for such termination or until termination is required by Applicable Law. Nothing in this Section 10 affects Borrower's obligation to pay interest at the rate provided in the Note.

Mortgage Insurance reimburses Lender (or any entity that purchases the Note) for certain losses it may incur if Borrower does not repay the Loan as agreed. Borrower is not a party to the Mortgage Insurance.

Mortgage insurers evaluate their total risk on all such insurance in force from time to time, and may enter into agreements with other parties that share or modify their risk, or reduce losses. These agreements are on terms and conditions that are satisfactory to the mortgage insurer and the other party (or parties) to these agreements. These agreements may require the mortgage insurer to make payments using any source of funds that the mortgage insurer may have available (which may include funds obtained from Mortgage Insurance premiums).

As a result of these agreements, Lender, any purchaser of the Note, another insurer, any reinsurer, any other entity, or any affiliate of any of the foregoing, may receive (directly or indirectly) amounts that derive from (or might be characterized as) a portion of Borrower's payments for Mortgage Insurance, in exchange for sharing or modifying the mortgage insurer's risk, or reducing losses. If such agreement provides that an affiliate of Lender takes a share of the insurer's risk in exchange for a share of the premiums paid to the insurer, the arrangement is often termed "captive reinsurance." Further:

(a) Any such agreements will not affect the amounts that Borrower has agreed to pay for Mortgage Insurance, or any other terms of the Loan. Such agreements will not increase the amount Borrower will owe for Mortgage Insurance, and they will not entitle Borrower to any refund.

(b) Any such agreements will not affect the rights Borrower has - if any - with respect to the Mortgage Insurance under the Homeowners Protection Act of 1998 or any other law. These rights may include the right to receive certain disclosures, to request and obtain cancellation of the Mortgage Insurance, to have the Mortgage Insurance terminated automatically, and/or to receive a refund of any Mortgage Insurance premiums that were unearned at the time of such cancellation or termination.

11. Assignment of Miscellaneous Proceeds; Forfeiture. All Miscellaneous Proceeds are hereby assigned to and shall be paid to Lender.

If the Property is damaged, such Miscellaneous Proceeds shall be applied to restoration or repair of the Property, if the restoration or repair is economically feasible and Lender's security is not lessened. During such repair and restoration period, Lender shall have the right to hold such Miscellaneous Proceeds until Lender has had an opportunity to inspect such Property to ensure the work has been completed to Lender's satisfaction, provided that such inspection shall be undertaken promptly. Lender may pay for the repairs and restoration in a single disbursement or in a series of progress payments as the work is completed. Unless an agreement is made in writing or Applicable Law requires interest to be paid on such Miscellaneous Proceeds, Lender shall not be required to pay Borrower any interest or earnings on such Miscellaneous Proceeds. If the restoration or repair is not economically feasible or Lender's security would be lessened, the Miscellaneous Proceeds shall be applied to the sums secured by this Security Instrument, whether or not then due, with the excess, if any, paid to Borrower. Such Miscellaneous Proceeds shall be applied in the order provided for in Section 2.

In the event of a total taking, destruction, or loss in value of the Property, the Miscellaneous Proceeds shall be applied to the sums secured by this Security Instrument, whether or not then due, with the excess, if any, paid to Borrower.

In the event of a partial taking, destruction, or loss in value of the Property in which the fair market value of the Property immediately before the partial taking, destruction, or loss in value is equal to or greater than the amount of the sums secured by this Security Instrument immediately before the partial taking, destruction, or loss in value, unless Borrower and Lender otherwise agree in writing, the sums secured by this Security Instrument shall be reduced by the amount of the Miscellaneous Proceeds multiplied by the following fraction: (a) the total amount of the sums secured immediately before the partial taking, destruction, or loss in value divided by (b) the fair market value of the Property immediately before the partial taking, destruction, or loss in value. Any balance shall be paid to Borrower.

In the event of a partial taking, destruction, or loss in value of the Property in which the fair market value of the Property immediately before the partial taking, destruction, or loss in value is less than the amount of the sums secured immediately before the partial taking, destruction, or loss in value, unless Borrower and Lender otherwise agree in writing, the Miscellaneous Proceeds shall be applied to the sums secured by this Security Instrument whether or not the sums are then due.

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If the Property is abandoned by Borrower, or if, after notice by Lender to Borrower that the Opposing Party (as defined in the next sentence) offers to make an award to settle a claim for damages, Borrower fails to respond to Lender within 30 days after the date the notice is given, Lender is authorized to collect and apply the Miscellaneous Proceeds either to restoration or repair of the Property or to the sums secured by this Security Instrument, whether or not then due. "Opposing Party" means the third party that owes Borrower Miscellaneous Proceeds or the party against whom Borrower has a right of action in regard to Miscellaneous Proceeds.

Borrower shall be in default if any action or proceeding, whether civil or criminal, is begun that, in Lender's judgment, could result in forfeiture of the Property or other material impairment of Lender's interest in the Property or rights under this Security Instrument. Borrower can cure such a default and, if acceleration has occurred, reinstate as provided in Section 19, by causing the action or proceeding to be dismissed with a ruling that, in Lender's judgment, precludes forfeiture of the Property or other material impairment of Lender's interest in the Property or rights under this Security Instrument. The proceeds of any award or claim for damages that are attributable to the impairment of Lender's interest in the Property are hereby assigned and shall be paid to Lender.

All Miscellaneous Proceeds that are not applied to restoration or repair of the Property shall be applied in the order provided for in Section 2.

12. Borrower Not Released; Forbearance By Lender Not a Waiver. Extension of the time for payment or modification of amortization of the sums secured by this Security Instrument granted by Lender to Borrower or any Successor in Interest of Borrower shall not operate to release the liability of Borrower or any Successors in Interest of Borrower. Lender shall not be required to commence proceedings against any Successor in Interest of Borrower or to refuse to extend time for payment or otherwise modify amortization of the sums secured by this Security Instrument by reason of any demand made by the original Borrower or any Successors in Interest of Borrower. Any forbearance by Lender in exercising any right or remedy including, without limitation, Lender's acceptance of payments from third persons, entities or Successors in Interest of Borrower or in amounts less than the amount then due, shall not be a waiver of or preclude the exercise of any right or remedy.

13. Joint and Several Liability; Co-signers; Successors and Assigns Bound. Borrower covenants and agrees that Borrower's obligations and liability shall be joint and several. However, any Borrower who co-signs this Security Instrument but does not execute the Note (a "co-signer"): (a) is co-signing this Security Instrument only to mortgage, grant and convey the co-signer's interest in the Property under the terms of this Security Instrument; (b) is not personally obligated to pay the sums secured by this Security Instrument; and (c) agrees that Lender and any other Borrower can agree to extend, modify, forbear or make any accommodations with regard to the terms of this Security Instrument or the Note without the co-signer's consent.

Subject to the provisions of Section 18, any Successor in Interest of Borrower who assumes Borrower's obligations under this Security Instrument in writing, and is approved by Lender, shall obtain all of Borrower's rights and benefits under this Security Instrument. Borrower shall not be released from Borrower's obligations and liability under this Security Instrument unless Lender agrees to such release in writing. The covenants and agreements of this Security Instrument shall bind (except as provided in Section 20) and benefit the successors and assigns of Lender.

14. Loan Charges. Lender may charge Borrower fees for services performed in connection with Borrower's default, for the purpose of protecting Lender's interest in the Property and rights under this Security Instrument, including, but not limited to, attorneys' fees, property inspection and valuation fees. In regard to any other fees, the absence of express authority in this Security Instrument to charge a specific fee to Borrower shall not be construed as a prohibition on the charging of such fee. Lender may not charge fees that are expressly prohibited by this Security Instrument or by Applicable Law.

If the Loan is subject to a law which sets maximum loan charges, and that law is finally interpreted so that the interest or other loan charges collected or to be collected in connection with the Loan exceed the permitted limits, then: (a) any such loan charge shall be reduced by the amount necessary to reduce the charge to the permitted limit; and (b) any sums already collected from Borrower which exceeded permitted limits will be refunded to Borrower. Lender may choose to make this refund by reducing the principal owed under the Note or by making a direct payment to Borrower. If a refund reduces principal, the reduction will be treated as a partial prepayment without any prepayment charge (whether or not a prepayment charge is provided for under the Note). Borrower's acceptance of any such refund made by direct payment to Borrower will constitute a waiver of any right of action Borrower might have arising out of such overcharge.

15. Notices. All notices given by Borrower or Lender in connection with this Security Instrument must be in writing. Any notice to Borrower in connection with this Security Instrument shall be deemed to have been given to Borrower when mailed by first class mail or when actually delivered to Borrower's notice address if sent by other means. Notice to any one Borrower shall constitute notice to all Borrowers unless Applicable Law expressly requires otherwise. The notice address shall be the Property Address unless

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Borrower has designated a substitute notice address by notice to Lender. Borrower shall promptly notify Lender of Borrower's change of address. If Lender specifies a procedure for reporting Borrower's change of address, then Borrower shall only report a change of address through that specified procedure. There may be only one designated notice address under this Security Instrument at any one time. Any notice to Lender shall be given by delivering it or by mailing it by first class mail to Lender's address stated herein unless Lender has designated another address by notice to Borrower. Any notice in connection with this Security Instrument shall not be deemed to have been given to Lender until actually received by Lender. If any notice required by this Security Instrument is also required under Applicable Law, the Applicable Law requirement will satisfy the corresponding requirement under this Security Instrument.

16. Governing Law; Severability; Rules of Construction. This Security Instrument shall be governed by federal law and the law of the jurisdiction in which the Property is located. All rights and obligations contained in this Security Instrument are subject to any requirements and limitations of Applicable Law. Applicable Law might explicitly or implicitly allow the parties to agree by contract or it might be silent, but such silence shall not be construed as a prohibition against agreement by contract. In the event that any provision or clause of this Security Instrument or the Note conflicts with Applicable Law, such conflict shall not affect other provisions of this Security Instrument or the Note which can be given effect without the conflicting provision.

As used in this Security Instrument: (a) words of the masculine gender shall mean and include corresponding neuter words or words of the feminine gender; (b) words in the singular shall mean and include the plural and vice versa; and (c) the word "may" gives sole discretion without any obligation to take any action.

17. Borrower's Copy. Borrower shall be given one copy of the Note and of this Security Instrument.

18. Transfer of the Property or a Beneficial Interest in Borrower. As used in this Section 18, "Interest in the Property" means any legal or beneficial interest in the Property, including, but not limited to, those beneficial interests transferred in a bond for deed, contract for deed, installment sales contract or escrow agreement, the intent of which is the transfer of title by Borrower at a future date to a purchaser.

If all or any part of the Property or any Interest in the Property is sold or transferred (or if Borrower is not a natural person and a beneficial interest in Borrower is sold or transferred) without Lender's prior written consent, Lender may require immediate payment in full of all sums secured by this Security Instrument. However, this option shall not be exercised by Lender if such exercise is prohibited by Applicable Law.

If Lender exercises this option, Lender shall give Borrower notice of acceleration. The notice shall provide a period of not less than 30 days from the date the notice is given in accordance with Section 15 within which Borrower must pay all sums secured by this Security Instrument. If Borrower fails to pay these sums prior to the expiration of this period, Lender may invoke any remedies permitted by this Security Instrument without further notice or demand on Borrower.

19. Borrower's Right to Reinstate After Acceleration. If Borrower meets certain conditions, Borrower shall have the right to have enforcement of this Security Instrument discontinued at any time prior to the earliest of: (a) five days before sale of the Property pursuant to any power of sale contained in this Security Instrument; (b) such other period as Applicable Law might specify for the termination of Borrower's right to reinstate; or (c) entry of a judgment enforcing this Security Instrument. Those conditions are that Borrower: (a) pays Lender all sums which then would be due under this Security Instrument and the Note as if no acceleration had occurred; (b) cures any default of any other covenants or agreements; (c) pays all expenses incurred in enforcing this Security Instrument, including, but not limited to, reasonable attorneys' fees, property inspection and valuation fees, and other fees incurred for the purpose of protecting Lender's interest in the Property and rights under this Security Instrument; and (d) takes such action as Lender may reasonably require to assure that Lender's interest in the Property and rights under this Security Instrument, and Borrower's obligation to pay the sums secured by this Security Instrument, shall continue unchanged. Lender may require that Borrower pay such reinstatement sums and expenses in one or more of the following forms, as selected by Lender: (a) cash; (b) money order; (c) certified check, bank check, treasurer's check or cashier's check, provided any such check is drawn upon an institution whose deposits are insured by a federal agency, instrumentality or entity; or (d) Electronic Funds Transfer. Upon reinstatement by Borrower, this Security Instrument and obligations secured hereby shall remain fully effective as if no acceleration had occurred. However, this right to reinstate shall not apply in the case of acceleration under Section 18.

20. Sale of Note; Change of Loan Servicer; Notice of Grievance. The Note or a partial interest in the Note (together with this Security Instrument) can be sold one or more times without prior notice to Borrower. A sale might result in a change in the entity (known as the "Loan Servicer") that collects Periodic Payments due under the Note and this Security Instrument and performs other mortgage loan servicing obligations under the Note, this Security Instrument, and Applicable Law. There also might be one or more changes of the Loan Servicer unrelated to a sale of the Note. If there is a change of the Loan Servicer, Borrower will be given written notice of the change which will state the name and address of the new Loan Servicer, the address to

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which payments should be made and any other information RESPA requires in connection with a notice of transfer of servicing. If the Note is sold and thereafter the Loan is serviced by a Loan Servicer other than the purchaser of the Note, the mortgage loan servicing obligations to Borrower will remain with the Loan Servicer or be transferred to a successor Loan Servicer and are not assumed by the Note purchaser unless otherwise provided by the Note purchaser.

Neither Borrower nor Lender may commence, join, or be joined to any judicial action (as either an individual litigant or the member of a class) that arises from the other party's actions pursuant to this Security Instrument or that alleges that the other party has breached any provision of, or any duty owed by reason of, this Security Instrument, until such Borrower or Lender has notified the other party (with such notice given in compliance with the requirements of Section 15) of such alleged breach and afforded the other party hereto a reasonable period after the giving of such notice to take corrective action. If Applicable Law provides a time period which must elapse before certain action can be taken, that time period will be deemed to be reasonable for purposes of this paragraph. The notice of acceleration and opportunity to cure given to Borrower pursuant to Section 22 and the notice of acceleration given to Borrower pursuant to Section 18 shall be deemed to satisfy the notice and opportunity to take corrective action provisions of this Section 20.

21. Hazardous Substances. As used in this Section 21: (a) "Hazardous Substances" are those substances defined as toxic or hazardous substances, pollutants, or wastes by Environmental Law and the following substances: gasoline, kerosene, other flammable or toxic petroleum products, toxic pesticides and herbicides, volatile solvents, materials containing asbestos or formaldehyde, and radioactive materials; (b) "Environmental Law" means federal laws and laws of the jurisdiction where the Property is located that relate to health, safety or environmental protection; (c) "Environmental Cleanup" includes any response action, remedial action, or removal action, as defined in Environmental Law; and (d) an "Environmental Condition" means a condition that can cause, contribute to, or otherwise trigger an Environmental Cleanup.

Borrower shall not cause or permit the presence, use, disposal, storage, or release of any Hazardous Substances, or threaten to release any Hazardous Substances, on or in the Property. Borrower shall not do, nor allow anyone else to do, anything affecting the Property (a) that is in violation of any Environmental Law, (b) which creates an Environmental Condition, or (c) which, due to the presence, use, or release of a Hazardous Substance, creates a condition that adversely affects the value of the Property. The preceding two sentences shall not apply to the presence, use, or storage on the Property of small quantities of Hazardous Substances that are generally recognized to be appropriate to normal residential uses and to maintenance of the Property (including, but not limited to, hazardous substances in consumer products).

Borrower shall promptly give Lender written notice of (a) any investigation, claim, demand, lawsuit or other action by any governmental or regulatory agency or private party involving the Property and any Hazardous Substance or Environmental Law of which Borrower has actual knowledge, (b) any Environmental Condition, including but not limited to, any spilling, leaking, discharge, release or threat of release of any Hazardous Substance, and (c) any condition caused by the presence, use or release of a Hazardous Substance which adversely affects the value of the Property. If Borrower learns, or is notified by any governmental or regulatory authority, or any private party, that any removal or other remediation of any Hazardous Substance affecting the Property is necessary, Borrower shall promptly take all necessary remedial actions in accordance with Environmental Law. Nothing herein shall create any obligation on Lender for an Environmental Cleanup.

NON-UNIFORM COVENANTS. Borrower and Lender further covenant and agree as follows:

22. Acceleration; Remedies. Lender shall give notice to Borrower prior to acceleration following Borrower's breach of any covenant or agreement in this Security Instrument (but not prior to acceleration under Section 18 unless Applicable Law provides otherwise). The notice shall specify: (a) the default; (b) the action required to cure the default; (c) a date, not less than 30 days from the date the notice is given to Borrower, by which the default must be cured; and (d) that failure to cure the default on or before the date specified in the notice may result in acceleration of the sums secured by this Security Instrument, foreclosure by judicial proceeding and sale of the Property. The notice shall further inform Borrower of the right to reinstate after acceleration and the right to assert in the foreclosure proceeding the non-existence of a default or any other defense of Borrower to acceleration and foreclosure. If the default is not cured on or before the date specified in the notice, Lender at its option may require immediate payment in full of all sums secured by this Security Instrument without further demand and may foreclose this Security Instrument by judicial proceeding. Lender shall be entitled to collect all expenses incurred in pursuing the remedies provided in this Section 22, including, but not limited to, reasonable attorneys' fees and costs of title evidence.

23. Release. Upon payment of all sums secured by this Security Instrument, Lender shall release this Security Instrument. Borrower shall pay any recordation costs. Lender may charge Borrower a fee for releasing this Security Instrument, but only if the fee is paid to a third party for services rendered and the charging of the fee is permitted under Applicable Law.

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24. Attorneys' Fees. As used in this Security Instrument and the Note, attorneys' fees shall include those awarded by an appellate court and any attorneys' fees incurred in a bankruptcy proceeding.

25. Jury Trial Waiver. The Borrower hereby waives any right to a trial by jury in any action, proceeding, claim, or counterclaim, whether in contract or tort, at law or in equity, arising out of or in any way related to this Security Instrument or the Note.

BY SIGNING BELOW, Borrower accepts and agrees to the terms and covenants contained in this Security Instrument and in any Rider executed by Borrower and recorded with it.

Signed, sealed and delivered in the presence of:

E C Booth — Jean Bruner Jeanclaude (Seal)
JEAN BRUNER JEANCLAUDE -Borrower
11 HEMMING DR
STAFFORD, VA 22554 (Address)

E C Booth — Gertrude Arthur-Jeanclaude (Seal)
GERTRUDE ARTHUR-JEANCLAUDE -Borrower
11 HEMMING DR
STAFFORD, VA 22554 (Address)

_______________ (Seal)
-Borrower
(Address)

_______________ (Seal)
-Borrower
(Address)

STATE OF FLORIDA, Palm Beach County ss:

The foregoing instrument was acknowledged before me this March 30th 2007 by JEAN B. JEANCLAUDE & GERTRUDE A. JEANCLAUDE

who is personally known to me or who has produced Driver's License as identification.

EMMANUEL C. BOOTH
Notary Public
Commonwealth of Virginia
My Commission Expires Jul 31, 2007

Emmanuel C. Booth
Notary Public
Emmanuel C. Booth

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PLANNED UNIT DEVELOPMENT RIDER

After Recording Return To:
COUNTRYWIDE HOME LOANS, INC.
MS SV-79 DOCUMENT PROCESSING
P.O.Box 10423
Van Nuys, CA 91410-0423

Prepared By:
HEATHER MCLAUGHLIN
COUNTRYWIDE HOME LOANS, INC.

2380 PERFORMANCE DR MSRGV
C931
RICHARDSON
TX 75082

165970934 [Escrow/Closing #] 00016597093403007 [Doc ID #]

THIS PLANNED UNIT DEVELOPMENT RIDER is made this THIRTIETH day of MARCH, 2007 , and is incorporated into and shall be deemed to amend and supplement the, Mortgage, Deed of Trust, or Security Deed (the "Security Instrument") of the same date, given by the undersigned (the "Borrower") to secure Borrower's Note to
COUNTRYWIDE HOME LOANS, INC.

(the "Lender") of the same date and covering the Property described in the Security Instrument and located at:

8671 THORNBROOK TERRACE PT
BOYNTON BEACH, FL 33437-4882
[Property Address]

The Property includes, but is not limited to, a parcel of land improved with a dwelling, together with

DOC ID #: 00016597093403007

other such parcels and certain common areas and facilities, as described in THE COVENANTS, CONDITIONS, AND RESTRICTIONS FILED OF RECORD THAT AFFECT THE PROPERTY

(the "Declaration"). The Property is a part of a planned unit development known as
CANYON ISLES

[Name of Planned Unit Development]

(the "PUD"). The Property also includes Borrower's interest in the homeowners association or equivalent entity owning or managing the common areas and facilities of the PUD (the "Owners Association") and the uses, benefits and proceeds of Borrower's interest.

PUD COVENANTS. In addition to the covenants and agreements made in the Security Instrument, Borrower and Lender further covenant and agree as follows:

A. PUD Obligations. Borrower shall perform all of Borrower's obligations under the PUD's Constituent Documents. The "Constituent Documents" are the (i) Declaration; (ii) articles of incorporation, trust instrument or any equivalent document which creates the Owners Association; and (iii) any by-laws or other rules or regulations of the Owners Association. Borrower shall promptly pay, when due, all dues and assessments imposed pursuant to the Constituent Documents.

B. Property Insurance. So long as the Owners Association maintains, with a generally accepted insurance carrier, a "master" or "blanket" policy insuring the Property which is satisfactory to Lender and which provides insurance coverage in the amounts (including deductible levels), for the periods, and against loss by fire, hazards included within the term "extended coverage," and any other hazards, including, but not limited to, earthquakes and floods, for which Lender requires insurance, then: (i) Lender waives the provision in Section 3 for the Periodic Payment to Lender of the yearly premium installments for property insurance on the Property; and (ii) Borrower's obligation under Section 5 to maintain property insurance coverage on the Property is deemed satisfied to the extent that the required coverage is provided by the Owners Association policy.

What Lender requires as a condition of this waiver can change during the term of the loan.

Borrower shall give Lender prompt notice of any lapse in required property insurance coverage provided by the master or blanket policy.

In the event of a distribution of property insurance proceeds in lieu of restoration or repair following a loss to the Property, or to common areas and facilities of the PUD, any proceeds payable to Borrower are hereby assigned and shall be paid to Lender. Lender shall apply the proceeds to the sums secured by the Security Instrument, whether or not then due, with the excess, if any, paid to Borrower.

C. Public Liability Insurance. Borrower shall take such actions as may be reasonable to insure that the Owners Association maintains a public liability insurance policy acceptable in form, amount, and extent of coverage to Lender.

D. Condemnation. The proceeds of any award or claim for damages, direct or consequential, payable to Borrower in connection with any condemnation or other taking of all or any part of the Property or the common areas and facilities of the PUD, or for any conveyance in lieu of condemnation, are hereby assigned and shall be paid to Lender. Such proceeds shall be applied by Lender to the sums secured by the Security Instrument as provided in Section 11.

E. Lender's Prior Consent. Borrower shall not, except after notice to Lender and with Lender's prior written consent, either partition or subdivide the Property or consent to: (i) the abandonment or termination of the PUD, except for abandonment or termination required by law in the case of substantial destruction by fire or other casualty or in the case of a taking by condemnation or eminent domain; (ii) any amendment to any provision of the "Constituent Documents" if the provision is for the

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DOC ID #: 00016597093403007

express benefit of Lender; (iii) termination of professional management and assumption of self-management of the Owners Association; or (iv) any action which would have the effect of rendering the public liability insurance coverage maintained by the Owners Association unacceptable to Lender.

F. Remedies. If Borrower does not pay PUD dues and assessments when due, then Lender may pay them. Any amounts disbursed by Lender under this paragraph F shall become additional debt of Borrower secured by the Security Instrument. Unless Borrower and Lender agree to other terms of payment, these amounts shall bear interest from the date of disbursement at the Note rate and shall be payable, with interest, upon notice from Lender to Borrower requesting payment.

BY SIGNING BELOW, Borrower accepts and agrees to the terms and provisions contained in this PUD Rider.

Jean Bruner Jeanglaude (Seal)
JEAN BRUNER JEANGLAUDE - Borrower
11 HEMMING DR
STAFFORD, VA 22554

Gertrude Arthur-Jeanglaude (Seal)
GERTRUDE ARTHUR-JEANGLAUDE - Borrower
11 HEMMING DR
STAFFORD, VA 22554

(Seal)
- Borrower

(Seal)
- Borrower

1-4 FAMILY RIDER
(Assignment of Rents)

After Recording Return To:
COUNTRYWIDE HOME LOANS, INC.
MS SV-79 DOCUMENT PROCESSING
P.O.Box 10423
Van Nuys, CA 91410-0423

Prepared By:
HEATHER MCLAUGHLIN
COUNTRYWIDE HOME LOANS, INC.

2380 PERFORMANCE DR MSRGV
C931
RICHARDSON

165970934 [Escrow/Closing #] 00016597093403007 [Doc ID #]

THIS 1-4 FAMILY RIDER is made this THIRTIETH day of MARCH, 2007, and is incorporated into and shall be deemed to amend and supplement the Mortgage, Deed of Trust, or Security Deed (the "Security Instrument") of the same date given by the undersigned (the "Borrower") to secure Borrower's Note to
COUNTRYWIDE HOME LOANS, INC.

(the "Lender") of the same date and covering the Property described in the Security Instrument and located at:

8671 THORNBROOK TERRACE PT
BOYNTON BEACH, FL 33437-4882
[Property Address]

1-4 FAMILY COVENANTS. In addition to the covenants and agreements made in the Security Instrument, Borrower and Lender further covenant and agree as follows:

DOC ID #: 00016597093403007

A. ADDITIONAL PROPERTY SUBJECT TO THE SECURITY INSTRUMENT. In addition to the Property described in the Security Instrument, the following items now or hereafter attached to the Property to the extent they are fixtures are added to the Property description, and shall also constitute the Property covered by the Security Instrument: building materials, appliances and goods of every nature whatsoever now or hereafter located in, on, or used, or intended to be used in connection with the Property, including, but not limited to, those for the purposes of supplying or distributing heating, cooling, electricity, gas, water, air and light, fire prevention and extinguishing apparatus, security and access control apparatus, plumbing, bath tubs, water heaters, water closets, sinks, ranges, stoves, refrigerators, dishwashers, disposals, washers, dryers, awnings, storm windows, storm doors, screens, blinds, shades, curtains and curtain rods, attached mirrors, cabinets, paneling and attached floor coverings, all of which, including replacements and additions thereto, shall be deemed to be and remain a part of the Property covered by the Security Instrument. All of the foregoing together with the Property described in the Security Instrument (or the leasehold estate if the Security Instrument is on a leasehold) are referred to in this 1-4 Family Rider and the Security Instrument as the "Property."

B. USE OF PROPERTY; COMPLIANCE WITH LAW. Borrower shall not seek, agree to or make a change in the use of the Property or its zoning classification, unless Lender has agreed in writing to the change. Borrower shall comply with all laws, ordinances, regulations and requirements of any governmental body applicable to the Property.

C. SUBORDINATE LIENS. Except as permitted by federal law, Borrower shall not allow any lien inferior to the Security Instrument to be perfected against the Property without Lender's prior written permission.

D. RENT LOSS INSURANCE. Borrower shall maintain insurance against rent loss in addition to the other hazards for which insurance is required by Section 5.

E. "BORROWER'S RIGHT TO REINSTATE" DELETED. Section 19 is deleted.

F. BORROWER'S OCCUPANCY. Unless Lender and Borrower otherwise agree in writing, Section 6 concerning Borrower's occupancy of the Property is deleted.

G. ASSIGNMENT OF LEASES. Upon Lender's request after default, Borrower shall assign to Lender all leases of the Property and all security deposits made in connection with leases of the Property. Upon the assignment, Lender shall have the right to modify, extend or terminate the existing leases and to execute new leases, in Lender's sole discretion. As used in this paragraph G, the word "lease" shall mean "sublease" if the Security Instrument is on a leasehold.

H. ASSIGNMENT OF RENTS; APPOINTMENT OF RECEIVER; LENDER IN POSSESSION. Borrower absolutely and unconditionally assigns and transfers to Lender all the rents and revenues ("Rents") of the Property, regardless of to whom the Rents of the Property are payable. Borrower authorizes Lender or Lender's agents to collect the Rents, and agrees that each tenant of the Property shall pay the Rents to Lender or Lender's agents. However, Borrower shall receive the Rents until: (i) Lender has given Borrower notice of default pursuant to Section 22 of the Security Instrument, and (ii) Lender has given notice to the tenant(s) that the Rents are to be paid to Lender or Lender's agent. This assignment of Rents constitutes an absolute assignment and not an assignment for additional security only.

If Lender gives notice of default to Borrower: (i) all Rents received by Borrower shall be held by Borrower as trustee for the benefit of Lender only, to be applied to the sums secured by the Security Instrument; (ii) Lender shall be entitled to collect and receive all of the Rents of the Property; (iii) Borrower agrees that each tenant of the Property shall pay all Rents due and unpaid to Lender or Lender's agents upon Lender's written demand to the tenant; (iv) unless applicable law provides otherwise, all Rents collected by Lender or Lender's agents shall be applied first to the costs of taking control of and managing the Property and collecting the Rents, including, but not limited to, attorneys' fees, receiver's fees, premiums on receiver's bonds, repair and

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DOC ID #: 00016597093403007

maintenance costs, insurance premiums, taxes, assessments and other charges on the Property, and then to the sums secured by the Security Instrument; (v) Lender, Lender's agents or any judicially appointed receiver shall be liable to account for only those Rents actually received; and (vi) Lender shall be entitled to have a receiver appointed to take possession of and manage the Property and collect the Rents and profits derived from the Property without any showing as to the inadequacy of the Property as security.

If the Rents of the Property are not sufficient to cover the costs of taking control of and managing the Property and of collecting the Rents any funds expended by Lender for such purposes shall become indebtedness of Borrower to Lender secured by the Security Instrument pursuant to Section 9.

Borrower represents and warrants that Borrower has not executed any prior assignment of the Rents and has not performed, and will not perform, any act that would prevent Lender from exercising its rights under this paragraph.

Lender, or Lender's agents or a judicially appointed receiver, shall not be required to enter upon, take control of or maintain the Property before or after giving notice of default to Borrower. However, Lender, or Lender's agents or a judicially appointed receiver, may do so at any time when a default occurs. Any application of Rents shall not cure or waive any default or invalidate any other right or remedy of Lender. This assignment of Rents of the Property shall terminate when all the sums secured by the Security Instrument are paid in full.

I. CROSS-DEFAULT PROVISION. Borrower's default or breach under any note or agreement in which Lender has an interest shall be a breach under the Security Instrument and Lender may invoke any of the remedies permitted by the Security Instrument.

BY SIGNING BELOW, Borrower accepts and agrees to the terms and provisions contained in this 1-4 Family Rider.

Jean Bruner Jeanglaude (Seal)
JEAN BRUNER JEANGLAUDE - Borrower
11 HEMMING DR
STAFFORD, VA 22554

Gertrude Arthur-Jeanglaude (Seal)
GERTRUDE ARTHUR-JEANGLAUDE - Borrower
11 HEMMING DR
STAFFORD, VA 22554

_______________ (Seal)
- Borrower

_______________ (Seal)
- Borrower

EXHIBIT A

SITUATED IN PALM BEACH COUNTY, FLORIDA, THE FOLLOWING DESCRIBED PROPERTY:

LOT 117, CANYON ISLES - PLAT TWO, ACCORDING TO THE PLAT THEREOF, AS RECORDED IN PLAT BOOK 105 AT PAGE 40, OF THE PUBLIC RECORDS OF PALM BEACH COUNTY, FLORIDA.

THORNBROOK TERRACE PLACE
ADDRESS: 8671 ~~THORN BROOK,~~ BOYNTON BEACH, FL 33437 TAX MAP OR PARCEL ID NO.: 00-42-45-32-03-000-1170

U38332630-01NP18
MORTGAGE
LOAN# T007-040958
US Recordings

IN THE CIRCUIT COURT FOR PALM BEACH COUNTY, FLORIDA.
CIVIL DIVISION

CASE NO.

THE BANK OF NEW YORK MELLON FKA THE BANK OF NEW YORK, AS TRUSTEE FOR THE CERTIFICATEHOLDERS, CWALT, INC., ALTERNATIVE LOAN TRUST 2007-12T1 MORTGAGE PASS-THROUGH CERTIFICATES, SERIES 2007-12T1,

Plaintiff,

vs.

50 2009 CA 027485 XXXX MB

JEAN BRUNER JEANGLAUDE; GERTRUDE ARTHUR JEANGLAUDE A/K/A GERTRUDE ARTHUR-JEANGLAUDE; CANYON ISLES HOMEOWNERS ASSOCIATION, INC.; UNKNOWN TENANT NO. 1; UNKNOWN TENANT NO. 2; and ALL UNKNOWN PARTIES CLAIMING INTERESTS BY, THROUGH, UNDER OR AGAINST A NAMED DEFENDANT TO THIS ACTION, OR HAVING OR CLAIMING TO HAVE ANY RIGHT, TITLE OR INTEREST IN THE PROPERTY HEREIN DESCRIBED,

AW

Defendants.
_______________________________/

09 AUG -4 PM 3:49
SHARON R. BOCK, CLERK
PALM BEACH COUNTY
CIRCUIT CIVIL

NOTICE OF LIS PENDENS

NOTICE IS HEREBY GIVEN that suit was instituted in the above styled Court on ____________ 2009, by the above styled Plaintiff against the above styled Defendants. The purpose of the suit is to foreclose a certain mortgage upon the following property:

LOT 117, CANYON ISLES - PLAT TWO, ACCORDING TO THE PLAT THEREOF, AS RECORDED IN PLAT BOOK 105 AT PAGE 40, OF THE PUBLIC RECORDS OF PALM BEACH COUNTY, FLORIDA.

All persons are therefore warned and advised of the pendency of this suit.

SMITH, HIATT & DIAZ, P.A.
Attorneys for Plaintiff
PO BOX 11438
Fort Lauderdale, FL 33339-1438
Telephone: (954) 564-0071

By: ____________________
Robert A. Smith
Florida Bar No. 116186
Patrice Tedescko
Florida Bar No. 0628451
Gavin MacMillan
Florida Bar No. 0037641
Gabrielle Strauss
Florida Bar No. 0059563
Glenn Matt Lindsay
Florida Bar No. 0059200
Tat-Lin Angus
Florida Bar No. 0051909
Annemarie Bui Tedford
Florida Bar No. 0030143

1183-70318

IN THE CIRCUIT COURT FOR PALM BEACH COUNTY, FLORIDA.
CIVIL DIVISION

CASE NO.

50 2009 CA027485 XXXX MB

THE BANK OF NEW YORK MELLON FKA THE BANK OF NEW YORK, AS TRUSTEE FOR THE CERTIFICATEHOLDERS, CWALT, INC., ALTERNATIVE LOAN TRUST 2007-12T1 MORTGAGE PASS-THROUGH CERTIFICATES, SERIES 2007-12T1,

Plaintiff,

vs.

JEAN BRUNER JEANGLAUDE; GERTRUDE ARTHUR JEANGLAUDE A/K/A GERTRUDE ARTHUR-JEANGLAUDE; CANYON ISLES HOMEOWNERS ASSOCIATION, INC.; UNKNOWN TENANT NO. 1; UNKNOWN TENANT NO. 2; and ALL UNKNOWN PARTIES CLAIMING INTERESTS BY, THROUGH, UNDER OR AGAINST A NAMED DEFENDANT TO THIS ACTION, OR HAVING OR CLAIMING TO HAVE ANY RIGHT, TITLE OR INTEREST IN THE PROPERTY HEREIN DESCRIBED,

AW

Defendants.
_______________________________/

09 AUG -4 PM 3:49
SHARON R. BOCK, CLERK
PALM BEACH COUNTY
CIRCUIT CIVIL

NOTICE OF LIS PENDENS

NOTICE IS HEREBY GIVEN that suit was instituted in the above styled Court on ____________ 2009, by the above styled Plaintiff against the above styled Defendants. The purpose of the suit is to foreclose a certain mortgage upon the following property:

LOT 117, CANYON ISLES - PLAT TWO, ACCORDING TO THE PLAT THEREOF, AS RECORDED IN PLAT BOOK 105 AT PAGE 40, OF THE PUBLIC RECORDS OF PALM BEACH COUNTY, FLORIDA.

All persons are therefore warned and advised of the pendency of this suit.

SMITH, HIATT & DIAZ, P.A.
Attorneys for Plaintiff
PO BOX 11438
Fort Lauderdale, FL 33339-1438
Telephone: (954) 564-0071

BY: ______________________
Robert A. Smith
Florida Bar No. 116186
Patrice Tedescko
Florida Bar No. 0628451
Gavin MacMillan
Florida Bar No. 0037641
Gabrielle Strauss
Florida Bar No. 0059563
Glenn Matt Lindsay
Florida Bar No. 0059200
Tat-Lin Angus
Florida Bar No. 0051909
Annemarie Bui Tedford
Florida Bar No. 0030143

1183-70318

CFN 20100076403
OR BK 23715 PG 1415
RECORDED 03/01/2010 08:30:07
Palm Beach County, Florida
AMT 640,000.00
Doc Stamp 4,480.00
Sharon R. Bock, CLERK & COMPTROLLER
Pgs 1415 - 1416; (2pgs)

This document was prepared by and Return to:
MICHAEL A. TRINKLER, ESQ.
MICHAEL A. TRINKLER, P.A.
5501 University Drive, Suite 101
Coral Springs, FL 33067
Phone: (954) 753-5700
Fax No. (954) 753-5767

(Reserved for Use by the Clerk)

WARRANTY DEED

THIS INDENTURE, is made this 5 day of February, 2010, between, JEAN BRUNER JEANGLAUDE and GERTRUDE ARTHUR JEANGLAUDE, husband and wife, party of the first part, and ROMUALD ALTINE and GETOSE ALTINE, husband and wife, whose post office address is: 8671 Thornbrook Terrace Point, Boynton Beach, FL 33437, party of the second part.

WITNESSETH:

That the party of the first part, for and in consideration of the sum of TEN AND NO/100 ($10.00) DOLLARS to them in hand paid by the party of the second part, the receipt whereof is hereby acknowledged, has granted, bargained and sold to the party of the second part, their heirs and assigns forever, the following described land, situate and being in the County of PALM BEACH and State of Florida, to-wit:

Lot 117, CANYON ISLES - PLAT TWO, according to the plat thereof, as recorded in Plat Book 105 at Page 40, of the Public Records of Palm Beach County, Florida.

Folio No.: 00-42-45-32-03-000-1170

SUBJECT TO:
1. Taxes for the year 2010, and subsequent years;
2. Conditions, restrictions, limitations and easements of record; without reimposing same;
3. Zoning restrictions, prohibitions and other requirements imposed by governmental authority.

And the party of the first part does hereby fully warrant the title to said land, and will defend the same against the lawful claims of all persons whomsoever.

(Reserved for Use by the Clerk)

IN WITNESS WHEREOF, the party of the first part has hereunto set her hand and seal the day and year first above written.

Signed, Sealed and Delivered
In the Presence of:

1st Witness Signature
Print Name of 1st Witness: Mellissa D. Sikes

JEAN BRUNER JEANGLAUDE

Dayna Solomey
2nd Witness Signature
Print Name of 2nd Witness: Dayna Solomey

Gertrude Arthur Jeanglaude
GERTRUDE ARTHUR JEANGLAUDE

Address: 11 Hemming Drive, Stafford, VA 22554

STATE OF Virginia)
) SS:
COUNTY OF Stafford)

The execution of the foregoing instrument was acknowledged before me this 5 day of February, 2010 by, JEAN BRUNER JEANGLAUDE and GERTRUDE ARTHUR JEANGLAUDE, who are personally known to me or who have produced VA drivers license as identification, and who did not take an oath.

My Commission Expires: 6/30/10

Karen Barrons
Notary Public
Print Name: Karen Barrons

OFFICIAL SEAL
NOTARY PUBLIC-COMMONWEALTH OF VIRGINIA
KAREN BARRONS
COUNTY OF STAFFORD
ID # 7012279
My Commission Expires
June 30, 2010

IN THE CIRCUIT COURT FOR PALM BEACH
COUNTY, FLORIDA. CIVIL DIVISION

CASE NO. 502009CA027485XXXXMB(AW)

THE BANK OF NEW YORK MELLON FKA THE
BANK OF NEW YORK, AS TRUSTEE FOR THE
CERTIFICATEHOLDERS,
CWALT,INC.,ALTERNATIVE LOAN TRUST
2007-12T1 MORTGAGE PASS-THROUGH
CERTIFICATES, SERIES 2007-12T1,

Plaintiff,

vs.

JEAN BRUNER JEANGLAUDE; GERTRUDE
ARTHUR JEANGLAUDE A/K/A GERTRUDE
ARTHUR-JEANGLAUDE; CANYON ISLES
HOMEOWNERS ASSOCIATION, INC.; UNKNOWN
TENANT NO. 1; UNKNOWN TENANT NO. 2; and
ALL UNKNOWN PARTIES CLAIMING INTERESTS
BY, THROUGH, UNDER OR AGAINST A NAMED
DEFENDANT TO THIS ACTION, OR HAVING OR
CLAIMING TO HAVE ANY RIGHT, TITLE OR
INTEREST IN THE PROPERTY HEREIN
DESCRIBED,

Defendants.
_______________________________________/

2010 JAN 29 PM 4:30
SHARON R. BOCK, CLERK
PALM BEACH COUNTY, FL
CIRCUIT CIVIL 1

3-8

SUMMARY FINAL JUDGMENT
OF FORECLOSURE

THIS ACTION came before the Court upon pleadings and proofs submitted herein, the motion of the Plaintiff, for the entry of a Summary Final Judgment, and on the evidence presented,

IT IS ADJUDGED THAT:

1. This Court has jurisdiction of the subject matter hereof and the parties hereto. The equities of this action are with the Plaintiff, THE BANK OF NEW YORK MELLON FKA THE BANK OF NEW YORK, AS TRUSTEE FOR THE CERTIFICATEHOLDERS,

CWALT,INC.,ALTERNATIVE LOAN TRUST 2007-12T1 MORTGAGE PASS-THROUGH CERTIFICATES, SERIES 2007-12T1, There is due to the Plaintiff, the sums of money as hereafter set forth:

A.	Principal Balance	$	807,000.00
B.	6.375% interest at $140.95 per diem from March 1, 2009 thru October 30, 2009	$	34,097.84
C.	Interest from October 31, 2009 thru January 29, 2010		12,826.45
D.	Advance for Taxes	$	17,066.99
E.	Pre-Acceleration Late Charges	$	643.08
F.	Property Preservation Fees	$	45.00
G.	Title Search	$	325.00
H.	Filing Fee	$	1,963.50
I.	Service of Process	$	475.00
J.	Corporate Search	$	15.00
K.	Attorneys' Fees	$	1,450.00
	TOTAL	$	875,907.86

2. Plaintiff is entitled to receive attorney's fees set forth above as compensation for 12 hours reasonably expended at a rate of $150.00 per hour, as set forth in the filed affidavit. However, pursuant to the Plaintiff's fee agreement with Smith, Hiatt & Diaz, P.A., the Plaintiff will pay attorneys' fees in the amount of $1450.00.

3. The original promissory note having been presented and delivered to the Court, Count I of Plaintiff's Complaint is hereby deemed moot.

4. A lien is held by the Plaintiff for the total sum specified in paragraph 1, plus interest, superior in dignity to any right, title, interest, or claim of the Defendants upon the mortgaged property herein foreclosed situate, lying and being in Palm Beach County, Florida, to-wit:

LOT 117, CANYON ISLES – PLAT TWO, ACCORDING TO THE PLAT THEREOF, AS RECORDED IN PLAT BOOK 105 AT PAGE 40, OF THE PUBLIC RECORDS OF PALM BEACH COUNTY, FLORIDA.

5. If the total sum due to the Plaintiff, plus interest on the unpaid principal at the rate prescribed in the note and mortgage to date, and at the current statutory interest rate after the date through which interest is calculated in paragraph 1 above, and all costs of this proceeding incurred after the date of this Judgment are not forthwith paid, the Clerk of this Court shall sell that property at public sale at 10:00 a.m. on the 8 day of MARCH, 2010, to the highest bidder or bidders for cash at the www.mypalmbeachclerk.clerkauction.com, after having first given notice as required by Section 45.031, Florida Statutes.

6. Plaintiff shall advance the cost of publishing the Notice of Sale and shall be reimbursed by the Clerk out of the proceeds of the sale if the Plaintiff is not the purchaser of the property, but such reimbursement will not be by the Clerk unless the Affidavit of Post Judgment Advances has been filed. The purchaser at the sale shall pay, in addition to the amount bid, the Clerk's fee, Clerk's registry fee and documentary stamps to be affixed to the Certificate of Title.

7. The Plaintiff may assign the Judgment or the bid to a third party without further order of the Court.

8. If the Plaintiff or Plaintiff's assignee is the purchaser at the sale, the Clerk shall credit on the bid of the Plaintiff or Plaintiff's assignee the total sum herein found to be due the Plaintiff or such portion thereof as may be necessary to pay fully the bid of the Plaintiff or Plaintiff's assignee.

9. On filing the Certificate of Title, the Clerk shall distribute the proceeds of the sale to Plaintiff c/o Smith, Hiatt & Diaz, P.A., PO BOX 11438, Fort Lauderdale, FL 33339-1438, so far as they are sufficient, by paying:

A. All of Plaintiff's costs,

B. Plaintiff's attorneys' fees,

C. The total sum due to Plaintiff as set forth above, less the items paid, with interest at the current statutory interest rate from the date through which interest is calculated in paragraph 1 above to the date of the sale. If, subsequent to the date of the Plaintiff's Affidavit of Indebtedness and prior to the sale contemplated in paragraph 5 hereof, the Plaintiff has to advance money to protect its mortgage lien, including but not limited to post judgment advances for property taxes and insurance, property preservation costs, post judgment attorney's fees and costs and post judgment bankruptcy attorney fees and costs, the Plaintiff or its Attorneys shall certify by affidavit to the Clerk and the amount due to Plaintiff shall be increased by the amount of such advances upon further order of the Court.

D. The remaining proceeds, if any, shall be retained by the Clerk pending further Order of the Court.

10. If the United States of America is a Defendant in this action, they shall have the right of redemption provided by 28 U.S.C. §2410(c) from the issuance of a Certificate of Title, but the right shall thereafter expire.

11. Upon filing the Certificate of Sale, the Defendants and all persons claiming under or against them since the filing of the Notice of Lis Pendens shall be foreclosed of all estate or claim in the property, with the exception of any assessments that are superior pursuant to Florida Statutes, Section 718.116 (effective 4/1/1992) or Florida Statutes 720.3085 (effective 7/1/2008), both of which state they are not to be applied retroactively to alter a lien priority existing prior to the effective date of the statute. Upon issuance of the Certificate of Title, the purchaser at the sale shall be let into possession of the property located at 8671 THORNBROOK TERRACE PT, BOYNTON BEACH, FL 33437. Upon further order of the court, the Clerk of the Court is hereby specifically authorized to issue a Writ of Possession for the property which is the subject matter of this action, and the Sheriff is hereby authorized

to serve the Writ forthwith .

12. IF THIS PROPERTY IS SOLD AT PUBLIC AUCTION, THERE MAY BE ADDITIONAL MONEY FROM THE SALE AFTER PAYMENT OF PERSONS WHO ARE ENTITLED TO BE PAID FROM THE SALE PROCEEDS PURSUANT TO THIS FINAL JUDGMENT.

13. IF YOU ARE A SUBORDINATE LIENHOLDER CLAIMING A RIGHT TO FUNDS REMAINING AFTER THE SALE, YOU MUST FILE A CLAIM WITH THE CLERK NO LATER THAN 60 DAYS AFTER THE SALE. IF YOU FAIL TO FILE A CLAIM, YOU WILL NOT BE ENTITLED TO ANY REMAINING FUNDS.

14. IF YOU ARE THE PROPERTY OWNER, YOU MAY CLAIM THESE FUNDS YOURSELF. YOU ARE NOT REQUIRED TO HAVE A LAWYER OR ANY OTHER REPRESENTATION AND YOU DO NOT HAVE TO ASSIGN YOUR RIGHTS TO ANYONE ELSE IN ORDER FOR YOU TO CLAIM ANY MONEY TO WHICH YOU ARE ENTITLED. PLEASE CHECK WITH THE CLERK OF THE COURT, OF PALM BEACH COUNTY WITHIN TEN (10) DAYS AFTER THE SALE TO SEE IF THERE IS ADDITIONAL MONEY FROM THE FORECLOSURE SALE THAT THE CLERK HAS IN THE REGISTRY OF THE COURT.

15. IF YOU DECIDE TO SELL YOUR HOME OR HIRE SOMEONE TO HELP YOU CLAIM THE ADDITIONAL MONEY, YOU SHOULD READ VERY CAREFULLY ALL PAPERS YOU ARE REQUIRED TO SIGN, ASK SOMEONE ELSE, PREFERABLY AN ATTORNEY WHO IS NOT RELATED TO THE PERSON OFFERING TO HELP YOU, TO MAKE SURE THAT YOU UNDERSTAND WHAT YOU ARE SIGNING AND THAT YOU ARE NOT TRANSFERRING YOUR PROPERTY OR THE EQUITY IN YOUR PROPERTY WITHOUT THE PROPER INFORMATION. IF YOU CANNOT AFFORD TO PAY AN ATTORNEY, YOU MAY CONTACT THE COUNTY LEGAL AID OFFICE OF FLORIDA RURAL LEGAL SERVICES, 1500 NW AVENUE

CFN 20100052148 BOOK 23688 PAGE 1857, 5 OF 7

"L" UNIT B, BELLE GLADE, FL 33430, PHONE: (888) 993-0003 TO SEE IF YOU QUALIFY FINANCIALLY FOR THEIR SERVICES. IF THEY CANNOT ASSIST YOU, THEY MAY BE ABLE TO REFER YOU TO A LOCAL BAR REFERRAL AGENCY OR SUGGEST OTHER OPTIONS. IF YOU CHOOSE TO CONTACT PALM BEACH COUNTY AID SERVICES FOR ASSISTANCE, YOU SHOULD DO SO AS SOON AS POSSIBLE AFTER RECEIPT OF THIS NOTICE.

16. The Court retains jurisdiction of this action to enter further orders as are proper including, without limitation, deficiency judgments.

DONE AND ORDERED in Chambers at the Palm Beach County Courthouse, West Palm Beach, Florida on 1-26-, 2010.

Circuit Judge

Copies furnished:

Gabrielle M Strauss, Esquire
SMITH, HIATT & DIAZ, P.A.
Attorneys for Plaintiff
PO BOX 11438
Fort Lauderdale, FL 33339-1438
Telephone: (954) 564-0071

All parties on the attached service list
1183-70318

SERVICE LIST
Case No. 502009CA027485XXMBAW

JEAN BRUNER JEANGLAUDE
11 Hemming Dr
Stafford, VA 22554

GERTRUDE ARTHUR JEANGLAUDE
A/K/A GERTRUDE ARTHUR-JEANGLAUDE
11 Hemming Dr
Stafford, VA 22554

MICHAEL S. FELDMAN, ESQ
Attorney For CANYON ISLES HOMEOWNERS ASSOCIATION, INC.
6111 BROKEN SOUND PKWY NW, STE 200
BOCA RATON, FL 33487

CFN 20100076403
OR BK 23715 PG 1415
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This document was prepared by and Return to:
MICHAEL A. TRINKLER, ESQ.
MICHAEL A. TRINKLER, P.A.
5501 University Drive, Suite 101
Coral Springs, FL 33067
Phone: (954) 753-5700
Fax No. (954) 753-5767

(Reserved for Use by the Clerk)

WARRANTY DEED

THIS INDENTURE, is made this 5 day of February, 2010, between, JEAN BRUNER JEANGLAUDE and GERTRUDE ARTHUR JEANGLAUDE, husband and wife, party of the first part, and ROMUALD ALTINE and GETOSE ALTINE, husband and wife, whose post office address is: 8671 Thornbrook Terrace Point, Boynton Beach, FL 33437, party of the second part.

WITNESSETH:

That the party of the first part, for and in consideration of the sum of TEN AND NO/100 ($10.00) DOLLARS to them in hand paid by the party of the second part, the receipt whereof is hereby acknowledged, has granted, bargained and sold to the party of the second part, their heirs and assigns forever, the following described land, situate and being in the County of PALM BEACH and State of Florida, to-wit:

Lot 117, CANYON ISLES - PLAT TWO, according to the plat thereof, as recorded in Plat Book 105 at Page 40, of the Public Records of Palm Beach County, Florida.

Folio No.: 00-42-45-32-03-000-1170

SUBJECT TO:
1. Taxes for the year 2010, and subsequent years;
2. Conditions, restrictions, limitations and easements of record; without reimposing same;
3. Zoning restrictions, prohibitions and other requirements imposed by governmental authority.

And the party of the first part does hereby fully warrant the title to said land, and will defend the same against the lawful claims of all persons whomsoever.

(Reserved for Use by the Clerk)

IN WITNESS WHEREOF, the party of the first part has hereunto set her hand and seal the day and year first above written.

Signed, Sealed and Delivered
In the Presence of:

1st Witness Signature
Print Name of 1st Witness: Melline D. Stiles

Jean Bruner Jeanglaude
JEAN BRUNER JEANGLAUDE

Dayna Solomey
2nd Witness Signature
Print Name of 2nd Witness: Dayna Solomey

Gertrude Arthur Jeanglaude
GERTRUDE ARTHUR JEANGLAUDE

Address: 11 Hemming Drive, Stafford, VA 22554

STATE OF Virginia)
) SS:
COUNTY OF Stafford)

The execution of the foregoing instrument was acknowledged before me this 5 day of February, 2010 by, JEAN BRUNER JEANGLAUDE and GERTRUDE ARTHUR JEANGLAUDE, who are personally known to me or who have produced VA drivers license as identification, and who did not take an oath.

My Commission Expires: 6/30/10

Karen Barrons
Notary Public
Print Name: Karen Barrons

OFFICIAL SEAL
NOTARY PUBLIC-COMMONWEALTH OF VIRGINIA
KAREN BARRONS
COUNTY OF STAFFORD
ID # 7012279
My Commission Expires
June 30, 2010

Document Prepared By:
ReconTrust Company, N.A.
2575 W. Chandler Blvd.
Mail Stop: AZ1-804-02-11
Chandler, AZ 85224
(800) 540-2684

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When recorded return to:
JEAN BRUNER JEANGLAUDE
11 Hemming Dr.
Stafford
VA 22554

DOC ID#0001659709342005N

SATISFACTION OF MORTGAGE

KNOW ALL MEN BY THESE PRESENTS: Mortgage Electronic Registration Systems, Inc. the owner and holder of a certain mortgage deed executed by
JEAN BRUNER JEANGLAUDE, AND GERTRUDE ARTHUR-JEANGLAUDE
to Mortgage Electronic Registration Systems, Inc. bearing date 03/30/2007, recorded on 04/19/2007 in Official Records Book OR 21639, Page 1219 , Instrument # 20070188785 in the office of the Clerk of the Circuit Court of PALM BEACH County State of Florida, securing a certain note in the principal sum of $807,000.00 Dollars, and certain promises and obligations set forth in said mortgage deed, upon the property situated in said State and County hereby acknowledge full payment and satisfaction of said note and mortgage deed, and surrenders the same as canceled, and hereby directs the Clerk of the said Circuit Court to cancel the same of record.

(CORPORATE SEAL)

IN WITNESS WHEREOF the said Corporation has caused these presents to be executed in its name, and its corporate seal to be hereunto affixed, by its proper officers thereunto duly authorized, the 4 day of May, 2010.

Mortgage Electronic Registration Systems, Inc.

ATTEST: ______________________
DeWayne Vardaman
Assistant Secretary

Signed and delivered in the presence of:

____
Amy DeLaPaz
Witness

By ______________________
Icela Lopez
Vice President

STATE OF ARIZONA
COUNTY OF MARICOPA

On 5-4-10, before me, Edward Napier, Notary Public, personally appeared Icela Lopez personally known to me (or proved to me on the basis of satisfactory evidence) to be the person whose name is subscribed to the within instrument and acknowledged to me that he/she executed the same in his/her authorized capacity, and that by his/her signature on the instrument the person, or the entity upon behalf of which the person acted, executed the instrument.

Witness my hand and official seal.

____
Edward Napier, Notary Public
Expires: 09/14/2013

EDWARD NAPIER
Notary Public - Arizona
Maricopa County
My Commission Expires
September 14, 2013

MORTGAGE ELECTRONIC REGISTRATION SYSTEMS
CORPORATE SEAL
1999
DELAWARE

Exhibit 5 - UCAV Distributed Mission Training Testbed: Lessons Learned and Future Challenges

by Dr. Dutch Guckenberger and Matt Archer

The Interservice/Industry Training, Simulation & Education Conference (I/ITSEC), Volume: 2000 (Conference Theme: Partnerships for Learning in the New Millennium)

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Interservice/Industry Training, Simulation & Education Conference

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The Interservice/Industry Training, Simulation & Education Conference (I/ITSEC)

Volume: 2000 (Conference Theme: Partnerships for Learning in the New Millennium)

URL: Linking Options

UCAV Distributed Mission Training Testbed: Lessons Learned and Future Challenges

Dr. Dutch Guckenberger [A1] and Matt Archer [A1]

[A1] SDS International Inc., Orlando, FL

[A2] BMH Associates, Inc., Norfolk, VA

Abstract:

The UCAV DMT Testbed research will focus on technologies for: defining effective training strategies for UAV/UCAV operators; assessing the delta in training required for multiple vehicles; advanced displays driven from human factors design; integration of Geneva Aerospace s Variable Autonomy Control System; and integrating several UAV and UCAV Flight Model into the Testbed. Potential applications include direct linkage of UCAV Testbeds as Participants in DMT. This paper chronicles the development of the UCAV DMT Testbed from the perspective of lessons learned and details features planned to support the initial research efforts planned for 2000.

Four successful UCAV DMT demonstrations and experiments are presented from a lessons learned perspective. Starting with the initial separately developed PC-Based UCAV simulations; evolving to the merging of the simulations and initial DMT research experiments including DMTO&I testbed, I/ITSEC99 and planned AFRL Mesa UCAV DMT Demonstrations. Key testbed components included the LiteFlite Flight Simulator, JSAF and SOAR applications, and the Variable Autonomy Control System (VACS). The unique and innovative portions of this paper detail the components integration for UCAV missions and operational concepts, along with the human factors engineering on the VACS human-system interface design and LiteFlite researcher toolkit interfaces. Illustrative examples, are also included with sufficient details to support other government, industry and academic organizations participation in future UCAV DMT experiments and demonstrations.

Participating organizations include but are not limited to AFRL Mesa, SDS International, Geneva Aerospace, Eglin 46th Test Wing PRIMES, NASA Dryden Flight Research Center/Tuskegee University, Computer Science Corporation. Future participants may include Navy Pax River (MFS and Distributed Simulation Groups), AFRL Wright-Patterson and Naval Aerospace Medical Research Lab. Additional discussion includes related UCAV DMT Research topics of :

• LiteFlite UCAV and Testbed Utilization of the Ordnance Server to ensure DMT Fair Fight

• Innovations associated with a new Distributed Ordnance Server to insure Temporal Correlation of the

• Target/Counter-Measure/Weapon Triad

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1

• An Innovative new concept of handing off UCAV Ownership from the Virtual LiteFlite Host Simulation to

the Constructive JSAF and SOAR Agents to automate tasks for the UCAV operators Results from three initial UCAV integration efforts are presented detailing DIS integration with existing DMT assets and HLA integration with planned DMT configurations I/ITSEC99, USAF Only DMTO&I Demonstration Jan2000, DMT UCAV Testbed development for AFRL/HEA and UAV 2000 Demonstration July 2000. An outline of planned research efforts that will utilize the DMT UCAV Testbed are presented along with Future Research Directions.

1

UCAV Distributed Mission Training Testbed: Lessons Learned and Future Challenges

Dr. Dutch Guckenberger & Matt Archer
SDS International Inc.
Orlando, FL
dutchg@sdslink.com & marcher@sdslink.com

Michael R. Oakes
BMH Associates, Inc.
Norfolk, VA
moakes@bmh.com

Abstract

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About the Authors

Dr. Dutch Guckenberger is the Chief Scientist at SDS International, with 15 years of experience in the defense simulation and training systems. He has earned degrees in Computer Science, Physics, & Simulation and Training. Research interests include Distributed Mission Training, High Resolution PC-Based Visual Systems, Above Real-Time Training (ARTT), UAV and UCAV Research. He is a member of ACM, IEEE, Human Factors Society & a Link Foundation Fellow in Advanced Simulation & Training.

Michael Oakes is a Sr. Systems Engineer with BMH Associates, Inc. He was responsible for the evolution and deployment of high priority classified special access required programs. He is a retired USAF fighter pilot with over 20 years of experience in the Pacific, European, and Southwest Asia theaters of operations and is a USAF F-15 Fighter Weapons School Graduate. Mr. Oakes was the WISSARD Lab Test Director for the STOW-97 ACTD. He continues to provide modeling and military domain expertise for Air Synthetic Force development used in JSAF technologies.

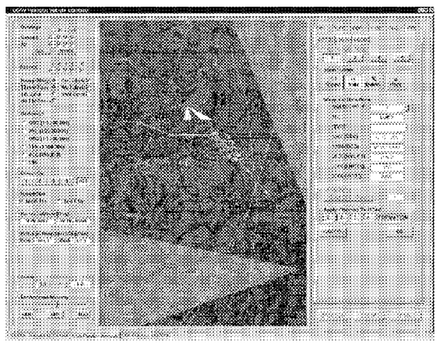

Figure 11. LiteFlite UCAV Situational/ MFD Display replicate based upon the original interface developed by WPAFB Operator Vehicle Interface Lab.

It is important to note that the LiteFlite image above was developed based upon JPEG images from AFRL/HECP Operator Vehicle Interface (OVI) Group. The key to economically supporting the UCAV researchers is effective rapid prototyping. To this end SDS with their DISTI team partner were able to develop the Situational Display and the major portions of the Multifunction Display to functional prototype level including the DIS connectivity in less than 120 Hours. (See figure 11 above for the prototype UCAV Multifunction Display.)

Variable Autonomy Control System (VACS)
As a portion of the DMT UCAV Testbed development, the Geneva AeroSpace Variable Autonomy Control System (VACS) was added to LiteFlite. The VACS is designed to be effective for UAV and UCAV systems as usable to individuals whose training is focused on the requirements of a given mission or the usability of the payload, rather than on the aviation of the vehicle. As the dependence on UAVs for military operations grows and UAV technology is integrated into the emerging global command and control architecture, the cost and complexity of managing and controlling these assets can easily become substantial. The VACS solution to this UAV control problem lies in the appropriate functional allocation between the human and the machine. By merging modern stand-off missile flight control, advanced aircraft flight control, and state-of-the-art communications technologies, Geneva has developed a novel hierarchical flight control structure with varied levels of remote operator input to address the human-machine functional allocation problem.
The VACS has been successfully demonstrated enabling a diverse range of users to effectively operate UAVs. Furthermore, the VACS solution eliminates the requirement for UAVs to be controlled by highly trained, rated pilots. In a continuing development and demonstration effort VACS is to be used Joint STARS MTE workstation and the Freewing Scorpion 100-50 UAV and conduct a flight test demonstration. This program will demonstrate the benefits of the variable autonomy flight control system design with simplified manual control modes, demonstrate the compatibility of such a system with the military s emerging C^4I architecture, and demonstrate the synergism between Joint STARS and UAVs using the simplified UAV flight control technology.

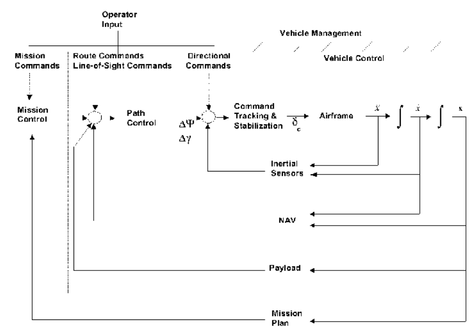

Figure 12. Variable Autonomy Control System (VACS)

JSAF, SOAR & SOAR Speak
Current distributive training technology has evolved towards larger Federations and greater entity resolution. DARPA s STOW has been the only demonstrated large-scale High Level Architecture (HLA) simulation using both large aggregates (for visualization) and entity resolution (for interaction arbitration). Since the October 1997 DoD Advanced Concept Technology Demonstration (ACTD) milestone, STOW has evolved to a viable technology demonstrating high resolution (platform level) simulation to support joint command and staff training, mission visualization capabilities and unit level training. STOW's ability for entity-level resolution has made it an excellent candidate for the USAF Distributed Mission Training (DMT) Program. The STOW Program has evolved into the Joint Semi Autonomous Forces (JSAF) and increased its applications to provide a robust simulation capable of supporting operational training, testing new concepts and doctrine as well as service and joint experimentation issues with direct linkages to real-world C^4ISR systems in a seamless live, virtual or constructive environment. The current JSAF sponsor is the United States Joint Forces Command (USJFCOM).

Exhibit 6 - Documents from Geneva Aerospace Trademark Application, Serial Number 78355947 for "Variable Autonomy Control System" From USPTO Trademark Document Retrieval (TDR) Web Site http://tmportal.uspto.gov/external/portal/tow

Trademark/Service Mark Application, Principal Register

Serial Number: 78355947
Filing Date: 01/22/2004

To the Commissioner for Trademarks:

MARK: (Standard Characters, see mark)

The mark consists of standard characters, without claim to any particular font, style, size, or color.

The literal element of the mark consists of VARIABLE AUTONOMY CONTROL SYSTEM.

The applicant, Geneva Aerospace, Inc., a corporation of Texas, residing at 4312 Sunbelt Dr., Addison, TX, USA, 75001, requests registration of the trademark/service mark identified above in the United States Patent and Trademark Office on the Principal Register established by the Act of July 5, 1946 (15 U.S.C. Section 1051 et seq.), as amended.

The applicant, or the applicant's related company or licensee, is using the mark in commerce, and lists below the dates of use by the applicant, or the applicant's related company, licensee, or predecessor in interest, of the mark on or in connection with the identified goods and/or services. 15 U.S.C. Section 1051(a), as amended.

International Class 009: computer software for autonomous aerial vehicle guidance and control systems

In International Class 009, the mark was first used at least as early as 09/01/1998, and first used in commerce at least as early as 09/01/1998, and is now in use in such commerce. The applicant is submitting or will submit one specimen for *each class* showing the mark as used in commerce on or in connection with any item in the class of listed goods and/or services, consisting of a(n) Portion of company website describing product.

Specimen - 1

The applicant hereby appoints Alexander M. Parker and R. Steven Jones of Jones & Davis, L.L.P., 15851 Dallas Parkway Suite 1220, Addison, TX, USA, 75001 to submit this application on behalf of the applicant. The attorney docket/reference number is Geneva/TM.

The USPTO is authorized to communicate with the applicant or its representative at the following email address: aparker@jonesdavis-law.com.

A fee payment in the amount of $335 will be submitted with the application, representing payment for 1 class(es).

Declaration

The undersigned, being hereby warned that willful false statements and the like so made are punishable by

1

fine or imprisonment, or both, under 18 U.S.C. Section 1001, and that such willful false statements, and the like, may jeopardize the validity of the application or any resulting registration, declares that he/she is properly authorized to execute this application on behalf of the applicant; he/she believes the applicant to be the owner of the trademark/service mark sought to be registered, or, if the application is being filed under 15 U.S.C. Section 1051(b), he/she believes applicant to be entitled to use such mark in commerce; to the best of his/her knowledge and belief no other person, firm, corporation, or association has the right to use the mark in commerce, either in the identical form thereof or in such near resemblance thereto as to be likely, when used on or in connection with the goods/services of such other person, to cause confusion, or to cause mistake, or to deceive; and that all statements made of his/her own knowledge are true; and that all statements made on information and belief are believed to be true.

Signature: /alexander_parker/ Date: 01/22/2004
Signatory's Name: Alexander M. Parker
Signatory's Position: Attorney

Mailing Address:
Alexander M. Parker
15851 Dallas Parkway Suite 1220
Addison, TX 75001

RAM Sale Number: 513
RAM Accounting Date: 01/23/2004

Serial Number: 78355947
Internet Transmission Date: Thu Jan 22 18:04:09 EST 2004
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2

VARIABLE AUTONOMY CONTROL SYSTEM

1

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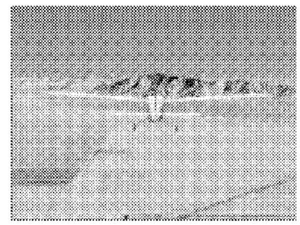
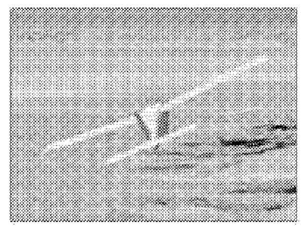
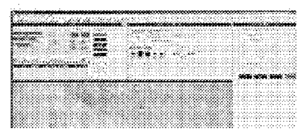
- Variable Autonomy Control System (VACS)
- Low-Cost UAV Avionics Kit
- Hi-Fidelity 6DOF Engineering Simulation
- 400 MHz UAV Flight Termination System
- Multi-UAV IP Datalink System

Products: Variable Autonomy Control System (VACS)™







Under Air Force Research Lab funding, Geneva has developed an innovative UAV control design that combines state-of-the-art missile technologies with fixed-wing aircraft control. Our design balances autonomous flight control with manual control to provide variable levels of directional independence and minimizes the personnel and training requirements for the operation of the UAV. The truly enabled UAV operator is not required to be a trained aviator, but still retains a wide range of control flexibility in order to successfully execute the mission objectives that call upon his/her specialized expertise.

Our solution is a hierarchical flight control structure with multiple levels of remote operator input combined with an off-board controller software package and intuitive human system interface. Research of the UAV control problem has indicated that the best solution lies in the appropriate functional allocation between the human and the machine, leading to the organization of the control problem between the two fundamental categories: flight governance and flight management.

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Serial Number: 78355939
Filing Date: 01/22/2004

To the Commissioner for Trademarks:

MARK: (Standard Characters, see mark)

The mark consists of standard characters, without claim to any particular font, style, size, or color.

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International Class 009: computer software for autonomous aerial vehicle guidance and control systems

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Signature: /alexander_parker/ Date: 01/22/2004
Signatory's Name: Alexander M. Parker
Signatory's Position: Attorney

Mailing Address:
Alexander M. Parker
15851 Dallas Parkway Suite 1220
Addison, TX 75001

RAM Sale Number: 498
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2

VACS

1

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- Dakota Unmanned Aerial Vehicle
- Variable Autonomy Control System (VACS)
- Low-Cost UAV Avionics Kit
- Hi-Fidelity 6DOF Engineering Simulation
- 400 MHz UAV Flight Termination System
- Multi-UAV IP Datalink System

Products: Variable Autonomy Control System (VACS)™

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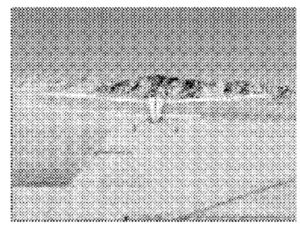

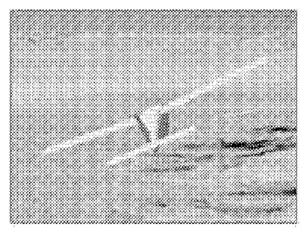

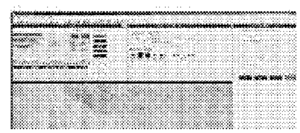

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<u>Exhibit 8</u> - **Development and Testing of a Variable Autonomy Control System (VACS) for UAVs**, by Dave Duggan of Geneva Aerospace and Luis A. Piñeiro of AFRL contained in the Proceedings AUVSI Symposium, 2002

Development and Testing of a Variable Autonomy Control System (VACS) for UAVs

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Abstract

As the role of UAVs expands throughout the DOD, increased consideration must be given to reduce cost and complexity of managing and controlling UAVs. First generation control schemes focus on either manual control (remote pilot-in-the-loop) or fully autonomous (pre-programmed) control. These schemes impose significant personnel and training requirements on one side, or increased logistics (mission planning and asset allocation) on the other. The objective of the Variable Autonomy Control System™ (VACS) program is to improve real-time control capability for UAVs by allowing autonomous route following capability (as it exists in current Air Force UAV systems) while providing for dynamic real-time control to deviate from pre-planned routes to accomplish a wide variety of tasks; and reduce human workload requirements significantly below that of existing UAV systems, thus allowing a single operator to effectively manage and control multiple UAVs as opposed to multiple operators per single UAV. The VACS architecture provides for varying levels of control autonomy, from fully autonomous control to simplified manual flight control modes, and provides a flexible and simple user interface with a much smaller logistical footprint. Furthermore, the VACS design facilitates manned and unmanned systems interoperability as will be demonstrated in follow-on initiatives.

This paper describes the approach to the system's architecture and design, as well as the testing accomplished to date to validate its capabilities. The effectiveness of the system was evaluated recently in a series of flight demonstrations.

Background

Although first generation military UAVs have an impressive set of capabilities, real-time control capability may have been somewhat limited by the need to pre-program routes for totally automated platforms, or the need to have rated pilots assigned in non-flying tours of duty to deal with manually controlled assets. Rarely, however, do real-world missions go exactly as planned. There are time-critical targets that pop up; traffic conflicts with manned aircraft; clouds that get in the way of EO/IR sensors; and, intelligent and devious adversaries who make target location and identification difficult. Real-time control is required to deviate from the planned route to find and identify new targets; to maneuver UAVs to avoid traffic; to fly under the weather; and to get better line-of-sight angles. Skilled pilots can maneuver aircraft, but then an additional operator is necessary to manage the sensors and the dynamic mission. Likewise, as the dependence on UAVs for military operations grows and UAV technology is integrated into the emerging global command and control architecture, the cost and complexity of managing and controlling these assets are expected to become substantial. Hence, an integrated flight control/flight management system that allows for, but minimizes, human intervention is necessary for the Joint Services.

The VACS effort was established with the purpose of addressing the aforementioned concerns, thus simplifying UAV operation and control. As its name suggests, the architecture includes varying levels of control autonomy from fully autonomous control to simplified manual flight control modes. The simplified manual modes are designed to address Air Combat Command's stated need for "improved real-time control of UAVs". Along with the need for improved real-time control capabilities, efforts exist within the Air Force to investigate the benefits of placing the UAV control onboard an aircraft. Doing this would allow a Joint STARS to capture imagery for positive ID of ground targets detected by radar. AWACS controllers could direct UAVs to jam enemy radar (when EA-6B Prowlers are unavailable) or direct UCAVs to attack radar sites. Rivet Joint controllers could maneuver UAVs to gather electronic intelligence. AC-130 gunship crews could maneuver a UAV below the clouds to identify targets and assess damage from a safe distance. These airborne platforms, however, have limited space on board for a crew dedicated to UAV control, and need a "de-skilled" UAV control system for their existing operators to use.

VACS Overview

The VACS architecture is designed to support an emerging generation of autonomous and semi-autonomous air vehicles. The design provides seamless transition between varying levels of control autonomy from fully autonomous control to simplified manual flight control modes. The VACS design evolved from high-performance aircraft and advanced standoff missile flight control technologies. Funding for the variable autonomy control concept was provided under the Small Business Innovative Research (SBIR) program Phase I, Phase II, and Phase III funding vehicles through the Air Force Research Laboratory (AFRL) Human Effectiveness and Air Vehicles Integration Directorates (Reference

1). The VACS is to improve real-time control of UAVs, providing autonomous route following capability (as exists in current Air Force UAV systems) while allowing for dynamic real-time control to:

- Deviate from the planned route
- Find and identify new targets
- Maneuver UAVs to avoid traffic
- Fly under the weather
- Avoid terrain collision and support low altitude terrain following
- Avoid airborne collisions with other manned and unmanned air vehicles
- Get better line-of-sight angles for target identification, bomb damage assessment, and other intelligence gathering missions

The VACS provides the real-time control capability that a flexible, operational UAV system requires to successfully execute a mission, including dynamic sensor control and real-time re-tasking, with human workload requirements significantly below that of existing UAV systems. Currently, the VACS capabilities include:

- Autonomous route navigation with autonomous on-station orbit and target search capabilities
- Real-time route editing
- Mixed/hybrid UAV control, such as execution of programmed, energy efficient climb to operator selected altitude mixed with autopilot assisted manual turn capability
- Tight integration of the UAV primary imaging sensor with the outer control loop for automatic sensor slave steering
- Simplified manual control allowing for real-time manual directional control capability (horizontal and vertical) with no operator training or aviation experience required
- Photo-realistic synthetic vision display (SVD) technology supporting synthetically enhanced situation awareness for the UAV operator

Additional capabilities currently being *implemented* are:

- Automatic takeoff and landing with no requirement for external aiding/guidance sensors
- Multi-ship control capability allowing a single operator the capability to simultaneously manage and control four or more UAVs at one time
- Digital terrain elevation database (DTED) based automatic ground collision avoidance
- Optical sensor based autonomous air collision avoidance

Each of these technologies is being implemented and flight-tested through multiple Air Force and Navy Autonomous Operations research and development programs that extend through the summer of FY2003. The significant UAV capability advancements offered by the VACS design are the culmination of leveraging advanced capabilities developed through several Army, Navy, and Air Force programs.

VACS was designed to offer a core autonomous and semi-autonomous air vehicle flight control and multi-modal management software package that facilitates rapid, affordable advancements in UAV automation while maintaining seamless integration of the operator and the UAV(s) at all levels of control automation. Reviewing a structure for generalized intelligent control architecture provides a method of relating the VACS design to such a core software package. Figure 1 shows the mapping between a generalized intelligent controller hierarchy and the VACS architecture. The VACS design is modular and generic in nature. Hence, adaptation of VACS in its entirety or of one or several subcomponents thereof to TCS, VTUAV, TUAV, and other future military UAV systems will be technically trivial and can be done with rapid turn-around for low cost. Geneva is currently engaged in several proprietary programs in which VACS adaptations are under way.

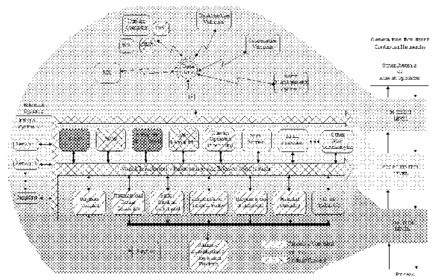


Figure 1 VACS Architecture

A key point to note in the above figure is that the core system architecture, core guidance, navigation, and control algorithms, and major sub-system interfaces are in place. New modules (i.e., new autonomous operations technologies) are added as funding permits. For example, the current AFRL 6.2 program is adding an automatic ground collision system (AutoGCAS, Reference 2). Additionally, an ONR funded Autonomous Operations program is adding an optical sensor-based autonomous "see and avoid" system. Capabilities such as these are modules that "plug" into the core architecture as facilitated by the modular "plug-n-play" design of the VACS system.

The VACS architecture is comprised of airborne management and control functions as well as off-board control interfaces and intuitive human-system interfaces. The off-board control station is comprised of faster-than-real-time simulation capability supporting real-time operator situation awareness and decision aids, intuitive graphical user interfaces and situation displays, and advanced photo-realistic synthetic vision displays.

The combination of high fidelity synthetic visualization tools (offered by Geneva's industry partner – SDS International), faster than real time simulation technology, and variable autonomy control provides a baseline architecture that is capable of supporting a new level of real-time UAV control and situation awareness. The synthetically enhanced situation awareness system (SESAS) supports real-time management and control of multiple UAVs by a single operator. The synthetic visualization display includes threat data realistically displayed over mapped and photo-realistic 3D terrain. These visuals are driven (dynamically propagated) by a combination of simulated and real UAV data. The simulated data is generated by the ground control station and propagated at a much higher rate than real data is received from the air vehicle. When real data is received, it is used to correct the simulation solution, thus providing an accurate, continuous representation of the UAV flight state within its environment.

The realism afforded by the synthetic visuals significantly enhances the operator's situation awareness. The synthetic visuals offer multiple views (or frames of reference) and increased field-of-view (FOV) over that of on-board sensors. Figure 2 illustrates the concept.

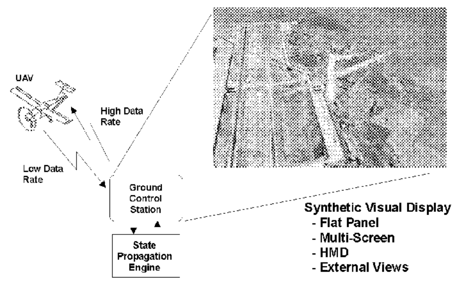


Figure 2 Synthetically Enhanced Situation Awareness Concept

The Synthetically Enhanced Situation Awareness technology can be utilized to provide a wide FOV that augments live video and sensor feeds while *circumventing payload and bandwidth limitations*. Specifically, correlated, photo-realistic 3D terrain can be presented on multiple monitors or flat panel displays to provide a wide area FOV and aid controllers in orientation and situation awareness. Furthermore, this photo-realistic representation of the scene can be viewed from various frames of reference with the simple push of a button.

The synthetic vision based enhanced situation awareness concept was recently demonstrated in a flight test conducted over the Army's 10th Mountain Division Ft. Drum training range located in upstate New York. VIPs in attendance noted the realism of the synthetic visuals with respect to the live video feed transmitted from the UAV.

Significant reductions in datalink bandwidth requirements can be achieved with the aid of the simulation. Background and high frequency update information is provided by the simulation, while low-frequency data specific to the UAV – data that changes in real time over long periods of time – is provided via downlinks. By filling in the high frequency gaps with simulated data, very low update rates over the datalink are made feasible in that the operator is provided with a continuous situation awareness that is comprised of mixed live and simulated data. SESAS addresses two key areas of needed technology improvements in the UAV community: datalink bandwidth and survivability. By significantly reducing the transmission requirements of the air vehicle, UAV detection becomes more difficult, thus increasing system survivability.

VACS Control Modes

The VACS is designed using a flight control architecture that is predominant in the missile industry. The autopilot software design utilizes state-of the-art flight control techniques, which allow the actuators to dynamically adjust the airframe stabilization properties "on the fly". The flight computer is programmed directly with the airframe physical properties, so that it can automatically adjust its settings with changes in airframe configuration, aerodynamic properties, or flight state. This provides for a simple and versatile design, and possesses the critical flexibility needed when adjustments to the airframe configuration become necessary during the course of the program.

The guidance executive manages path regulation and operator inputs and selects the appropriate guidance law to achieve the desired control requirement, supporting varying levels of control from fully autonomous waypoint / route following to fully manual directional control steering. All of the control capability requirements needed to support management and control of multiple UAVs by a single operator are comprehended in the existing VACS design and have been flight proven on Geneva's Dakota UAV testbed.

The distinguishing aspect of the design is the fluidity with which control levels are transitioned. Through algorithm research and human factors engineering trials, we derived a *trajectory synthesis* based control scheme. This control scheme uses trajectory predictive techniques that allow the operator to effortlessly interact with the control system at any control level from manual through autonomous. The marvel of the control scheme selected, which was derived primarily from advanced missile controls concepts, is its effectiveness in achieving the performance objectives with an uncomplicated, yet advanced, algorithm implementation.

The design is founded on rigorous, tractable mathematical formulations that allow interaction with the operator inputs and allow the operator to instantaneously remove himself from the loop without concern over corresponding vehicle reactions – the vehicle does what the pilot expects. We avoid, however, heuristic techniques (neural networks, artificial intelligence, fuzzy controllers), as they are not needed at this level of control. These techniques will be employed at the observer level for subsystem fault detection in future intelligent autonomy efforts. Consequently, the control system design is robust, predictable, and verifiable. From the UAV perspective, the vehicle that is sent out is the exact same vehicle that returns – a crucial design tenant that allows us to verify safe and predictable performance.

Although human factors played a key role in the design evolution, equally important were robustness, reliability, and affordability. The design features a tolerance to inertial sensor errors and large system latencies. A COTS-based design approach utilizing micro electromechanical systems (MEMS) sensors and commercial grade components was a primary objective in our research. Consequently, the control system design had to provide precision control (e.g., precision path regulation and operator command responsiveness) in the presence of low quality inertial sensors (gyros, accelerometers, pressure transducers) and "sloppy" actuators. The trajectory synthesis based control solution proved to be robust in the presence of all such sensor errors and subsystem latencies. Mathematically speaking, for example, large inertial measurement unit (IMU) biases wash out in the closed loop at all levels of control. We have demonstrated – in flight tests – precision, highly responsive control (relatively high bandwidth design) with the use of low-grade inertial sensors and low performance actuators.

The VACS implementation currently provides the following set of control modes:

- R/C or Manual Control Mode
- Control-Stick-Steer Mode
- Programmed Maneuver Mode (See Table 1)
- Sensor-Slave Steering Mode
- Waypoint Guidance Mode (See Table 2)
- Park Mode
- Go To Mode (waypoint)
- Return-to-Base (RTB) Mode
- Launch Mode
- Fail-Safe Mode

Table 1: Programmed Maneuvers

Maneuver	Description
MAX CL	Climb at maximum climb rate to input altitude
BEST CL	Climb at best climb (most efficient) climb rate to input altitude
STEEP DEC	Descend at max descent angle to input altitude
SHAL DEC	Descend at approach descent angle to input altitude
BEST RNG	Cruise at best range speed
BEST END	Cruise at best endurance speed
MAX (SPD)	Cruise at maximum cruise speed
MIN (SPD)	Cruise at minimum speed
RT	Turn right an amount equal to the input value
LT	Turn left an amount equal to the input value
ABS HDG	Turn to the exact heading input
DISABLE D	Disable the programmed maneuver

Table 2 Waypoint Properties

Event Type	Waypoint, figure 8, racetrack, ellipse (circle is racetrack with equal length and width)
Waypoint latitude	Geodetic latitude of waypoint or orbit pattern center
Waypoint longitude	Geodetic latitude of waypoint or orbit pattern center
Waypoint Altitude	Ellipsoidal altitude of waypoint or orbit pattern center
Waypoint Speed	Speed setting at waypoint location
Orbit pattern length	Length of desired orbit pattern
Orbit pattern width	Width of desired orbit pattern
Orbit pattern orientation	Rotation angle of orbit pattern (relative to true North)
Number of orbit laps	Desired number of orbit laps
Time in orbit	Desired time to maintain orbit pattern (overrides orbit laps if greater than minimum threshold)
Orbit pattern center offset	Offset vector of orbit pattern center from known target location

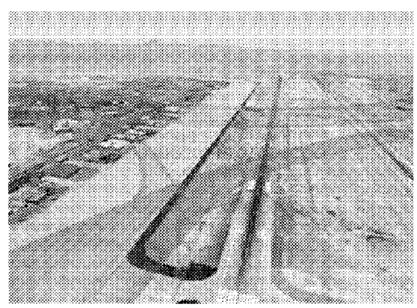
Synthetic Vision Displays

Geneva's industry partner, SDS International, has emerged as a leader in high-fidelity PC based photo-realistic synthetic visualization technologies. ArchAngel Synthetic Vision Displays (SVD), one of SDS' SVD products provides revolutionary improvements to the efficiency and effectiveness of the war fighters by providing real-time displays of 2D and 3D images that include threats, friendlies, and command and control overlays. The visuals offer complete and current sensor/decision maker/shooter information, plus situation awareness for safety and navigation. ArchAngel utilizes synthetic vision plus simulation functionality assimilated from Distributed Mission Training (DMT), DIS and HLA Tools, and Constructive Simulations to support combat missions.

ArchAngel is aimed at providing innovative visualization technologies as an "Information Portal" based upon XML and Intelligent agents to provide "Pull" and "Push" to address a broad range of sensor-decision maker-shooter issues. ArchAngel's design focus is to provide relevant real-time portions of AWACS, JSTARS, Rivet-Joint and sensor data to the cockpit of the shooters including relaying of Satellite and UAV imagery.

Geneva Aerospace has an ongoing funded effort to adapt the ArchAngel technology to the VACS UAV control station environment to include in-time and coordinated sensor/decision maker/shooter information that is HLA distributed from the VACS ground control station to the synthetic visual displays. The displays include threat data realistically displayed over mapped and photo-realistic 3D terrain. Damage Assessment prediction visuals are supported with fire, smoke and even wind blown smoke. The key innovations include the ArchAngel project features of real-time multi-source fusion and display via Super-MFD and SDS's Fast-Panel technology.

The following figure illustrates examples of the visualization technologies, including "pathway in the sky" visual overlays and visualization enhancements gained from overlaying / fusing synthetic terrain with ortho-rectified, geo-registered imagery.



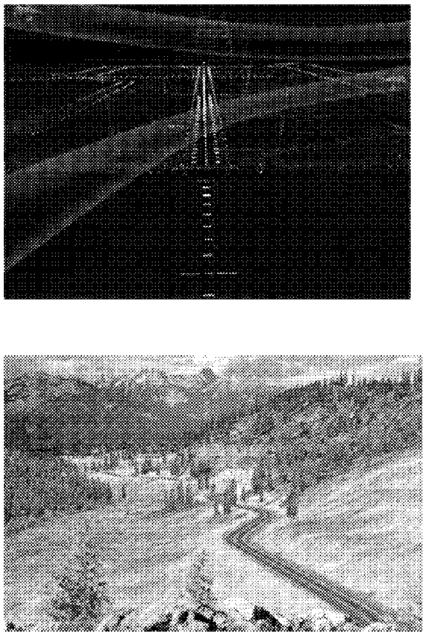


Figure 3 Photo-Realistic Synthetic Visualization Illustrations

The Synthetic Visuals are driven by the UAV in a manner very similar to the original design intent of a high fidelity flight simulator commanding own ship eye-point, environment and other entities. The main difference being that instead of a high fidelity flight simulator, live UAV state information drives the own ship eye-point. Furthermore, the other entities (ground-based threats, other aircraft, etc.) can be real-world sensed entities as opposed to simulated entities.

The photo-realistic, geo-specific visuals that were originally developed for training and mission rehearsal are now directly usable in operational UAV contexts. In the simplest terms the GPS and INS data that report UAV position are utilized as inputs to the Synthetic Visual Display's API, which couples the state data with FOV and orientation information from the cameras and sensors onboard the UAV. Replication of the simulated visuals provides "perfect weather", daylight visuals regardless of the night, weather, fog, clouds, or camera/sensor battle damage. The use of wider FOV, multiple screens, augmented symbology and network integrated data exchange support an entire new generation of situation awareness enhancements, tools and operator decision aids, especially in the context of UAVs with flexible ground control stations and network interconnectivity.

The Synthetic Vision Display (SVD) technical approach is based upon integrating advanced simulated visuals originally developed for training purposes, into UAV operational systems. Specifically, the successful integration of SDS's Simulated Visuals with the Geneva VACS Ground Control Station (GCS) during recent AFRL sponsored flight testing at the Army's 10th Mountain Division training range at Ft. Drum, NY is indicative of the potential advances that merging these technologies can have in the near-term. Further, simulated HUDs developed for other training simulations have direct utility in the Synthetic Visuals. A high level description of the technical approach encompasses SDS International's Acuity Visual

Products to provide the basic synthetic visuals and some of the simulated HUD features. Additional "Super-HUD" functions, features and symbologies are being leveraged from AFRL/SDS's UCAV DMT Testbed effort, the Space Maneuver Vehicle Prototype, ArchAngel Prototype and AFRL VR-HMD R&D efforts. SDS's considerable experience with DIS and HLA has also lead to innovations utilizing the Dead Reckoning Algorithm's (DRAs) to reduce the frequency of communication updates required in the UAV operational context.

Multi-UAV Control using VACS

Key technology areas that have been employed to support the VACS multi-vehicle control research, development, and flight-testing include communications, controls, vehicle management, human factors, and simulations. The VACS design implements spread-spectrum communications hardware architectures and supporting multi-layered communications software packages that enable multi-vehicle messaging. Furthermore, we have conducted extensive work in multi-vehicle simulation development – both in the area of pure simulation based, network centric multi-vehicle analysis with Geneva's industry partner SDS International as well as in the more pertinent area of real-time system multi-vehicle simulation, including Processor-in-the-Loop (PIL) and Hardware-in-the-Loop (HIL) simulation. The fundamental difference between the two simulation approaches is that the former approach placed less emphasis on real-world implementation concerns and focused on higher-level concept development whereas the latter is designed entirely around real systems and considers all pertinent real-world implementation concerns. The simulations from the latter approach drive our real-time, flight-worthy systems and, therefore, consider all of the limiting factors associated with the communications and flight control systems hardware and operating environments.

The multi-vehicle simulation studies have followed two approaches: 1) the Distributed Mission Training (DIS/HLA network protocols) approach for trade study analysis and 2) real-time, multi-system simulation using Geneva's internally developed multi-layered communications packages across RS232, 115.2 kpbs, using wireless RF (via spread-spectrum datalinks) connectivity between systems. For simulation studies in a non-laboratory environment, approach (2) uses the same-layered communications software package as in the lab environment, however the lowest level of the communications layer uses the Ethernet as opposed to the serial Input/Output device.

Finally, as discussed previously in this paper, we have designed and implemented a novel, variable autonomy vehicle management and control architecture that facilitate multi-vehicle control with varying levels of functional allocation between the operator and the UAV network. Human factors engineering and live flight-testing have played key roles in the evolution of the VACS design. This gradient control implementation supports the full spectrum of autonomy from manual to supervised, to autonomous. The core architecture is highly flexible and offers a proven, core architecture to support the full evolution of the cooperative control solution.

Included in the VACS core are a set of mission health assessments generated based on much faster-than-real-time simulations that monitor vehicle performance utilizing UAV sensor inputs. Also included in the VACS core is an automated DTED based ground collision avoidance system. These capabilities play an important role, from the human factors perspective, in the multi-vehicle control problem as they offer automated system health monitoring and fault mitigation capabilities that significantly reduce operator workloads associated with managing a network of cooperative and non-cooperative UAVs.

As previously discussed, inherent in our efforts is the design and implementation of novel situation awareness technologies that facilitate effective management and control of multiple UAVs by a single operator. The VACS approach features mixed reality concepts using photo-realistic 3D synthetic vision displays driven with both sensed and simulated vehicle state information.

Additionally, the work in variable autonomy controls has extended to the areas of automated collision avoidance technologies, where Geneva Aerospace has secured an ONR sponsored Autonomous Operations program to integrate VACS software with multi-vehicle sensing technologies to provide an optical sensor based automated air collision avoidance capability for UAVs. As evidenced by the research so far, the multi-vehicle cooperative behavior and control problem is dependent on both control system and situation awareness technologies.

VACS GCS Software

The VACS human-system interface (HSI) is a graphical user interface (GUI) that allows the operator to quickly alter the UAV course with little effort. The VACS HSI focuses on the UAV mission tasking rather than vehicle aviation; hence, the VACS interface places minimal significance on standard “cockpit” displays and focuses on situation displays. The operator interacts with VACS through the use of a mouse, a joystick (or game pad), and a keyboard. The software can easily be modified to take advantage of the touch-screen capabilities of the rugged notebook computer.

Push buttons in the main GUI provide access to dialogs that provide vehicle status information, sensor management and control functionality, and information dissemination capability through both data logging and network connectivity. A route editing dialog is accessed from the map display and provides the operator rapid, intuitive point-n-click system interaction for real-time mission planning and route editing capability, as well as map display editing features (zoom, center, change map background, etc). The route editing pop-up dialog provides the operator the capability to either type in known, precise waypoint coordinates or record graphically edited route event coordinates and parameters. The situation (map) display also contains a target editor with the capability to tie targets to UAV mission objectives and a corridor editor set no-fly zones and/or other mission planning boundary constraints.

Currently, the mission / route editing is performed manually by the operator, using the graphical user interface "point-n-click" functionality on the map or "fat-fingering" the coordinates. The interface, however, was designed generically so automated route plans can be accepted. VACS contains automatic route/mission analysis tools to alert the operator if a planned mission is not physically realizable due to vehicle performance constraints or terrain collision issues. Geneva Aerospace is planning efforts with various VACS customers to automate the entire in-flight route planning process by integrating the Air Force's In-Flight Planning modules (3) with the VACS ground control station.

The VACS GCS also contains a Cautions, Alerts, and Warnings (CAWS) panel that alerts the operator to system malfunctions, low fuel, route errors, and various other off-nominal conditions. The CAWS display will alert the operator when a vehicle subsystem fault is detected.

Using the VACS GUI interface, the operator can maintain any level of control over the UAV, from fully manual to fully autonomous, with the simple click of a mouse.

A feature in the VACS GCS GUI is the incorporation of the Digital Terrain Elevation Database (DTED) with the map display and route planning tools. The VACS software includes a module that performs real-time interpolation on the DTED and provides terrain elevation at the vehicle's current geodetic location, along with a terrain elevation projection 5 km along the vehicle's current heading. Additionally, the DTED routine provides a real-time display of the operator's input device pointer location (such as the mouse cursor) over the map to provide rapid feedback of terrain elevation at selected geodetic locations. This DTED feature is used to aid in preflight and real time mission planning.

The DTED capability is currently being extended to the VACS airborne digital flight control system to provide a DTED-based automatic ground collision avoidance system (AutoGCAS) for both cruise missile and UAV applications. This AutoGCAS capability will be flight test demonstrated on the Dakota UAV testbed in late summer 2002.

The VACS design offers enormous flexibility to the UAV operator and reduces the operator workload to a level that facilitates the control of multiple UAVs by a single operator. The synergistic combination of the VACS design, the In-Flight Planning system, and the Synthetic Vision Display provide a comprehensive multi-mission, multi-vehicle automated UAV mission management and control system.

VACS TESTING

Testing of VACS has consisted of hundreds of thousands of all digital Monte Carlo simulation cycles, hundreds of hardware in-the-loop (HIL) simulations, over a dozen developmental test flights on two different UAV platforms, and one operational scenario demonstration flight at the Army's 10th Mountain Division training range at Ft. Drum, NY.

The live flight exercises have demonstrated that a single operator with no aviation skills can simultaneously manage and control the UAV and the UAV primary sensor. In these demonstrations, the operator was able to effectively transition control levels, update mission plans, monitor the UAV imagery, monitor the UAV systems status, and trouble shoot system malfunctions from the ground control station while the UAV demonstrated seamless mode transitions and at all times behaved as the operator expected and required. Furthermore, we demonstrated both in simulation and in flight exercises that the design eliminates common pilot induced faults such as pilot induced oscillation, stall, spin, over-g, or other pilot induced phenomena that over-drive the airframe and result in the loss of the vehicle.

During the Phase II effort, Geneva Aerospace teamed with Northrop Grumman Corporation to integrate the Variable Autonomy Control System ground control station with the Joint STARS Moving Target Exploitation (MTE) workstation to demonstrate the effectiveness of the VACS human-system interface and VACS UAV control approach in a real-world, airborne battle management system. The VACS control station proved to offer an effective, intuitive human interface for the Joint STARS operator. This capability was successfully demonstrated in a scenario representative of that of Figure 4, with the Joint STARS participation being simulated by a ground operator utilizing a modified Joint STARS MTE workstation. The next round of demonstration flights is scheduled for the late summer 2002 tests, and will

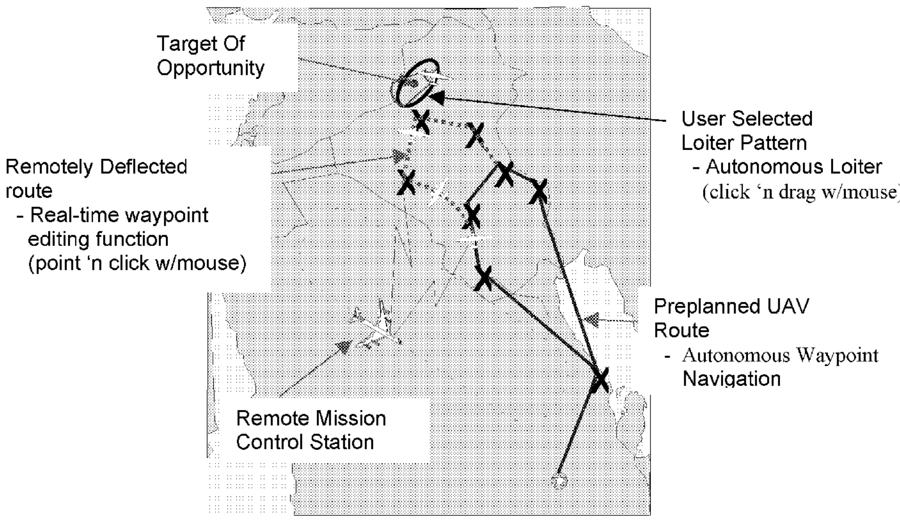


Figure 4 Wide Area Surveillance Sample Mission

showcase the multi-vehicle control, ground collision avoidance, and auto take-off and auto land capabilities.

Conclusions

The Variable Autonomy control System (VACS) is a comprehensive, flight proven air vehicle multi-modal management and control architecture designed to support the emerging generation of autonomous and semi-autonomous UAV systems. The synergistic combination of advanced, gradient control concepts, intuitive human-system interfaces, and photo-realistic synthetic vision displays offers a comprehensive, off-the-shelf multi-UAV management and control package and provides a core flight control architecture that will enable the rapid transition of autonomous UAV technologies to the war fighting community.

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Exhibit 9 - From Geneva Aerospace Provisional Application 60/480,192

Small Business Innovation Research (SBIR) Program Projects

Summary, Topic Number AF98-179

APPENDIX B

U.S. DEPARTMENT OF DEFENSE
SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
PROJECT SUMMARY

TOPIC NUMBER: AF98-179

PROPOSAL TITLE: **Examination of an Integrated Autopilot Design for Simplified UAV Flight Control**

FIRM NAME: Geneva Aerospace, Inc.

PHASE I or II PROPOSAL: Phase I

Technical Abstract

In order to be truly versatile, Unmanned Aerial Vehicle (UAV) Systems must be usable to individuals who's training is more focused on the requirements of a given mission or on the usability of the payload, rather than on the aviation of the air vehicle. This suggests that flight control systems must respond to higher level, more intuitive remote commands such as "go left", "go right", "climb", or "dive".

Modern embedded guidance and control processing methods such as those used for autonomously guided cruise missiles or advanced military aircraft demonstrate that low-level stick-and-rudder commands can be eliminated as a requirement on the remote operator. In addition to a more intuitive command-response autopilot, Geneva Aerospace has developed a design which allows the integration of intuitive "mission-level" remote commands into the guidance system, significantly reducing the work-load on the operator as it pertains to the aviation of the UAV.

The guidance system is evaluated on the Freewing Tilt-Body airframe, which provides unique inherent camera stabilization and "Extremely" Short Take-off and Landing properties. The integrated guidance design and systems engineering approach proposed provides a modular core structure that can easily be upgraded and can grow with increasing technology.

Anticipated Benefits/Potential Commercial Applications of the Research or Development.

A well integrated mixed-reality guidance system could Make UAV's useful for border patrol, speed control, hazardous area investigation, atmospheric sampling, or even motion picture filming by persons who could operate with minimal aviation expertise or manual skill.

Keywords:

Unmanned Arial Vehicle	Mixed Reality
Guidance/Autopilot	Autonomous
Virtual Reality	GPS Aided Navigation
Telepresence	Ground Station

1.0 Identification and Significance of Opportunity

The nature of this research opportunity is best appreciated by first posing a set of top-level requirements for an "Ideal UAV System":

The system must be easy to use with minimal training. As recognized in the solicitation, an effective UAV system will respond to more intuitive command motions. This will allow the operator to focus on the payload and mission operations rather than on aircraft piloting. Commercialized products such as video games and CAD utilities provide an excellent model for human interfaces which have already been evaluated and tested on the open market. In fact, the ideal simplified UAV autopilot should be compatible with COTS hardware such as standard joysticks, track-balls, lap-top computers, and Virtual Reality Head Mounted Displays and Glove Input Devices.

The system must be able to operate autonomously as well as respond to high-level remote commands. Autonomous mission capability with the ability to remotely interrupt the mission is essential to minimize the work load of the operator when flying multiple-UAV's from a single ground control station. The ideal guidance concept will nominally operate with enough autonomy even when responding to remote commands that one person will be able to operate several UAV's from the same station.

The system must be adaptable to on-going command-and-control software development efforts. For military applications, the system will be required to operate within the advanced Command, Control, Communications, Computers, and Intelligence (C4I) infrastructure and interface with associated Common Ground Control Stations such as the Joint STARS Common Ground Station. As a commercial application, this could be a lap-top version of a somewhat less complicated, but similar ground control package. The guidance software must have the capability not only to respond to the command interface, but must also be capable of expanding modularly as new capabilities are desired without significant changes in the interface.

Advances in Virtual Reality simulation graphics display technology makes the concept of a Virtual Reality interface to real-time systems feasible. Already used by surgeons in the Medical community, the use of Virtual Reality, such as Telepresence or Mixed Reality systems, in UAVs is not far away. For this reason, we include an evaluation of a Line-of-Sight Slave mode capability in which the operator's point of reference is the image scene transmitted from the UAV's on-board camera (we will refer to this as the "tactical situation display"). In this mode the operator does not provide direct directional commands to the UAV. Instead, the operator focuses his attention on the tactical situation display, commanding the look angle of the UAV's on-board sensor to survey the battlefield (or other topographical region for non-military applications) while the UAV autonomously commands a flight profile which is slaved to the operator's sensor line-of-sight commands. As discussed below, our integrated guidance solution adapts easily to this mode.

The system must be easy to land. Even with directional-response controls, the operator must be capable of commanding the flare and touch-down phase of landing. To eliminate this operator requirement, the simplified autopilot must be compatible with existing COTS automatic landing systems such as the Sierra Nevada Corporation's UAV Common Automatic Recovery System (UCARS), and hence must be able to land autonomously under nominal conditions. The system must also be able to respond to changes in the terminal approach when the operator detects an obstruction or desires a change in the landing conditions. In addition to its other benefits, the ESTOL capability of the Freewing Tilt-Body airframe design simplifies and reduces the risk of vehicle recovery over that of conventional fixed-wing UAVs

The system will be highly modular, and manufactured from Commercial, Off-the-Shelf (COTS) components. To compete as a marketable product, the system must be affordable, maintainable, and easy to upgrade. For the system to be flexible enough to do so, the guidance software must be designed to work under varying configurations with changing levels of uncertainty. For this reason, a robust, integrated control system design approach will be evaluated.

The above requirements point toward on-going Freewing Tilt-Body UAV development efforts by Freewing Aerial Robitics Corporation and Geneva Aerospace. The proposed SBIR study effort presents an opportunity to evaluate this system against the above desired capabilities, leading to a rapid development and marketing of the "Ideal UAV".

The Geneva guidance concept is founded in the understanding that a UAV can be controlled more like a missile than an airplane because human comfort is not a constraint. We can use a more flexible multivariable controller structure and can allow the airframe to perform conventionally unacceptable maneuvers such as negative accelerations, skidding turns, and high body-rate stabilization. Our controller structure integrates the guidance and autopilot sub-functions (outer loop path commands and inner loop stabilization). As we will show later in this proposal, the simplified autopilot concept is a straightforward augmentation of our integrated guidance design approach.

We have chosen the surveillance mission as a platform for evaluation because of its apparent commercial application potential. A well integrated mixed-reality guidance system could Make UAV's useful for border patrol, speed control, hazardous area investigation, atmospheric sampling, or even motion picture filming by persons who could operate with minimal aviation expertise or manual skill.

2.0 Feasibility of Technical Approach

The proposed technical design approach to the simplified autopilot and integrated surveillance system is made feasible by both the maturity and unique aerodynamic features of the host UAV platform, the Freewing Scorpion Model 100-50, and the maturity of the Geneva all-digital Six-Degree-of-Freedom (6DOF) simulation and integrated guidance design solution. A key feature of the Freewing design concept is its inherent ability to automatically neutralize the effects of turbulence on the fuselage, providing a host sensor platform which requires a significantly less expensive gimbal stabilization system than conventional fixed-wing air vehicles.

Geneva Aerospace has independently developed an integrated guidance design solution using modern robust control systems design techniques. This multivariable integrated guidance design solution provides a low-risk systematic design approach for the simplified autopilot application. The integrated guidance design solution uses system model uncertainties in the vehicle controller design, providing a robust controller design over the model uncertainty region.

2.1 Simplified Autopilot Feasibility

The simplified autopilot provides a UAV control mechanism which allows the remote pilot to provide intuitive directional commands rather than conventional stick and rudder commands. These so-called intuitive commands can be paralleled to outer loop guidance commands in conventional missile flight control systems. Typically the outer guidance loop in these systems provides fairly low frequency acceleration and bank angle commands to a three-axis (pitch, yaw, and roll) autopilot. It is this autopilot which is responsible for generating the commands to the actuators and performing the higher frequency body rate stabilization, thereby resolving the body accelerations and bank angle to the desired commands in a stable manner and tracking the desired trajectory. Such control systems have been in existence for decades and have been proven both in the test environment as well as on the battle-field. In recent years, the advancement of embedded controller technology (e.g., embedded microprocessors) has driven the industry standard to the use of digital autopilots. High performance microprocessors such as Intel's Pentium processors or Texas Instruments' C40 chips can be procured at relatively low cost, making the use of a fairly high performance digital autopilots in UAV systems cost effective and, therefore, feasible.

Geneva has combined the technology associated with high performance missile and aircraft fly-by-wire autopilots with the application of a remote piloted UAV to develop an integrated design solution which satisfies the need for a simplified UAV autopilot system. Utilizing a robust multivariable control system design approach, we have developed a *single* control structure for a UAV autopilot which is robust and modular in nature, allowing multiple levels of remote pilot control as well as fully autonomous flight. We believe that the proven digital autopilot technology in modern weapon systems and high performance aircraft combined with readily available commercial off-the-shelf (COTS) microprocessors and integrated GPS inertial navigation kits makes our concept the right solution for the next generation UAV autopilot.

2.2 Freewing UAV Description

The Freewing Scorpion Model 100-50 has been privately developed by Freewing and represents the culmination of nearly fourteen years of design evolution. The fairly recent formulation of diverse military UAV mission needs has created the venue for which this technology is most attractive. The first UAV variant of the Freewing design flew in 1992, manned variants having flown as early as 1983. The Scorpion evolved through 40% and 50% scale models developed by Freewing with Burt Rutan in 1992 and 1993, respectively. The design featured the freely hinged wing and vectored thrust gained simply by independently rotating the forward fuselage upward relative to the tail boom assembly. The Scorpion 100, also developed with Rutan, first flew in 1994. The Scorpion 100 capabilities include conventional vehicle-like dash and cruise performance, an extremely short takeoff/landing capability, and turbulence mitigation characteristics. Additionally the vehicle is inherently stable and relatively insensitive to large center-of-gravity changes, making it an appealing platform for a variety of COTS sensors.

The Freewing Scorpion 100-50 provides extremely short takeoff and landing (ESTOL) performance in a simple, modular vehicle that provides a stable sensor platform while retaining all the advantages of a conventional fixed wing aircraft. The freewing tilt-body is a new kind of aircraft, distinct from fixed wings and rotary wings. It is a combination of two tested technologies, the improved free-wing and the tilt-body, which combine to provide an extremely short takeoff and landing aircraft that is stable throughout its flight envelope, while requiring only a few moving parts.

In the Freewing aircraft, the wing is placed on bearings so that it is completely free to rotate in pitch, de-coupling the wing in pitch from the fuselage. Trim surfaces on the trailing edge of the wing are used to control the wing angle of attack and to provide roll control. The resulting "flying wing" has a fraction of the effective pitching moment of inertia compared to an otherwise identical fixed wing vehicle. This allows the wing to rapidly and automatically adjust the angle of attack (as would a weathervane) in response to gusts and other changes in the relative wind. Traditional fixed wing aircraft must overcome the moment of inertia of the entire aircraft to accomplish the same change. But the rapid pitch response of the Freewing allows it to effectively maintain a constant angle of attack with respect to instantaneous wind direction for a given trim surface setting. In addition, the absence of a root moment means that only very small variations in the magnitude/direction of aerodynamic forces are transmitted to the fuselage. The result is a smoother, more stable flight and better sensor resolution since air turbulence is largely neutralized before being transmitted to the fuselage. NASA studies show that accelerations due to gusts are reduced by as much as an order of magnitude in a Freewing aircraft compared to a similar fixed wing aircraft. Conservative estimates developed for the Scorpion by Texas A&M show a 50% reduction in gust loading over the low frequency end of the wind spectrum.

With the Freewing Tilt-body vehicle, the de-coupling between fuselage and wing is taken a step further. Here, fuselage trim surfaces generate body pitching moments independent of the wings, effectively de-coupling the thrust vector from the aircraft velocity vector. The fuselage itself is a lifting body, so the result is a left/right wing pair joined by a rotating spar passing through the lifting body. Both the left/right wing pair and the central lifting body are free to rotate about the span-wise shaft.

The Scorpion tilt-body aircraft has all the attributes of the Freewing Tilt-Body class. The Scorpion 100-50 was designed by Burt Rutan and Scaled Composites, in collaboration with Freewing Aerial Robotics, to meet the original Joint Tactical UAV requirements. The Scorpion was designed to make maximum use of commercial off-the-shelf (COTS) equipment to reduce costs and ensure availability of spares. The following figure shows a side view of the Scorpion in both a take-off/land and cruise configuration. This figure also shows a planform view of the vehicle.

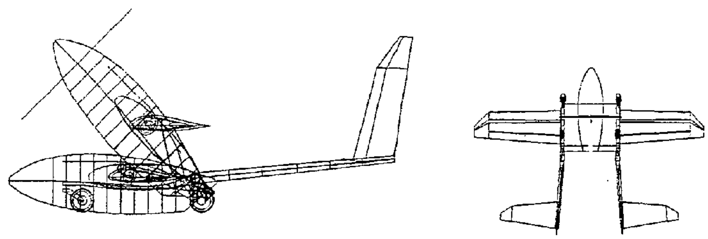

Figure 1: Freewing Side-View and Planform

The following table provides the main physical characteristics of the Scorpion 100-50.

Table 1: Scorpion 100-50 Air Vehicle Physical Properties

Total length	11.8 ft
Span	16.1 ft
Wing area (total) Freewing area Stub wing area	37.3 sq ft 61% sq ft 39% sq ft
Total height (cruise mode)	4.1 ft
Total height (tilt body mode)	6.75 ft
Maximum take-off weight	444 lbs
Empty weight	322 lbs
Maximum payload weight	50 lbs
Maximum fuel load	72 lbs
Power	52 hp
Max RPM	7000 (3000 output shaft)
BSCF	.52 - .57 lbs/hp-hr
Propeller	60" fixed pitch
Direction of rotation	CW (facing propeller)
Static thrust	270 lbs

2.2.1 Freewing UAV Capability

The following figures show the Scorpion Model 100-50 climb rate, flight envelope, range efficiency, and loiter efficiency. The predicted rate of climb as a function of airspeed and altitude is given in Figure 2, indicating a service ceiling of about 13 kft and a best climb speed of 60 to 70 knots. The resulting times to climb at full power are 5.0, 11.9 and 17.3 minutes to

5K, 10K and 12K feet, respectively. The maximum level flight envelope and service ceiling are shown on Figure 3. Since the vehicle's wing does not stall, the minimum speed will be determined by control limitations and maximum thrust. The indicated limitation at low speed is based on present flight test experience.

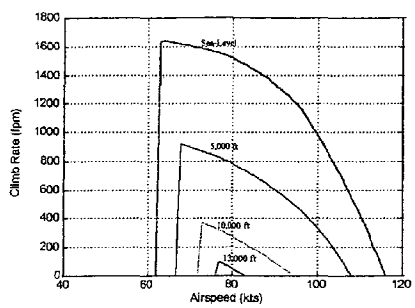

Figure 2: Rate-of-Climb

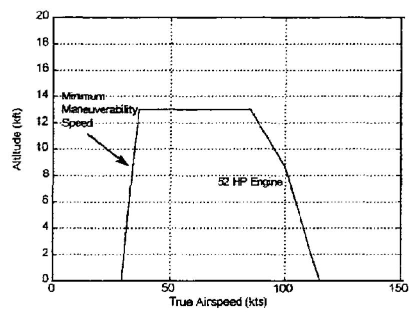

Figure 3: Flight Envelope

The range factor for this engine at sea-level is about 7 nm/lb at 65 knots. The endurance factor is predicted to be 6.8 min/lb. Data for this engine at altitude will not be available until the completion of the flight test program. We have therefore used the sea-level fuel consumption figures for range and endurance calculations for all altitudes.

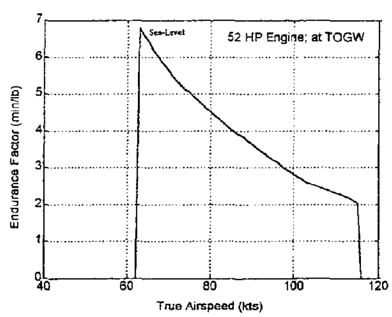

Figure 4: Endurance Factor

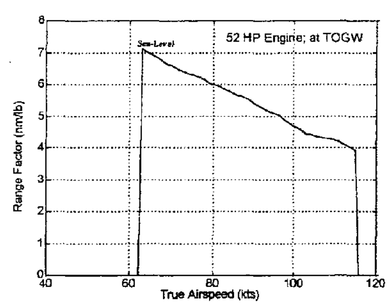

Figure5: Range Factor

With a maximum fuel load of 72 lbs and an endurance factor of approximately 6.8 min/lb, it is evident that the Scorpion vehicle is capable of providing several hours of time on station. The Scorpion loiter efficiency combined with its inherent insensitivity to turbulence makes this vehicle an attractive platform for the development and test of the simplified UAV autopilot concept.

3.0 Phase I Technical Approach

We view the research opportunity for this effort to be two-fold. The Geneva integrated guidance design approach merges the seeker, GPS/Navigator, guidance/autopilot, and remote command sub-functions in a structure that will greatly reduce workload and training requirements for the operator. In addition to the functionality of this design, we will assess a systems engineering design approach which will result in a lower-cost, more produceable, and more maintainable UAV. We therefore additionally propose to gather data which will show a cost benefit to our improved integrated systems engineering process.

3.1 Control System Architecture

Our controller design approach introduces several high-level operational modes, with varied levels of automation:

Energy-Optimization: Autonomous flight with only a single observation point and time-on-station requirement. The guidance determines speed, altitudes and flight paths to minimize energy expenditure.

Pre-Planned Waypoint: The vehicle flies the pre-programmed waypoints, either specifying speed and altitude, or allowing the UAV to autonomously determine them from the energy management system.

Real-Time Waypoint Editing: Can be entered at any time during a mission by specifying a waypoint that the UAV can physically reach from its current location, or by changing the location of an existing waypoint.

Directional Response Autopilot: Entered automatically by moving the joystick. The joystick commands immediately override the existing commands and relate to changes in flight path.

Line-of-Sight Slave: The vehicle heading is commanded to align with the camera line-of-sight commands until the vehicle comes within a specified radius, in which case it is commanded to circle the designated point.

These operational modes suggest an hierarchical control structure with varied levels of remote pilot command insertion. For example, when flying in the "stick and rudder" mode, the pilot commands would be inserted at the lowest control level immediately prior to actuation. Conversely when flying the directional-response autopilot, the commands will be inserted as vertical or horizontal flight path turning rates. LOS Slave commands would be inserted at the guidance command level. Figure 6 shows the proposed control loop organization structure:

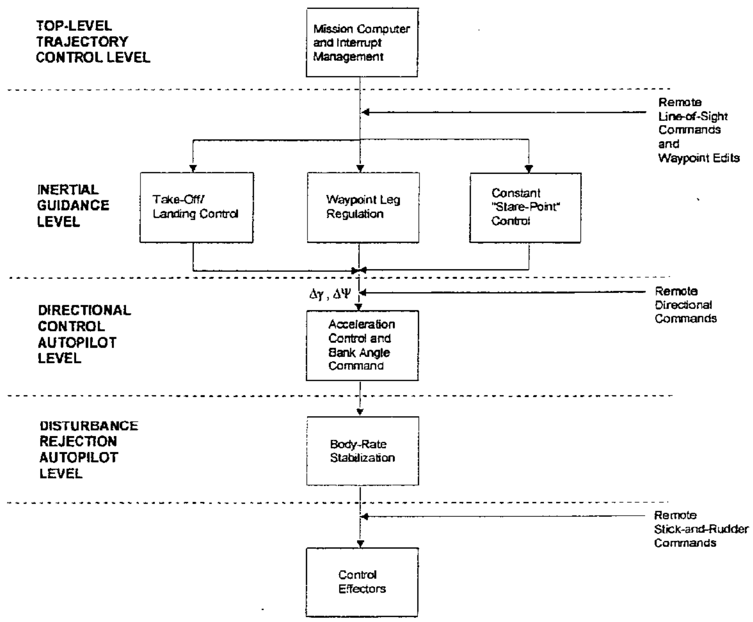

Figure 6 Airframe Control Structure Organization

Perturbations in flight path and ground track angles ($\Delta\gamma$ and $\Delta\Psi$) provide the command signals used for outer loop guidance because they can be mapped directly to "go up/go down" and "go left/go right" intuitive commands and because they lend themselves well to the inertial control laws which are used for the autonomous guidance modes. Figure 6 shows several parallel processing paths at the guidance level. Processing for the outer-loop control is determined by the top-level trajectory control, which is driven primarily by the remote pilot's mode selection and by inertial trajectory requirements. This controller structure leads to a more modular software architecture, which will be useful for future capabilities or use on other UAV systems.

By mapping joystick motion into $\Delta\gamma$ and $\Delta\Psi$, we can achieve the added benefit that letting go of the joystick (referred to here as "stick-free") will result in constant velocity, straight-and-level flight. This will be valuable to the operator when he/she needs to change to another task such as camera slewing or waypoint editing without having to switch to a completely autonomous autopilot mode.

The primary modes for use, and therefore the focus of the evaluation efforts will be on the directional-response autopilot, the LOS slave mode guidance, and the waypoint editing capability. The following discussion defines the operational concept for each of these modes.

Directional-Response Autopilot. The purpose of directional command response is to enable an untrained operator to maneuver the vehicle in a stable manner as he or she affects the trajectory from ground-station information without having to compensate the faster loop dynamics of rate stabilization, aerodynamic coupling, or speed control. This can be achieved by associating changes in flight-path with the joystick motion, and by injecting these commands into a multi-variable digital autopilot which autonomously controls engine throttle, thrust vector setting, and body rate stabilization. Figure 7 shows the proposed multi-variable control loop structure, augmented with the higher-level functions.

When operating in directional response mode, the joystick commands are converted to flight-path angle change commands through a scheduled gain. This gain must be scheduled versus thrust setting and body tilit angle to maintain equivalent command-per-joystick deflection slope.

The operator will have command of speed control via a simplified, constant setting on his/her display. The directional commands and velocity setting comprise the command vector entering the autopilot. It should be pointed out that the other operational modes also provide the same command signals after some level of processing.

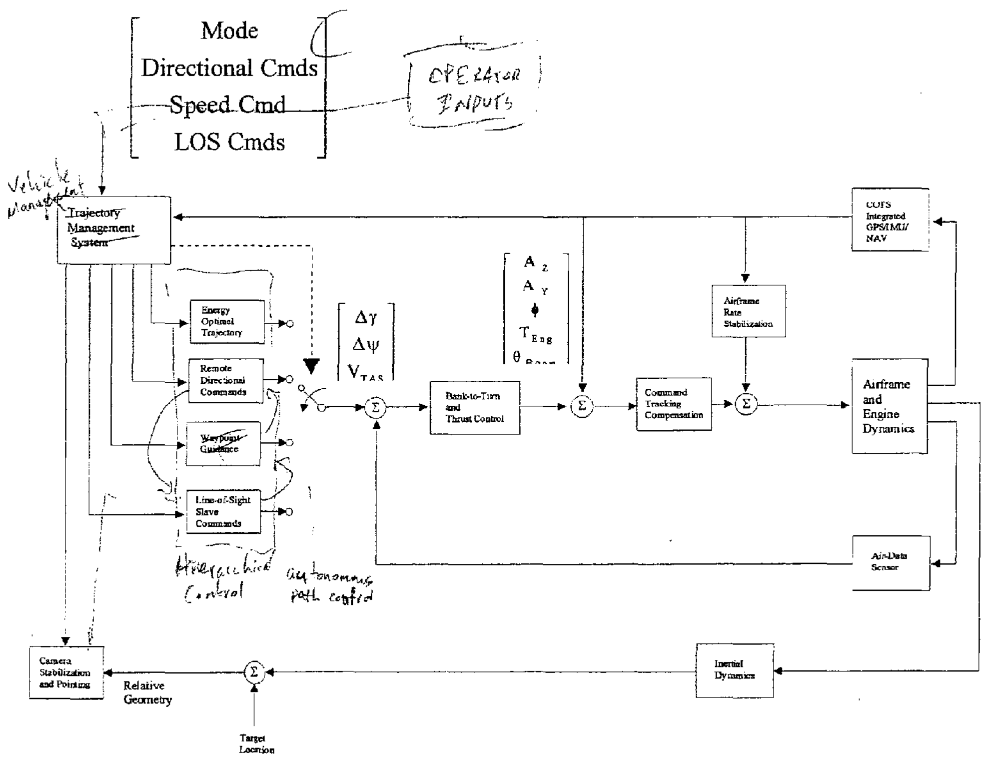

Figure 7 Multivariable Control Loop Structure

1

The Tilt-Body provides a unique thrust-vectoring capability which is optimally utilized in the thrust vector controller. Figure 8 shows that there are several trim points for most operating conditions across the locus of boom angles and elevator deflections. The data depicted in this figure represent the sum of the aerodynamic force coefficients and installed thrust coefficients at a 50% throttle setting.

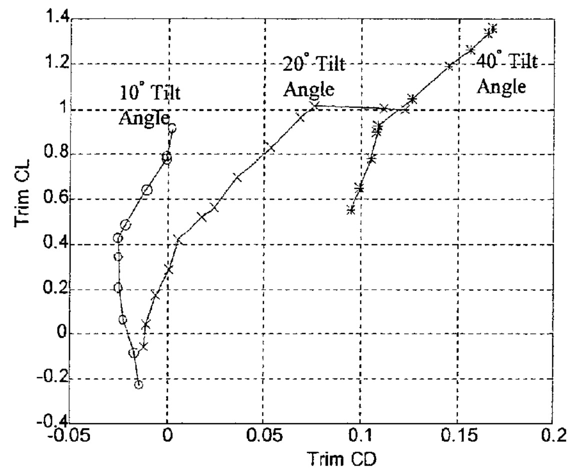

Figure 8: Trimmed Lift vs Drag

The above figure shows both the benefits and penalties associated with the thrust vector. For example, note that when the body tilt is increased from 10 to 40 deg, the total maximum lift capability at 50% power increases by 50%. Also note, however, the severe drag penalty associated with the high boom angle configuration. Consequently, these trim solutions are scheduled as functions of energy management constraints, maneuverability requirements, and desired speed. The curves are synthesized into an integrated multi-variable boom angle and throttle control, which are driven by the operator's speed and mode settings as command inputs. The low speeds available from the Tilt-Body will be a benefit for surveillance purposes, but can result in aerodynamic stall on the tail surfaces. This is particularly a concern when flying at higher boom angles, where the vehicle must fly at slow speeds in order to maintain speed trim. For this reason, the stall limits are multi-dimensional in nature and include a predictive stall-avoidance algorithm.

Because the operator may be inexperienced or otherwise occupied, the system includes control deflection and command limits at several levels to prevent non-linear aerodynamics such as stall and cross-channel coupling, over-expenditure of any mixed control surface in a single axis, structural over-loading, or actuator slew rate limiting.

LOS-Slave Control.

The directional-response autopilot, combined with the stabilized seeker platform allows a single minimally trained operator to easily conduct a UAV surveillance mission. A further level of user simplification is achieved by combining seeker designation command logic with the outer loop guidance. This mixing provides Line-of-Sight Slave mode capability in which the operator's point of reference is the image scene transmitted from the UAV's on-board camera. In this mode the operator does not provide direct directional commands to the UAV. Instead, the operator focuses his attention on the tactical situation display, commanding the look angle of the UAV's on-board sensor to survey the battlefield (or other topographical region for non-military applications) while the UAV autonomously commands a flight profile which is slaved to the operator's sensor line-of-sight commands. This integration of the camera platform with the guidance provides the following benefits:

1. Time-on-station loiter control which can be easily selected and designated.
2. Further reduction of workload on the operator, who can now focus primarily on the surveillance aspects the mission.
3. An easily adaptable relative Navigation method.

Figure 9 shows an example of how LOS-slave control would be used with the ground station display. The Navigation display would be a top-view with a schematic of the aircraft for easier conceptualization. This symbology would be added to the set of flight state information normally found on the display. The outer circle around the aircraft is a projection of the entire seeker field-of-view onto the ground. The smaller pie-shaped queue is a ground projection of the current seeker borsight position. These would be calculated by the ground station software from the positional information and seeker angle sent across the data-link.

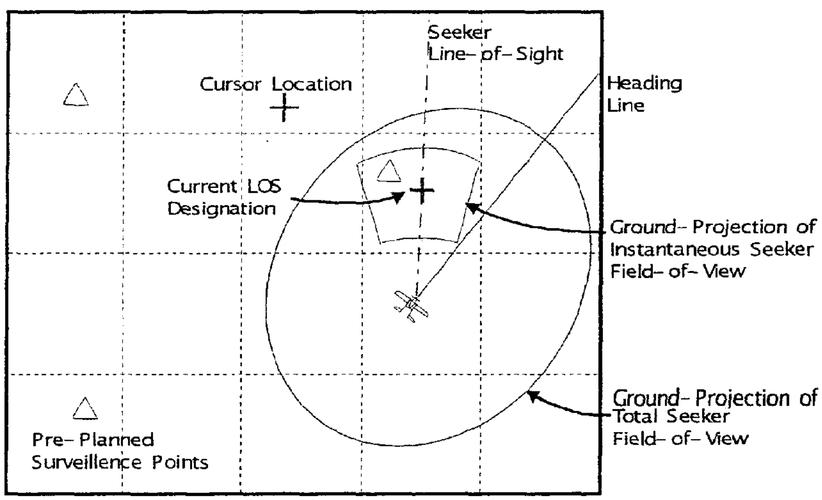

Figure 9 Augmentation to Tactical Situation Display

The remote pilot can opt to either keep the cursor active as the continual steering point, or he/she can designate a "surveillance-point" by clicking on a desired ground location. In the latter case, the staring point would be captured so the cursor could be moved to a new constant location.

If the pilot chooses a surveillance location outside the total FOV, then the outer loop guidance will follow a command-to-LOS mode guide law until the UAV flight path points toward the target. Once the desired staring-point comes within a minimum range threshold, the guidance automatically trips into a loiter pattern (either constant-radius or elliptical) to maintain track on the desired location. This guidance structure allows the operator to park the vehicle at a station with a single key-click while he/she conducts other activities. Figure 10 shows a diagram of the surveillance-point approach scenario.

If a constant location is selected within the minimum turning radius, then the guidance must fly over the surveillance-point and plan an out-and-back pattern to avoid a singularity in the loiter guide-law. This can be easily achieved by inserting waypoint legs autonomously.

If the operator chooses, he/she can select a standoff range (or accept the default range) for surveillance over a hostile target. The seeker line-of-sight commands will also comprehend the offset location to track on the desired location. This is achieved by inserting the offset range vector in the positional component of the loiter guide-law.

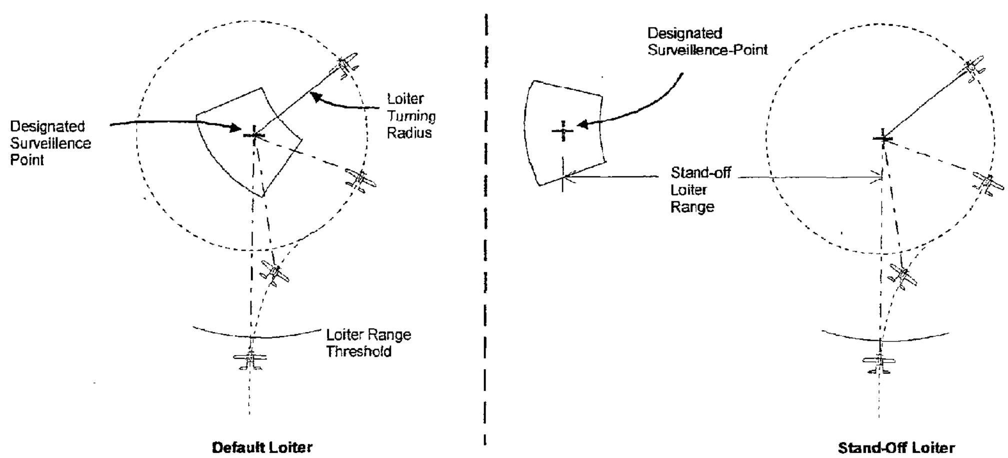

Figure 10 Surveillance-Point Approach Trajectory

The following simplified equations are used to show the basic structure of the LOS Slave mode guidance:

If (R_{Target} > Loiter_Threshhold) then

$$\dot{\psi}_{Cmd} = K_{\dot{\psi}} \left(\lambda_{Horiz} - \psi_{Heading} \right)$$

$$\dot{\gamma}_{Cmd} = K_H (H_{CMD} - H) + K_{\dot{H}} \dot{H} + \frac{g}{V}$$

else

$$\dot{\psi}_{Cmd} = K_{\dot{\psi}} \Delta\psi + K_\rho \left(\rho_{Turn} - \left\| \bar{R}_{Target} + \bar{R}_{Stand-Off} \right\| \right)$$

$$\dot{\gamma}_{Cmd} = K_H (H_{CMD} - H) + K_{\dot{H}} \dot{H} + \frac{g}{V}$$

endif

where

R_{Target} = Horizontal Range – to – Target
$\dot{\psi}_{Cmd}$ = Horizontal Turning Rate Command
$\Delta\psi$ = Heading Error Relative to Loiter Path
λ_{Horiz} = Horizontal Line – of – Sight to Target
$\dot{\gamma}_{Cmd}$ = Vertical Turning Rate Command
$\psi_{Heading}$ = Heading Angle
ρ_{Turn} = Loiter Turning Radius
H = Altitude
g = Gravity Acceleration Magnitude
V = Vehicle Inertial Velocity Magnitude

The above equations show two active horizontal guidance terms when flying the constant turning radius circle. The first term is the damping term which drives the vehicle to align its ground track with the desired circular loiter pattern and is the dominating term. The second term is a positional term to help maintain the constant arc.

Waypoint Mode with Real-Time Waypoint Editing

The waypoint guidance system is organized as a linked list of waypoints augmented with smooth turn and leg propagation logic at each station. This provides the capability to easily edit the waypoint list from the graphical display both during pre-flight mission planning and while the UAV is in the air.

The operator will now have the ability to insert waypoints visually with a track-ball or mouse. If the operator discovers an unknown hazard in the pre-planned flight-path, then he can either "drag-and-drop" the existing waypoints or he can delete and insert new waypoints as necessary.

By grabbing the joystick, the operator automatically overrides the waypoint mode and enters directional response mode. Waypoint mode can be re-entered by commanding the vehicle back to alignment with the current waypoint leg.

Autonomous and Directional Response Landing

The usability of typical UAV systems is strongly dependent upon how much skill and instrumentation is required at landing. Completely autonomous landings with conventional fixed-wing UAV's are only possible with very accurate terminal altitude instrumentation such as a millimeter-wave capture and recovery systems, differential GPS Navigation, or RADAR altimeters.

Most systems rely upon remote piloting at the terminal phase. Landing would present a challenge to the simplification of the remote pilot commands because of the complexity and timing of the terminal flare maneuver. However, the Tilt-Body design provides a solution to both autonomous and simplified-remote command landings. When the vehicle flies at high body tilt angle, a large component of lift is afforded at very low airspeeds. This makes it possible to fly the vehicle at steady-state terminal sink rates which will not harm the structure of the vehicle at impact. With this feature, the pilot needs only to command a landing point, and the vehicle guidance responds by setting up its own terminal leg geometrically. A weight-on-wheels sensor is added to shut off the motor at impact and to command negative lift on the Freewing.

The operator can correct the terminal flight-path if he visually detects an obstruction, or he can land the vehicle purely with the directional response autopilot. In this case, the internal command limits prevent him from slamming the vehicle into the ground with too much vertical velocity.

3.2 Typical Mission Profile

The utility of the modes discussed above are demonstrated with a example of how they might be used for a surveillance scenario. The sequence of events correspond to the diagram in figure 11:

(1) After take-off, the operator points the camera or seeker with the joystick as the UAV flies autonomously along either per-planned or real-time inserted wayopints.
(2) Operator-controlled maneuver to avoid reported hazard along flight path. The mode is invoked automatically by grabbing the joystick.
(3) By letting go of the joystick (and not yet designating to re-capture waypoint plan), the UAV flies straight-and-level while the operator scans the seeker
(4) Operator designates a stand-off surveillance of one of the original mission objective points.
(5) The operator edits the original waypoints to command a return-to-base, flying by the second mission objective point.
(6) Operator evokes continuous LOS Slave control to examine third target.
(7) Operator commands a loiter prior to approach in order to coordinate with other mission objectives or vehicles
(8) Applies the terminal waypoint to establish the run-in heading.

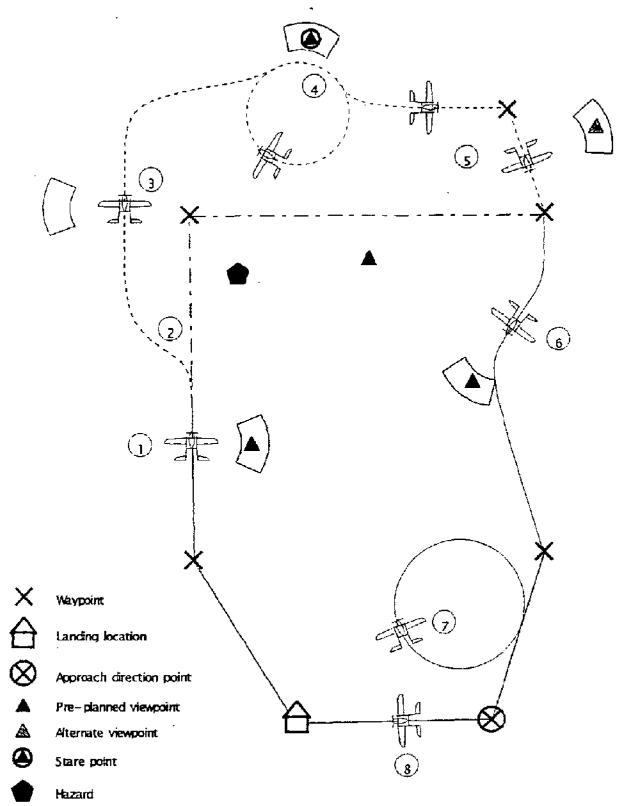

Figure 11: Sample Mission Profile

3.3 Systems Engineering Approach

The systems engineering process is modified to develop systems with COTS components by enabling us to evaluate the contributions of each subsystem to the top level requirements as well as the subsystem component interactions in the presence of a synthesized controller.

Rather than beginning with subsystem requirements from systems engineering trade studies, our process begins with cost and performance data from existing production-ready components. We will design modularity into the system by recognizing those de-facto interface standards which exist with the most cost-effective components. The guidance and autopilot compensation is then developed in parallel with the trade studies identifying the subsystems to be used. This allows us to trade-off certain characteristics of subsystems for equivalent top-level performance. For example, the degraded performance of a lower-cost IMU may be acceptable if slightly better actuators are available.

The cost/performance trades will be evaluated by observing their effects on the highest reasonable level of performance requirements. Several candidate systems will then be projected, and their performance plotted versus cost. The most cost-effective system will then be identified, and the associated performance characteristics become the system specifications. If the resulting performance is less than what would be considered marketable, then the next higher performing candidate system will be chosen. Subsystem allocations will then be completed by recognizing the specifications of those already-procured components. This design approach has several benefits:

1. The development cycle-time and associated cost is greatly reduced by avoiding procurement on the subsystem level.
2. The design is modular by definition, thereby facilitating future subcomponent upgrades or system capability expansion.
3. The development cycle results in a low-cost, production-ready system design.
4. In this case, the system design can more effectively take advantage of the Freewing Tilt-Body's unique flying qualities.

3.4 Research Plan

We have introduced a guidance design concept and systems engineering approach that we believe can fulfill the list of requirements posed for a usable and versatile UAV system. Throughout phase II and into development, the final ground station and interface may take one of several possible forms. We feel our UAV guidance/autopilot structure will be compatible with existing C4I Common Ground Control Stations and will facilitate the advance of the UAV surveillance community into the realm of Virtual Reality, linking the senses of the operator with the sensors from the remote platform. We intend to show this by performing a simulation-based integration of the above guidance laws and relevant modeling parameters.

We will then perform a series of simulation trade studies and cost analyses to demonstrate the effectiveness of our integrated guidance design with the Freewing airframe. When complete, our results will either position us to begin phase II efforts or they will point toward other development tasks that should be pursued. The following work breakdown structure is proposed:

1.0 <u>Industry survey of COTS performance parameters.</u>

We will attempt to collect enough COTS subsystem cost and performance data to simulate at least 3 candidate integrated system designs. We will also collect the data necessary to model the subsystems.

2.0 <u>Update 6DOF simulation to include subsystem models and interface.</u>

In addition to subcomponent models, a set of prototype controller hardware must be integrated with the simulation. This will include a standard COTS joystick and mouse with appropriate driver software. This will not include a prototype of the ground controller interface.

3.0 Integrate the directional-response controller into simulation.
This integration effort will include the core multivariable controller structure with the body tilt angle and thrust vector regulator as well as bank-to-turn autopilot.

4.0 Integrate Line-of-Sight Slave mode controller into simulation

5.0 Integrate waypoint-guidance mode controller into simulation

6.0 Assess performance and usability of the high-level controller functions
A simulation-based study will seek to answer the following questions:

- Is this controller intuitive and usable by an untrained pilot ?
- It the controller robust and stable under all operating conditions ?
- Can the operator over-drive the UAV, or does the software effectively limit his/her commands ?
- Can the controller be implemented with existing data-link interfaces ?

7.0 Perform a cost-performance build-up on the candidate systems and assess optimal cost vs. performance system

8.0 Investigate interfaces and expandability of current ground control stations and mission planning modules.
The last effort will be important to establish the basis for phase II planning. We will seek opportunities to acquire government-furnished ground station equipment which would represent the perceived direction of technology.

4.0 Related Work

Geneva Aerospace is currently under contract with Freewing Aerial Robotics, Inc. to assess the performance capability and to develop an operational autopilot for the Freewing Tilt-Body series of UAV's. In order to execute this contract, Geneva is also currently developing a Six Degree-of-Freedom simulation which accurately models the Freewing's unique kinematic and aerodynamic properties. These and the other significant development efforts are identified discussed:

University of Maryland, MATRA BAe and Texas A&M Wind Tunnel Tests
Freewing and its partners have logged over 560 hours of wind tunnel testing for use in the development of a Freewing Tilt-Body aerodynamics model. Researchers at the University of Maryland, Texas A&M University, and most recently, Geneva Aerospace have teamed to analyze the Freewing wind tunnel data and develop a realistic Freewing Tilt-Body vehicle aerodynamics model. Geneva Aerospace has integrated this aerodynamics model into a 6DOF simulation for use in the development of an automatic flight control system for the Freewing UAV. Geneva has also used this aerodynamics model to conduct a comprehensive vehicle performance assessment.

Boeing Instrumented Flight Test Series

Freewing has recently teamed with Boeing to conduct a comprehensive instrumented flight test program using the Scorpion Model 100-50. This flight test program is the first in a planned series of test programs to collect real flight test data which will be used to validate the Freewing aerodynamics model as well as the propeller, engine, and actuator models used in Geneva's 6DOF simulation. This flight test program along with the follow-on aerodynamics and simulation model updates will be completed prior to the AF98 Phase I SBIR contract award, providing both technical merit for entrance into a Phase I study effort as well as risk reduction for advancement to a Phase II flight test demonstration program.

Geneva Six Degree-of-Freedom Simulation

Geneva is currently developing a generic off-the-shelf six degree-of-freedom simulation to support this and several other design and analysis efforts. The long-term goal of this effort is to provide a validated and accredited core simulation package for missile, UAV, and aircraft development efforts. The simulation is highly modular and written in the C++ object-oriented language .

The Freewing dynamics model and aerodynamic database has been integrated into the generic 6DOF, which is currently being used for on-going performance evaluation and design trades.

Freewing Tilt-Body Development Program

Most recently Freewing has been in active development of a variant of its Scorpion Tilt-Body in collaboration with Europe's Matra BAe Dynamics. This variant, known as the "Marvel," is to be employed by the French Navy for use aboard its frigates and other surface combatants. This ambitious program is scheduled to demonstrate the suitability of the Scorpion platform in the late 1998 time-frame. The program gained a further boost amid indications that the French Army may consider a 60% scale version for its UAV reconnaissance needs.

Geneva's Integrated Guidance Systems Design Methodology

The desire for more use of COTS components in modern military applications calls for a modified systems engineering design approach. We feel that this can be done more effectively by focusing on the highest level requirements, and by designing the embedded controller to optimize the interactions between the subsystems. Geneva has developed a methodology which uses the framework of modern robust control theory to synthesize a controller, allowing us to assess the effects of degrading subsystem uncertainties on top-level performance. From there, a comprehensive Cost vs. Performance curve can be developed, whereby cost can truly be treated as an independent design variable. It is the merging of systems engineering, COTS subsystem procurement, and multivariable robust control theory that makes this approach so unique.

5.0 Relationship with Phase II Work

As the development of the Freewing aerial vehicle progresses, the guidance, navigation, and ground station systems must develop in parallel. Although an innovative guidance system architecture has been developed from projected mission profiles, several questions regarding the usability of our design must be answered prior to entering full-scale system development. The results of the phase I research will provide the critical information needed to enter into the full-scale development of the integrated system.

With this information, Freewing and Geneva will propose a phase II integration and test plan with the goal of developing a complete low-cost UAV capable of interfacing with current and future ground stations, payloads, and seekers.

6.0 Company Information

Geneva Aerospace is a progressive engineering firm specializing in integrated flight control systems technology. Formed in 1995 and formally founded in early 1997 by several Members of the Group Technical Staff of Raytheon-TI Systems, Geneva's flight control systems team has a proven track record on various military weapon systems programs such as the U.S. military's Joint Standoff Weapon (JSOW), High-Speed Anti-Radiation Missile (HARM), and the Extended Range Guided Munitions (ERGM) weapon. Geneva's staff specializes in design and implementation of inertially guided autonomous glider weapons and maintains leading-edge expertise in robust real-time control system design techniques.

Freewing Aerial Robotics Corporation is one of a new breed of high-tech companies launched in university-based business incubators, in a special kind of public/private partnership, with its R&D partially funded by competitive government technology grants. Consulting and shareholding agreements with other engineers, such as Burt Rutan and John Roncz, expand Company capabilities. A number of Texas A&M University faculty members and graduate students also work extensively with Freewing. Freewing has been selected by European aerospace giant Matra BAe Dynamics as partner and vehicle subcontractor in a UAV proposal to the French government.

7.0 Key Personnel

David Allen Felio - Principal Investigator

Dave Felio has developed autonomously-guided weapon systems as an autopilot and guidance specialist at Texas Instruments Missile Systems Division for the past 11 years. He has had extensive experience developing anti-radiation homing missiles, GPS inertially guided glider weapons, and cannon-launched smart munitions. He is currently a Member of the Group Technical Staff at Raytheon-TI Systems, and has served as the lead G&C systems designer for the Joint Stand-Off Weapon System, RTIS's Interdiction Weapons Division, and several proprietary development programs. Mr. Felio holds a Masters of Mechanical Engineering with an emphasis in control theory from the University of Texas at Arlington, and a Bachelor's Degree in Electrical Engineering from Texas Tech University.

David Shane Duggan

Dave Duggan has developed missile systems as an autopilot and guidance specialist at Texas Instruments Missile Systems Division for the past 8 years. He has had extensive experience developing anti-radiation homing missiles, GPS inertially guided glider weapons, and precision guided imaging missiles. He is currently a member of the Group Technical Staff at Raytheon-TI Systems, and has served as the lead G&C systems designer of the Unitary variant of the Joint Stand-Off Weapon system for the past 3 years. He currently holds the lead G&C systems functional position over RTIS's Interdiction Weapons Division. Mr. Duggan holds a Bachelor's Degree in Aerospace Engineering from the University of Texas, Arlington.

8.0 Facilities

Geneva Aerospace maintains state-of-the art computing platforms and engineering software to support analysis, simulation, and control system design work for Freewing. All hardware integration necessary for the studies will be conducted on-site at the Freewing facility in College Station.

Freewing's research and development laboratory is housed in a 20,000 ft2 complex of four buildings in College Station, Texas. Freewing conducts its flight tests at an airport on the Riverside campus of Texas A&M University, which participates in flight testing as a subcontractor to Freewing.

Freewing has formed a business arrangement with L&L Tooling & Manufacturing, Inc. of Itasca, Texas, to acquire pre-production models of its Scorpion Tilt-Body and to gain production tooling. L&L is a premier maker of composites tooling, whose customer list includes Rockwell, Gulfstream and Bell Helicopter. Freewing's production line for the Scorpion Model 100-50, a 50-pound payload Freewing Tilt-Body UAV, is scheduled to open in 1997 in Texas. Several Scorpions have been produced from the soft production tooling. The final tooling will be capable of producing up to one aircraft per day.

Bibliography

Porter, R.F., Hall, D.W., Brown J.H., Gregorek, G.M., "Analytical study of the Free-Wing Free-Trimmer Concept ", NASA CR-2946, February 1978.

Chen, W. & Barlow, J.B., "Stability, Control and Gust Response Characteristics of an Ultralight freewing Aircraft ", AIAA-92-4342, Atmospheric Flight mechanics Meeting, Hilton Head, SC, August 10-12, 1992.

Chen, W. & Barlow, J.B., "An Ultralight Freewing Aircraft Design Study', AIAA-92-4194, AIAA Aircraft Design System Meeting, Hilton Head, SC, August 24-26, 1992.

Chen, W., "Stability, Control and Gust Sensitivity of a Low Wing Loading Freewing Airplane ", M.S. Thesis, 1992.

Barlow, J.B. & Chen, W., "Aerodynamic Characteristics and Control Aspects of a Freewing Tilt-Body Airplane", presented at the Twelfth Briston International Conference on RPVs, 9-11 September 1996, Bristol, UK.

APPENDIX C

U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
PROJECT SUMMARY

1. Name of Offerer: Geneva Aerospace, Inc.

2. Home office address: PO Box 613018
Dallas, TX 75261-3018

3. Location where work will be performed: 2215 St. Andrew
Highland Village, TX 75067

4. Title of proposed effort: "Examination of a Generalized Guidance and Autopilot Design for UAV Flight Control Simplification"

5. Topic Number And Title: AF98-179. "Simplified Manual Flight Control"

6. Total dollar amount of Proposed Effort		$ 93,177	
7. Direct material costs			
COTS Controller Sim. Hardware		$ 10,000	$10,000
8. Direct labor (specify)			
a. Principal Investigator	700 Hours @ $ 38.00	$ 26,600	
Assistant Investigator	500 Hours @ $ 31.50	$ 15,750	
b. Total		$ 38,550	$ 42,350
9. Labor overhead	51% of Direct Labor Costs	$ 21,675	$ 21,675
10. Travel (if direct charge)			
a. Transportation to acquire typical system parameters:			
	Rental Car	$ 50	
	Airline Tickets	$ 2,000	
b. Per diem or subsistence			
	Hotel	$ 200	
	Meals	$ 100	
c. Estimated total travel		$ 2,350	$ 2,350
11. Other direct costs			none

12. Total Costs	$ 76,375
13. General and Administrative (15%)	$ 11,456
14. Fee (7%)	$ 5,346
15. Total Firm Fixed-Price Cost	$ 93,177

16. Type of contract proposed: Firm-fixed-price.

17.

a) Has any executive agency of the United States Government performed any review of your accounts or records in connection with any other government prime contract or subcontract within the past twelve months? No.
b) Will you require the use of any government property in the performance of this proposal? No.
c) Do you require government contract financing to perform this proposed contract? Yes. If yes, then specify type as advanced payments or progress payments. Progress Payments

________________________ __________________

David A. Felio Date

President

Exhibit 10 - Geneva Phase I Contract information for AF98-179
from Air Force SBIR Web site at
http://www.afsbirsttr.com/TechMall/Default.aspx?kwa=AF98-179

GOVERNMENT
SMALL BUSINESS
PRIME CONTRACTOR
ACADEMIA

Program Office

Air Force Research Laboratory (AFRL/XPP)
1864 4th Street
Bldg 15 Rm 225
Wright-Patterson AFB, OH
45433
Toll Free:
1-800-222-0336
Fax: (937) 255-2219

AWARD DETAILS

Back to List Printer Friendly

AIR FORCE

Proposal #:	98AL-306	**DoD Submission #:**	
Phase:	I	**Program:**	SBIR
Proposal Title:	Examination of an Integrated Autopilot Design for Simplified UAV Flight Control		
AF Sol Topic #:	AF98-179	**DoD Technology Area:**	Air Platforms
Solicitation #:	98.1	**Gov't Managing Office:**	RH
Agency:	AF	**Gov't Sponsoring Office:**	
Topic Title:	Simplified Manual Flight Control		

AWARD DETAILS

Status:	Successful (Invited for Phase II)		
Amount:	93177	**Contract:**	F41624-98-C-5058
Start:	5/14/1998 12:00:00 AM	**End:**	2/14/1999 12:00:00 AM
Annual Report FY:	1998		
Transition Success Story written?		**Impact Story Submitted?**	No
HUBZone:	No		
TRL Level:	Level 3		
TRL Application:	Analytical and experimental critical function and/or characteristic proof-o- concept		
DTIC Rpt. Date:	3/20/2001 12:00:00 AM	**DTIC Rpt. Num.:**	AFRL-HE-WP-TR-1999-0017-
DTIC Accession Number:	B242868		

FIRM DETAILS

Firm:	Geneva Aerospace, Inc.	**Socially & Economically Disadvantaged Business?:**	No
Address:	PO Box 613018	**Woman Owned?:**	No
		Veteran Owned?:	No
City:	Dallas	**Disabled Veteran Owned?:**	No
State:	TX	**HBCU/MI:**	No
Zip:	75261	**HBCU/MI Name:**	
Employees:	6		

CONTACT INFORMATION

Project Manager Name:	David A. Felio
Project Manager Title:	President
Project Manager Phone:	(972) 317-3124
Project Manager Email:	
Corp Official Name:	David S. Duggan
Corp Official Title:	Secretary and V.P.
Corp Official Phone:	(940) 440-9312
Corp Official Email:	

APPENDIX B

Abstract:
In order to be truly versatile, Unmanned Aerial Vehicle (UAV) Systems must be usable to individuals who's training is more focused on the requirements of a given mission or on the usability of the payload, rather than on the aviation of the air vehicle. This

TOPIC/AWARD DATA

SEARCH TOPICS

SEARCH AWARDS

LOGIN

Please select the area you work within in relation to the SBIR & STTR programs from the menu on the left.

PUBLICATIONS

SBIR/STTR Advantage
Innovation Stories
Transition Stories

Exhibit 11 - IDS From Duggan Provisional Application No. 60/480,192

1FW

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First Named Inventor : Dave Duggan et al.	
Appln. No. : 60/480,192	
Filed : June 20, 2003	Group Art Unit: ---
For : METHOD AND APPARATUS FOR AUTONOMOUS AND SEMI-AUTONOMOUS COMMAND AND CONTROL OF UNMANNED AIR VEHICLE	Examiner: ---
Docket No.: G46.12-0001	

INFORMATION DISCLOSURE STATEMENT

I HEREBY CERTIFY THAT THIS PAPER IS BEING SENT BY U.S. MAIL, FIRST CLASS, TO THE COMMISSIONER FOR PATENTS, P.O. BOX 1450, ALEXANDRIA, VA 22313-1450, THIS 29th DAY OF July, 2004.
Christopher L. Holt
PATENT ATTORNEY

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

The patents or publications listed on the enclosed PTO Form-1449 are submitted pursuant to 37 C.F.R. § 1.97. Copies of the patents or publications cited are enclosed.

TIME OF FILING

The information disclosure statement is being filed:

1. _X_ with the application or within three months of the filing date of the application or date of entry into the national stage of an international application or before the mailing date of a first Office action on the merits, whichever event occurs last. In accordance with 37 C.F.R. § 1.97(b), no statement or fee is required.

2. ___ after the time period specified in paragraph 1 above, but before the mailing date of a final action under 37 C.F.R. § 1.113 or notice of allowance under 37 C.F.R. § 1.311. Therefore, in accordance with 37 C.F.R. § 1.97(c), submitted herewith is:

(check either A or B below)

A. ___ a statement as specified in 37 C.F.R. § 1.97(e).

B. ___ the fee set forth in 37 C.F.R. § 1.17(p) for submission of an information disclosure statement under 37 C.F.R. § 1.97(c).

3. ___ after the mailing date of either a final action under 37 C.F.R. § 1.113 or a notice of allowance under 37 C.F.R. § 1.311, whichever occurs first, but before payment of the issue fee. Therefore, Applicant petitions for consideration and submits herewith:

A. a statement as specified in 37 C.F.R. § 1.97(e);

B. the petition fee set forth in 37 C.F.R. § 1.17(p).

STATEMENT

(only used if No. 2(A) or No. 3 above is checked)

The person(s) signing below certify

(check appropriate paragraph)

___ that each item of information contained in this Information Disclosure Statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of this statement. 37 C.F.R. § 1.97(e)(1).

OR

___ that no item of information contained in this Information Disclosure Statement was cited in a communication from a foreign patent office in a counterpart foreign application or, to the knowledge of the person signing the certification after making reasonable inquiry, was known to any individual designated in 37 C.F.R. § 1.56(c) more than three months prior to the filing of this statement. 37 C.F.R. § 1.97(e)(2).

METHOD OF PAYMENT

__X__ No fee is required.

____Attached is a check in the amount of $_____.

The Director is authorized to charge any fee deficiency required by this paper or credit any overpayment to Deposit Account No. 23-1123. A duplicate copy of this communication is enclosed.

Respectfully submitted,

WESTMAN, CHAMPLIN & KELLY, P.A.

By: Christopher L. Holt

Christopher L. Holt, Reg. No. 45,844
Suite 1600 - International Centre
900 Second Avenue South
Minneapolis, Minnesota 55402-3319
Phone: (612) 334-3222
Fax: (612) 334-3312

CLH/rkp

OIPE AUG 0 3 2004 PATENT & TRADEMARK OFFICE

Sheet 1 of 2

FORM PTO-1449	Atty. Docket No.: G46.12-0001	Appl. No.: 10/871,612
LIST OF PATENTS AND PUBLICATIONS FOR APPLICANT'S INFORMATION DISCLOSURE STATEMENT	First Named Inventor: Dave Duggan et al.	
	Filing Date: June 18, 2004	Group Art: ---

U.S. PATENT DOCUMENTS

Examiner Initial		Document No.	Date	Name	Class	Sub Class	Filing Date If Appropriate
	AA	5,214,584	05/1993	Dingee et al.	364	423	
	AB	5,123,610	06/1992	Oaks	244	3.12	
	AC	4,611,771	09/1986	Gibbons et al.	244	3.12	
	AD	4,725,956	02/1988	Jenkins	364	434	
	AE	5,522,567	06/1996	Kinstler	244	3.15	
	AF	5,904,724	05/1999	Margolin	701	120	
	AG	4,848,755	09/1989	McNulty et al.	364	434	
	AH	4,642,774	02/1987	Centala et al.	364	434	
	AI	5,951,609	09/1999	Hanson et al.	701	13	
	AJ	5,951,607	09/1999	Senn et al.	701	1	
	AK	5,944,762	08/1999	Bessacini et al.	701	27	

FOREIGN PATENT DOCUMENTS

		Document No.	Date	Country	Class	Sub Class	Translation Yes No
	AL						
	AM						
	AN						

OTHER ART (Including Author, Title, Date, Pertinent Pages, Etc.)

	AO	
	AP	
	AQ	

EXAMINER:	DATE CONSIDERED:

EXAMINER: Initial if citation considered, whether or not citation is in conformance with MPEP 609; draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

OIPE AUG 0 3 2004 PATENT & TRADEMARK OFFICE

Sheet 2 of 2

FORM PTO-1449	Atty. Docket No.: G46.12-0001	Appl. No.: 10/871,612
LIST OF PATENTS AND PUBLICATIONS FOR APPLICANT'S INFORMATION DISCLOSURE STATEMENT	First Named Inventor: Dave Duggan et al.	
	Filing Date: June 18, 2004	Group Art: ---

U.S. PATENT DOCUMENTS

Examiner Initial		Document No.	Date	Name	Class	Sub Class	Filing Date If Appropriate
	AR	5,822,515	10/1998	Baylocq	395	185.09	
	AS	5,782,429	07/1998	Mead	244	3.11	
	AT	5,691,531	11/1997	Harris et al.	244	3.14	
	AU	5,048,771	09/1991	Siering	244	3.15	
	AV	5,042,743	08/1991	Edwin R. Carney	244	3.11	
	AW	5,240,207	08/1993	Eiband et al.	244	190	
	AX	5,938,148	08/1999	Orenstein	244	3.15	
	AY	5,552,983	09/1996	Thornberg et al.	364	424.01	
	AZ	5,181,673	01/1993	Hubricht et al.	244	3.12	
	BA	5,605,307	02/1997	Batchman et al.	244	3.11	
	BB						

FOREIGN PATENT DOCUMENTS

		Document No.	Date	Country	Class	Sub Class	Translation Yes No
	BC						
	BD						
	BE						

OTHER ART (Including Author, Title, Date, Pertinent Pages, Etc.)

	BF	
	BG	
	BH	

EXAMINER:	DATE CONSIDERED:

EXAMINER: Initial if citation considered, whether or not citation is in conformance with MPEP 609; draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

Electronic Acknowledgement Receipt

EFS ID:	8924136
Application Number:	11736356
International Application Number:	
Confirmation Number:	3649
Title of Invention:	System and Method For Safely Flying Unmanned Aerial Vehicles in Civilian Airspace
First Named Inventor/Applicant Name:	Jed Margolin
Customer Number:	23497
Filer:	Jed Margolin
Filer Authorized By:	
Attorney Docket Number:	
Receipt Date:	29-NOV-2010
Filing Date:	17-APR-2007
Time Stamp:	16:40:35
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Amendment/Req. Reconsideration-After Non-Final Reject	jm_rpv2_foar_final.pdf	9816788 41d523e85154415ff727658ec4d74d7fd5e87796	no	241

Warnings:

Information:

Total Files Size (in bytes):	9816788

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/06 (07-06)
Approved for use through 1/31/2007. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD
Substitute for Form PTO-875

Application or Docket Number	Filing Date	
11/736,356	04/17/2007	☐ To be Mailed

APPLICATION AS FILED – PART I

FOR	NUMBER FILED (Column 1)	NUMBER EXTRA (Column 2)	SMALL ENTITY ☒ RATE ($)	SMALL ENTITY FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =		OR	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =			X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $250 ($125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							
			TOTAL			TOTAL	

* If the difference in column 1 is less than zero, enter "0" in column 2.

APPLICATION AS AMENDED – PART II

AMENDMENT

11/29/2010	CLAIMS REMAINING AFTER AMENDMENT (Column 1)		HIGHEST NUMBER PREVIOUSLY PAID FOR (Column 2)	PRESENT EXTRA (Column 3)	SMALL ENTITY RATE ($)	SMALL ENTITY ADDITIONAL FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	* 14	Minus	** 20	= 0	X $26 =	0	OR	X $ =	
Independent (37 CFR 1.16(h))	* 4	Minus	***4	= 0	X $110 =	0	OR	X $ =	
☐ Application Size Fee (37 CFR 1.16(s))									
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
					TOTAL ADD'L FEE	**0**	OR	TOTAL ADD'L FEE	

AMENDMENT

	CLAIMS REMAINING AFTER AMENDMENT (Column 1)		HIGHEST NUMBER PREVIOUSLY PAID FOR (Column 2)	PRESENT EXTRA (Column 3)	SMALL ENTITY RATE ($)	SMALL ENTITY ADDITIONAL FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =		OR	X $ =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =		OR	X $ =	
☐ Application Size Fee (37 CFR 1.16(s))									
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
					TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
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Legal Instrument Examiner:
/LAJUAN HICKSON/

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/736,356	04/17/2007	Jed Margolin		3649

23497 7590 09/01/2010

JED MARGOLIN
1981 EMPIRE ROAD
RENO, NV 89521-7430

EXAMINER	
MANCHO, RONNIE M	
ART UNIT	**PAPER NUMBER**
3664	
MAIL DATE	**DELIVERY MODE**
09/01/2010	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)
	11/736,356	MARGOLIN, JED
	Examiner	**Art Unit**
	RONNIE MANCHO	3664

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on 17 April 2007.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 1-14 is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) 1-14 is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date 4/2007.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

2. Claims 1-14 are rejected under 35 U.S.C. 103(a) as being unpatentable over Margolin (5904724) in view of Duggan et al (US 2005004723).

Regarding claim 1, Margolin (abstract; figs. 1-7; col. 3, lines 8-67; col. 4, lines 1-67; col. 5, lines 1-67) discloses a system for safely flying an unmanned aerial vehicle in civilian airspace comprising:

(a) a ground station 400 (fig. 1&4) equipped with a synthetic vision system (figs. 1&3; col. 4, lines 1 to col. 5, lines 67);

(b) an unmanned aerial vehicle 300 (figs. 1&3) capable of supporting said synthetic vision system (305, 306, 307, 311 on aircraft; col. 3, lines 8-67; col. 4, lines 1-67; col. 5, lines 1-67);

(c) a remote pilot 102 operating said ground station 400 (figs. 1&4; col. 3, lines 8-67; col. 4, lines 1-67; col. 5, lines 1-67);

(d) a communications link between said unmanned aerial vehicle 300 and said ground station 400;

e) a system onboard said unmanned aerial vehicle 300 for detecting the presence and position of nearby aircraft (305, 306, 307, 311 on aircraft) and communicating this information to said remote pilot 102 (col. 3, lines 8-67; col. 4, lines 1-67; col. 5, lines 1-67);

whereas said remote pilot uses said synthetic vision system (305, 306, 307, 311 on aircraft) to control said unmanned aerial vehicle 300 during at least selected phases of the flight of said unmanned aerial vehicle.

Margolin did not disclose that the vehicle is flown using an autonomous control system. However, Duggan teach of a system for safely flying an unmanned aerial vehicle in civilian airspace comprising:

a ground station controlling an unmanned aerial vehicle (sec. 0352, 00353), wherein during phases of a flight of an unmanned aerial vehicle (UAV, sec 0318, 0322, 0353) when a synthetic vision (sec. 0356, 0365, 0388, 0390) is not used to control said unmanned aerial vehicle said unmanned aerial vehicle is flown using an autonomous control system (autopilot, sec 0346 to 0350, 0390-0329).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Margolin as taught by Duggan for the purpose of incorporating an autopilot to ensure smooth transitions (Duggna abstract, sec 0014, 0085, 0086).

The different embodiments in both prior arts are combinable as it would be obvious to ne having ordinary skill in the art.

Regarding claim 2, Margolin (abstract; figs. 1-7; col. 3, lines 8-67; col. 4, lines 1-67; col. 5, lines 1-67) in view of Duggan disclose the system of claim 1 whereby said selected phases of the flight of said unmanned aerial vehicle comprise:

(a) when said unmanned aerial vehicle is within a selected range of an airport or other designated location and is below a first specified altitude;

(b) when said unmanned aerial vehicle is outside said selected range of an airport or other designated location and is below a second specified altitude.

Regarding claim 3, Margolin (abstract; figs. 1-7; col. 3, lines 8-67; col. 4, lines 1-67; col. 5, lines 1-67) in view of Duggan disclose the system of claim 1 further comprising a system onboard said unmanned aerial vehicle for periodically transmitting the identification, location, altitude, and bearing of said unmanned aerial vehicle.

Regarding claim 4, Margolin (abstract; figs. 1-7; col. 3, lines 8-67; col. 4, lines 1-67; col. 5, lines 1-67) in view of Duggan disclose the system of claim 1 further comprising a system onboard said unmanned aerial vehicle for providing a communications channel for Air Traffic Control and the pilots of other aircraft to communicate directly with said remote pilot.

Regarding claim 5, Margolin (abstract; figs. 1-7; col. 3, lines 8-67; col. 4, lines 1-67; col. 5, lines 1-67) in view of Duggan disclose a system for safely flying an unmanned aerial vehicle in civilian airspace comprising:

(a) a ground station equipped with a synthetic vision system;

(b) an unmanned aerial vehicle capable of supporting said synthetic vision system;

(c) a remote pilot operating said ground station;

(d) a communications link between said unmanned aerial vehicle and said ground station;

e) a system onboard said unmanned aerial vehicle for detecting the presence and position of nearby aircraft and communicating this information to said remote pilot;

whereas said remote pilot uses said synthetic vision system to control said unmanned aerial vehicle during at least selected phases of the flight of said unmanned aerial vehicle, and during those phases of the flight of said unmanned aerial vehicle when said synthetic vision system is not used to control said unmanned aerial vehicle said unmanned aerial vehicle is flown using an autonomous control system, and

whereas the selected phases of the flight of said unmanned aerial vehicle comprise:

(a) when said unmanned aerial vehicle is within a selected range of an airport or other designated location and is below a first specified altitude;

(b) when said unmanned aerial vehicle is outside said selected range of an airport or other designated location and is below a second specified altitude.

Margolin did not disclose that the vehicle is flown using an autonomous control system. However, Duggan teach of a system for safely flying an unmanned aerial vehicle in civilian airspace comprising:

a ground station controlling an unmanned aerial vehicle (sec. 0352, 00353), wherein during phases of a flight of an unmanned aerial vehicle (UAV, sec 0318, 0322, 0353) when a synthetic vision (sec. 0356, 0365, 0388, 0390) is not used to control said unmanned aerial vehicle said unmanned aerial vehicle is flown using an autonomous control system (autopilot, sec 0346 to 0350, 0390-0329).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Margolin as taught by Duggan for the purpose of incorporating an autopilot to ensure smooth transitions (Duggna abstract, sec 0014, 0085, 0086).

The different embodiments in both prior arts are combinable as it would be obvious to ne having ordinary skill in the art.

Regarding claim 6, Margolin (abstract; figs. 1-7; col. 3, lines 8-67; col. 4, lines 1-67; col. 5, lines 1-67) in view of Duggan disclose the system of claim 5 further comprising a system onboard said unmanned aerial vehicle for periodically transmitting the identification, location, altitude, and bearing of said unmanned aerial vehicle.

Regarding claim 7, Margolin (abstract; figs. 1-7; col. 3, lines 8-67; col. 4, lines 1-67; col. 5, lines 1-67) in view of Duggan disclose the system of claim 5 further comprising a system onboard said unmanned aerial vehicle for providing a communications channel for Air Traffic Control and the pilots of other aircraft to communicate directly with said remote pilot.

Regarding claim 8, Margolin (abstract; figs. 1-7; col. 3, lines 8-67; col. 4, lines 1-67; col. 5, lines 1-67) in view of Duggan disclose a method for safely flying an unmanned aerial vehicle as part of a unmanned aerial system equipped with a synthetic vision system in civilian airspace comprising the steps of:

(a) using a remote pilot to fly said unmanned aerial vehicle using synthetic vision during at least selected phases of the flight of said unmanned aerial vehicle, and during those phases of the flight of said unmanned aerial vehicle when said synthetic vision system is not used to control said unmanned aerial vehicle an autonomous control system is used to fly said unmanned aerial vehicle;

(b) providing a system onboard said unmanned aerial vehicle for detecting the presence and position of nearby aircraft and communicating this information to said remote pilot.

Margolin did not disclose that the vehicle is flown using an autonomous control system. However, Duggan teach of a system for safely flying an unmanned aerial vehicle in civilian airspace comprising:

a ground station controlling an unmanned aerial vehicle (sec. 0352, 00353), wherein during phases of a flight of an unmanned aerial vehicle (UAV, sec 0318, 0322, 0353) when a synthetic vision (sec. 0356, 0365, 0388, 0390) is not used to control said unmanned aerial vehicle said unmanned aerial vehicle is flown using an autonomous control system (autopilot, sec 0346 to 0350, 0390-0329).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Margolin as taught by Duggan for the purpose of incorporating an autopilot to ensure smooth transitions (Duggna abstract, sec 0014, 0085, 0086).

The different embodiments in both prior arts are combinable as it would be obvious to ne having ordinary skill in the art.

Regarding claim 9, Margolin (abstract; figs. 1-7; col. 3, lines 8-67; col. 4, lines 1-67; col. 5, lines 1-67) in view of Duggan disclose the method of claim 8 whereby said selected phases of the flight of said unmanned aerial vehicle comprise:

(a) when said unmanned aerial vehicle is within a selected range of an airport or other designated location and is below a first specified altitude;

(b) when said unmanned aerial vehicle is outside said selected range of an airport or other designated location and is below a second specified altitude.

Regarding claim 10, Margolin (abstract; figs. 1-7; col. 3, lines 8-67; col. 4, lines 1-67; col. 5, lines 1-67) in view of Duggan disclose the method of claim 8 further comprising the step of providing a system onboard said unmanned aerial vehicle for periodically transmitting the identification, location, altitude, and bearing of said unmanned aerial vehicle.

Regarding claim 11, Margolin (abstract; figs. 1-7; col. 3, lines 8-67; col. 4, lines 1-67; col. 5, lines 1-67) in view of Duggan disclose the method of claim 8 further comprising the step of providing a system onboard said unmanned aerial vehicle for providing a communications channel for Air Traffic Control and the pilots of other aircraft to communicate directly with said remote pilot.

Regarding claim 12, Margolin (abstract; figs. 1-7; col. 3, lines 8-67; col. 4, lines 1-67; col. 5, lines 1-67) in view of Duggan disclose a method for safely flying an unmanned aerial vehicle as part of a unmanned aerial system equipped with a synthetic vision system in civilian airspace comprising the steps of:

(a) using a remote pilot to fly said unmanned aerial vehicle using synthetic vision during at least selected phases of the flight of said unmanned aerial vehicle, and during those phases of the flight of said unmanned aerial vehicle when said synthetic vision system is not used to control said unmanned aerial vehicle an autonomous control system is used to fly said unmanned aerial vehicle;

(b) providing a system onboard said unmanned aerial vehicle for detecting the presence and position of nearby aircraft and communicating this information to said remote pilot;

whereas said selected phases of the flight of said unmanned aerial vehicle comprise:

(a) when said unmanned aerial vehicle is within a selected range of an airport or other designated location and is below a first specified altitude;

(b) when said unmanned aerial vehicle is outside said selected range of an airport or other designated location and is below a second specified altitude.

Margolin did not disclose that the vehicle is flown using an autonomous control system. However, Duggan teach of a system for safely flying an unmanned aerial vehicle in civilian airspace comprising:

a ground station controlling an unmanned aerial vehicle (sec. 0352, 00353), wherein during phases of a flight of an unmanned aerial vehicle (UAV, sec 0318, 0322, 0353) when a synthetic vision (sec. 0356, 0365, 0388, 0390) is not used to control said unmanned aerial vehicle said unmanned aerial vehicle is flown using an autonomous control system (autopilot, sec 0346 to 0350, 0390-0329).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Margolin as taught by Duggan for the purpose of incorporating an autopilot to ensure smooth transitions (Duggna abstract, sec 0014, 0085, 0086).

The different embodiments in both prior arts are combinable as it would be obvious to ne having ordinary skill in the art.

Regarding claim 13, Margolin (abstract; figs. 1-7; col. 3, lines 8-67; col. 4, lines 1-67; col. 5, lines 1-67) in view of Duggan disclose the method of claim 12 further comprising the step of providing a system onboard said unmanned aerial vehicle for periodically transmitting the identification, location, altitude, and bearing of said unmanned aerial vehicle.

Regarding claim 14, Margolin (abstract; figs. 1-7; col. 3, lines 8-67; col. 4, lines 1-67; col. 5, lines 1-67) in view of Duggan disclose the method of claim 12 further comprising the step of providing a system onboard said unmanned aerial vehicle for providing a communications channel for Air Traffic Control and the pilots of other aircraft to communicate directly with said remote pilot.

Communication

3. Any inquiry concerning this communication or earlier communications from the examiner should be directed to RONNIE MANCHO whose telephone number is (571)272-6984. The examiner can normally be reached on Mon-Thurs: 9-5.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Tran Khoi can be reached on 571-272-6919. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Ronnie Mancho/
Primary Examiner, Art Unit 3664

/Ronnie Mancho/
Primary Examiner, Art Unit 3664

Notice of References Cited	Application/Control No. 11/736,356	Applicant(s)/Patent Under Reexamination MARGOLIN, JED	
	Examiner RONNIE MANCHO	Art Unit 3664	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-5,904,724	05-1999	Margolin, Jed	701/120
*	B	US-2005/0004723	01-2005	Duggan et al.	701/024
*	C	US-7,765,038	07-2010	Appleby et al.	701/23
*	D	US-7,747,364	06-2010	Roy et al.	701/28
	E	US-			
	F	US-			
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
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	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L13	8	UAV and (synthetic near3 vision) and control and station and communication and sensor and aircraft and remote and pilot and autopilot	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/08/28 17:26
L14	70	"5438517"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/08/28 17:38
L15	2	"5438517" and UAV	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/08/28 17:38
L16	2	("5438517").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2010/08/28 17:39
L17	2	("5933120").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2010/08/28 17:39
L18	2	("7131136").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2010/08/28 17:40
L19	2	("5153836").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2010/08/28 17:41

L20	2	("5187485").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2010/08/28 17:41
L21	2	("5904724").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2010/08/28 17:43
L22	13	"5904724" and autopilot	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/08/28 18:04
L23	8033205	701/2, 3, 4, 11, 14, "36", "28"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/08/28 18:40
L24	952515	244/158.1, "189", "190"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/08/28 18:41
L25	842	701/120	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/08/28 18:41
L26	602095	23 and 24	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/08/28 18:41
L27	103	25 and 26	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/08/28 18:42

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PTO/SB/08a (09-06)
Approved for use through 03/31/2007. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Substitute for form 1449A/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet 1 of 3

Complete if Known	
Application Number	
Filing Date	
First Named Inventor	Jed Margolin
Art Unit	
Examiner Name	
Attorney Docket Number	

U. S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number Number-Kind Code[2] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		US- 5,153,836	10-06-1992	Fraughton, et al.	
		US- 5,187,485	02-16-1993	Tsui, et al.	
		US- 5,904,724	05-18-1999	Margolin	
		US- Publication Number 20060174221	08-03-2006	Kinsella, et al.	Paragraphs 0018, 0019, and 0042
		US-			
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FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3] -Number[4] -Kind Code[5] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T[6]

Examiner Signature	/Ronnie Mancho/ (08/28/2010)	Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. 1 Applicant's unique citation designation number (optional). 2 See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. 3 Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). 4 For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. 5 Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. 6 Applicant is to place a check mark here if English language Translation is attached.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /R.M./

PTO/SB/08b (09-06)
Approved for use through 03/31/2007. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Complete if Known	
Application Number	
Filing Date	
First Named Inventor	Jed Margolin
Art Unit	
Examiner Name	
Attorney Docket Number	

Sheet 2 of 3

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No.[1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[2]
		Sensing Requirements for Unmanned Air Vehicles, AFRL's Air Vehicles Directorate, Control Sciences Division, Systems Development Branch, Wright-Patterson AFB OH, June 2004, www.afrlhorizons.com/Briefs/Jun04/VA0306.html	
		Presentation: **Developing Sense & Avoid Requirements for Meeting an Equivalent Level of Safety** given by RUSS WOLFE, Technology IPT Lead, Access 5 Project at UVS Tech 2006. (January 18, 2006)	
		Presentation: **Integration into the National Airspace System (NAS)** given by JOHN TIMMERMAN of the FAA's Air Traffic Organization (July 12, 2005)	
		Zone Ready for Drone, April 7, 2006 on the web site for the FAA's Air Traffic Organization Employees, www.ato.faa.gov/DesktopDefault.aspx?tabindex=4&tabid=17&itemid=937&mid=103	
		Virtual Cockpit Window for a Windowless Aerospacecraft NASA Tech Brief, January 2003 page 40. www.nasatech.com/Briefs/Jan03/MSC23096.html	
		Press Release from Rapid Imaging Software, Inc. www.landform.com/pages/PressReleases.htm **"On December 13th, 2001, Astronaut Ken Ham successfully flew the X-38 from a remote cockpit ... "**	

Examiner Signature	/Ronnie Mancho/ (08/30/2010)	Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.
[1] Applicant's unique citation designation number (optional). [2] Applicant is to place a check mark here if English language Translation is attached.
This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 2 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: **Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /R.M./

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application Number	
	Filing Date	
	First Named Inventor	Jed Margolin
	Art Unit	
(Use as many sheets as necessary)	Examiner Name	
Sheet 3 of 3	Attorney Docket Number	

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No.[1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[2]
		Article: **Flying UAVs in Civil Airspace By Using Synthetic Vision** JED MARGOLIN, www.jmargolin.com/todo/uavs.htm	
		NTSB Incident Report on crash of Predator on April 25, 2006, northwest of Nogales, NM. NTSB Identification **CHI06MA121**	
		Lockheed's Polecat UCAV Demonstrator Crashes Aviation Week & Space Technology, AMY BUTLER, 03/19/2007, page 44	
		The F-22 Continues to Encounter Aviation Week & Space Technology, 02/26/2007, page 18	
		Gulf of Mexico Helo Ops Ready for ADS-B Aviation Week & Space Technology, FRANCES FIORINO, 02/26/2007, page 56	
		Embedded Experts: Fix code bugs or cost lives, RICK MERIT, EE Times, 04/10/2006 www.eetimes.com/showArticle.jhtml?articleID-184429901	
		Entries from the Software Failure Hall of Shame, Part 1, TOM RHINELANDER, July 06, 2006, www.g2zero.com/2006/07/notable_entries_from_the_softw_1.html	
		Hardware-in-the-Loop Simulation, MARTIN GOMEZ, Embedded Systems Design, 11/30/01, www.embedded.com/shoArticle.jhtml?articleID=15201692	
		Supreme Court Decision, Boyle v. United Technologies Corp., **487 U.S. 500 (1988)**	
		Basic Concepts of real-time operating systems, DAVID KALINSKY (Nov. 18, 2003) http://linuxdevices.com/articles/AT4627965573.html	

Examiner Signature	/Ronnie Mancho/ (08/30/2010)	Date Considered	

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /R.M./

Search Notes	Application/Control No. 11/736,356	Applicant(s)/Patent under Reexamination MARGOLIN, JED	
	Examiner RONNIE MANCHO	Art Unit 3664	

SEARCHED

Class	Subclass	Date	Examiner
701	2	8/28/2010	RM
	3	8/28/2010	RM
	4	8/28/2010	RM
	11	8/28/2010	RM
	14	8/28/2010	RM
	36	8/28/2010	RM
	28	8/28/2010	RM
	120	8/28/2010	RM
244	158.1	8/28/2010	RM
	189	8/28/2010	RM
	190	8/28/2010	RM

INTERFERENCE SEARCHED

Class	Subclass	Date	Examiner

SEARCH NOTES (INCLUDING SEARCH STRATEGY)

	DATE	EXMR
EAST	8/28/2010	RM

Index of Claims	Application/Control No.	Applicant(s)/Patent under Reexamination
	11/736,356	MARGOLIN, JED
	Examiner	**Art Unit**
	RONNIE MANCHO	3664

√	Rejected		–	(Through numeral) Cancelled		N	Non-Elected		A	Appeal
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DEPARTMENT OF DEFENSE

ACCESS ACKNOWLEDGEMENT / SECRECY ORDER RECOMMENDATION

FOR PATENT APPLICATION

Application Serial No: DP11736356 Filing Date: Date Referred: 05/02/2007

I hereby acknowledge that the Department of Defense reviewers has inspected this application in administration of 35 USC 181 on befalf of the Agencies/Commands specified below. DoD reviewers will not divulge any information from this application for any purpose other than administration of 35 USC 181.

Defense Agency	Recommendation	Reviewer Name	Date Reviewed
Army	Secrecy Not Recommended	Alan Klein	09/04/2007
Air Force	Secrecy Not Recommended	Richard Lambert	10/10/2007
AFRL/VA		J.B. Schroeder	
Navy	Secrecy Not Recommended	Lawana Brady	08/24/2007

Type of Recommendations:	*SNR: Secrecy Not Recommended*
	SR: Secrecy Recommended
	NC: No Comment

Instructions to Reviewers:

1. All DoD personnel reviewering this application will be listed on this form regardless of whether they are making a secrecy order recommendation.

2. This form will be forwarded to USPTO once all assigned DoD entities have provided their secrecy order recommendation.

Time for Completion of Review:

Pursuant to 35 USC 184, the subject matter of this applicaiton may be filed in a foreign country for the purposed of filing a patent application without a license anytime after the expriation of six (6) months from filing date unless the application becomes the subject of a secrecy order.

The USPTO publishes patent application at 18 months from the earliest claimed filing date. The USPTO will delay the publication of a patent application made available to a defense agency under 35 USC 181 until no earlier than 6 months from the filing date or 90 days from the date of referral to that agency. This application will be cleared for publication 6 months from the filing date or 90 days from the above Date Referred, whichever is later, unless a response is is provided to the USPTO regarding the necessary recommendations as to the imposition of a secrecy order.

DoD Completion of Review: Final

Forwarded to USPTO: 10/11/2007 By: Luis Marrero

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APPLICATION NUMBER	FILING OR 371(c) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
11/736,356	04/17/2007	Jed Margolin	

CONFIRMATION NO. 3649

23497
JED MARGOLIN
1981 EMPIRE ROAD
RENO, NV89521-7430

Title: System and Method For Safely Flying Unmanned Aerial Vehicles in Civilian Airspace

Publication No. US-2008-0033604-A1
Publication Date: 02/07/2008

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently http://www.uspto.gov/patft/.

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In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through the Patent Electronic Business Center at www.uspto.gov using the public side of the Patent Application Information and Retrieval (PAIR) system. The direct link to access this status information is currently http://pair.uspto.gov/. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

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Pre-Grant Publication Division, 703-605-4283

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APPLICATION NUMBER	FILING OR 371(c) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
11/736,356	04/17/2007	Jed Margolin	

CONFIRMATION NO. 3649

23497
JED MARGOLIN
1981 EMPIRE ROAD
RENO, NV89521-7430

Date Mailed. 10/25/2007

NOTICE OF NEW OR REVISED PROJECTED PUBLICATION DATE

The above-identified application has a new or revised projected publication date. The current projected publication date for this application is 01/31/2008. If this is a new projected publication date (there was no previous projected publication date), the application has been cleared by Licensing & Review or a secrecy order has been rescinded and the application is now in the publication queue.

If this is a revised projected publication date (one that is different from a previously communicated projected publication date), the publication date has been revised due to processing delays in the USPTO or the abandonment and subsequent revival of an application. The application is anticipated to be published on a date that is more than six weeks different from the originally-projected publication date.

More detailed publication information is available through the private side of Patent Application Information Retrieval (PAIR) System. The direct link to access PAIR is currently http://pair.uspto.gov. Further assistance in electronically accessing the publication, or about PAIR, is available by calling the Patent Electronic Business Center at 1-866-217-9197.

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PART 1 - ATTORNEY/APPLICANT COPY

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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
11/736,356	04/17/2007	3644	525		14	4

CONFIRMATION NO. 3649

23497
JED MARGOLIN
1981 EMPIRE ROAD
RENO, NV89521-7430

FILING RECEIPT

Date Mailed: 05/07/2007

Receipt is acknowledged of this regular Patent Application. It will be considered in its order and you will be notified as to the results of the examination. Be sure to provide the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION when inquiring about this application. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please mail to the Commissioner for Patents P.O. Box 1450 Alexandria Va 22313-1450. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections (if appropriate).**

Applicant(s)

Jed Margolin, VC Highlands, NV;

Power of Attorney: None

Domestic Priority data as claimed by applicant

This appln claims benefit of 60/745,111 04/19/2006

Foreign Applications

If Required, Foreign Filing License Granted:

Projected Publication Date: To Be Determined - pending completion of Security Review

Non-Publication Request: No

Early Publication Request: No

** SMALL ENTITY **

Title

System and Method For Safely Flying Unmanned Aerial Vehicles in Civilian Airspace

Preliminary Class

244

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

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For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4158).

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Title 37, Code of Federal Regulations, 5.11 & 5.15

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PTO/SB/05 (02-07)
Approved for use through 02/28/2007. OMB 0651-0032
U.S. Patent and Trademark Office. U.S. DEPARTMENT OF COMMERCE
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UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No.	
First Inventor	**Jed Margolin**
Title	**System and Method For Safely Flying Unmanned Aerial Vehicles in Civilian Airspace**
Express Mail Label No.	

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

ADDRESS TO: **Commissioner for Patents, P.O. Box 1450, Alexandria VA 22313-1450**

1. [X] **Fee Transmittal Form** (e.g., PTO/SB/17) *(Submit an original and a duplicate for fee processing)*
2. [X] **Applicant claims small entity status.** See 37 CFR 1.27.
3. [X] **Specification** [*Total Pages* 21] Both the claims and abstract must start on a new page *(For information on the preferred arrangement, see MPEP 608.01(a))*
4. [X] **Drawing(s)** (*35 U.S.C. 113*) [*Total Sheets* 4]
5. **Oath or Declaration** [*Total Sheets* 2]
   a. [X] Newly executed (original or copy)
   b. [ ] A copy from a prior application (37 CFR 1.63(d)) *(for continuation/divisional with Box 18 completed)*
      i. [ ] DELETION OF INVENTOR(S) Signed statement attached deleting inventor(s) name in the prior application, see 37 CFR 1.63(d)(2) and 1.33(b).
6. [ ] **Application Data Sheet.** See 37 CFR 1.76
7. [ ] **CD-ROM or CD-R** in duplicate, large table or Computer Program *(Appendix)*
   [ ] Landscape Table on CD
8. **Nucleotide and/or Amino Acid Sequence Submission** *(if applicable, items a. – c. are required)*
   a. [ ] Computer Readable Form (CRF)
   b. Specification Sequence Listing on:
      i. [ ] CD-ROM or CD-R (2 copies); or
      ii. [ ] Paper
   c. [ ] Statements verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

9. [ ] **Assignment Papers** (cover sheet & document(s))
   Name of Assignee__________
10. [ ] **37 CFR 3.73(b) Statement** *(when there is an assignee)* [ ] **Power of Attorney**
11. [ ] **English Translation Document** *(if applicable)*
12. [X] **Information Disclosure Statement** (PTO/SB/08 or PTO-1449)
   [ ] Copies of foreign patent documents, publications, & other information
13. [ ] **Preliminary Amendment**
14. [ ] **Return Receipt Postcard** (MPEP 503) *(Should be specifically itemized)*
15. [ ] **Certified Copy of Priority Document(s)** *(if foreign priority is claimed)*
16. [ ] **Nonpublication Request** under 35 U.S.C. 122(b)(2)(B)(i). Applicant must attach form PTO/SB/35 or equivalent.
17. [ ] Other:__________

18. If a CONTINUING APPLICATION, *check appropriate box, and supply the requisite information below and in the first sentence of the specification following the title, or in an Application Data Sheet under 37 CFR 1.76:*

[ ] Continuation [ ] Divisional [ ] Continuation-in-part (CIP) of prior application No.: ....

Prior application information: *Examiner* __________ *Art Unit:* __________

19. CORRESPONDENCE ADDRESS

[X] The address associated with Customer Number: **23497** *OR* [ ] Correspondence address below

Name					
Address					
City		State		Zip Code	
Country		Telephone		Email	

Signature	*Jed Margolin*	Date	4-17 07
Name (Print/Type)	**Jed Margolin**	Registration No. (Attorney/Agent)	

DECLARATION FOR UTILITY OR DESIGN PATENT APPLICATION (37 CFR 1.63)

[X] Declaration Submitted With Initial Filing *OR* [ ] Declaration Submitted after Initial Filing (surcharge (37 CFR 1.16 (e)) required)

Attorney Docket Number	
First Named Inventor	**Jed Margolin**
COMPLETE IF KNOWN	
Application Number	
Filing Date	
Art Unit	
Examiner Name	

I hereby declare that:

Each inventor's residence, mailing address, and citizenship are as stated below next to their name.

I believe the inventor(s) named below to be the original and first inventor(s) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

System and Method For Safely Flying Unmanned Aerial Vehicles in Civilian Airspace

(Title of the Invention)

the specification of which

[X] is attached hereto

OR

[ ] was filed on (MM/DD/YYYY) [ ] as United States Application Number or PCT International Application Number [ ] and was amended on (MM/DD/YYYY) [ ] (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment specifically referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the national or PCT international filing date of the continuation-in-part application.

I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or (f), or 365(b) of any foreign application(s) for patent, inventor's or plant breeder's rights certificate(s), or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent, inventor's or plant breeder's rights certificate(s), or any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application Number(s)	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Not Claimed	Certified Copy Attached? YES	NO
			[ ]	[ ]	[ ]
			[ ]	[ ]	[ ]
			[ ]	[ ]	[ ]
			[ ]	[ ]	[ ]

[ ] Additional foreign application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto.

PTO/SB/01 (02-07)
Approved for use through 02/28/2007. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

DECLARATION — Utility or Design Patent Application

Direct all correspondence to:	[X] The address associated with Customer Number:	23497	OR	[ ] Correspondence address below

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Address		
City	State	ZIP
Country	Telephone	Email

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

NAME OF SOLE OR FIRST INVENTOR: [ ] A petition has been filed for this unsigned inventor

Given Name (first and middle [if any]): **Jed**		Family Name or Surname: **Margolin**	
Inventor's Signature: Jed Margolin			Date: 4-17-07
Residence: City: **VC Highlands**	State: **NV**	Country: **USA**	Citizenship: **USA**
Mailing Address: **1981 Empire Rd.**			
City: **Reno**	State: **NV**	Zip: **89521-7430**	Country: **USA**

[ ] Additional inventors or a legal representative are being named on the ______ supplemental sheet(s) PTO/SB/02A or 02LR attached hereto.

ABSTRACT OF THE DISCLOSURE

A system and method for safely flying an unmanned aerial vehicle (UAV), unmanned combat aerial vehicle (UCAV), or remotely piloted vehicle (RPV) in civilian airspace uses a remotely located pilot to control the aircraft using a synthetic vision system during at least selected phases of the flight such as during take-offs and landings.

UNITED STATES PATENT APPLICATION FOR PATENT
FOR

SYSTEM AND METHOD FOR SAFELY FLYING UNMANNED AERIAL VEHICLES IN CIVILIAN AIRSPACE

INVENTOR: JED MARGOLIN

SYSTEM AND METHOD FOR SAFELY FLYING UNMANNED AERIAL VEHICLES IN CIVILIAN AIRSPACE

CROSS REFERENCES TO RELATED APPLICATIONS

[001] This application claims the benefit of U.S. Provisional Application No. 60/745,111 filed on April 19, 2006.

BACKGROUND OF THE INVENTION - Field of Invention

[002] This invention relates to the field of remotely piloted vehicles (RPVs) and unmanned aerial vehicles (UAVs). RPV is an older term for UAV. UCAV shall mean "Unmanned Combat Aerial Vehicle." UCAV is also sometimes defined as an "Uninhabited Combat Aerial Vehicle." UCAV is a UAV that is intended for use in combat. UAS means "Unmanned Aerial System." UCAS means "Unmanned Combat Air System." ROA means "Remotely Operated Aircraft." The characteristics all these vehicles have in common is that there is no human pilot onboard and although they may be operated autonomously they can also be controlled by a remotely located operator or pilot. The term UAV shall be used as a generic term for such vehicles. "Synthetic Vision" is the current term for three dimensional projected image data presented to the pilot or other observer. Another term for "Synthetic Vision" is "Synthetic Environment." An older term for "Synthetic Vision" is "Virtual Reality." The term "Augmented Reality" (AR) refers to a human/computer interaction in which synthetic, computer generated elements are mixed or juxtaposed with real world elements in such a way that the synthetic elements appear to be part of the real world. A common method used by Augmented Reality systems is to combine and overlay a synthetic vision system with the video from one or more video or infrared cameras. Augmented

Reality is also sometimes referred to as "Enhanced Vision." The term "Remote Pilot" shall mean the same as "Remote Operator." The term "Sense and Avoid" shall mean the same as "See and Avoid."

BACKGROUND OF THE INVENTION – Prior Art

[003] The use of Synthetic Vision in flying a UAV is taught by U.S. Patent 5,904,724 **Method and apparatus for remotely piloting an aircraft** issued May 18, 1999 to Margolin (the present Applicant) which is hereby incorporated by reference. From the **Abstract:**

> A method and apparatus that allows a remote aircraft to be controlled by a remotely located pilot who is presented with a synthesized three-dimensional projected view representing the environment around the remote aircraft. According to one aspect of the invention, a remote aircraft transmits its three-dimensional position and orientation to a remote pilot station. The remote pilot station applies this information to a digital database containing a three dimensional description of the environment around the remote aircraft to present the remote pilot with a three dimensional projected view of this environment. The remote pilot reacts to this view and interacts with the pilot controls, whose signals are transmitted back to the remote aircraft. In addition, the system compensates for the communications delay between the remote aircraft and the remote pilot station by controlling the sensitivity of the pilot controls.

[004] The system by which an aircraft periodically transmits its identification, location, altitude, and bearing was taught by U.S. Patent 5,153,836 issued October 10, 1992 to Fraughton et al. and was materially adopted by the FAA as **Automatic Dependent Surveillance-Broadcast (ADS-B).** According the article **Gulf of Mexico Helo Ops Ready for ADS-B** in Aviation Week & Space Technology (02/26/2007, page 56):

> By the end of 2010, FAA expects to have the ADS-B system tested and operationally acceptable for the NAS, with Houston Center providing services in the Gulf region. By 2013, all of the U.S. is scheduled to be covered with ground infrastructure.

BACKGROUND OF THE INVENTION – Current Practice

[005] The current practice in flying UAVs in civilian airspace is typified by the report **Sensing Requirements for Unmanned Air Vehicles** by AFRL's Air Vehicles Directorate, Control Sciences Division, Systems Development Branch, Wright-Patterson AFB OH, June 2004, which relies on computer-intelligence to use sensors to sense and avoid other aircraft.

[006] According to the presentation entitled **Developing Sense & Avoid Requirements for Meeting an Equivalent Level of Safety** given by Russ Wolfe, Technology IPT Lead, Access 5 Project at UVS Tech 2006 this had not changed as of January 18, 2006. Access 5 was a national project sponsored by NASA and Industry with participation by the FAA and DOD to introduce high altitude long endurance (HALE) remotely operated aircraft (ROA) to routine flights in the National Airspace System (NAS). Access 5 started in May 2004 but when NASA withdrew its support (and funding) the Industry members decided not to spend their own money and Access 5 was dissolved at the end of 2005.

[007] The presentation **Integration into the National Airspace System (NAS)** given by John Timmerman of the FAA's Air Traffic Organization (July 12, 2005) essentially says that under current UAS Operations in the NAS UAVs should not harm other aircraft or the public. (Page 3: "***While ensuring 'no harm' to other NAS customers and public***")

[008] The article **Zone Ready for Drone**, April 7, 2006, on the web site for the FAA's Air Traffic Organization Employees states that,

> Since March 29, a temporary flight restriction … has limited access to the airspace along almost 350 miles of the border, expanding an earlier TFR near Nogales. The restriction is in effect nightly from 6 p.m. to 9 a.m., although that time can be expanded by issuance of a Notice to Airmen. Aircraft wishing to fly in the TFR when it is active must receive authorization from air traffic control prior to entry. Once in, pilots are required to maintain two-way communication with ATC and transmit a discrete transponder code.

The reason for the TFR is to enable Predator UAVs to patrol the border. The article quotes Stephen Glowacki, a Systems Safety and Procedures specialist with the FAA's Air Traffic Organization as saying:

> This is an extreme situation that has been presented to us," states Stephen Glowacki, a Systems Safety and Procedures specialist with the FAA's Air Traffic Organization, stressing the nation's security. "We have been working with U.S. Customs and Border Protection to try and answer this situation."
>
> Inserting UASs into the National Airspace System is not a simple feat. According to Glowacki, the technology and certification that will permit unmanned aircraft to "see and avoid" other air traffic is still eight to ten years away. In the mean time, a carefully controlled environment is needed.

[009] The track record of current UAV systems shows two major problem areas:

a. The communications link between the UAV and the ground station is unreliable, even at short ranges.

A recent example is the December 2006 crash of Lockheed Martin's Polecat UAV. When it lost communications with the ground it deliberately crashed itself to avoid flying into civil airspace. (See the article **Lockheed's Polecat UCAV Demonstrator Crashes** in Aviation Week & Space Technology, 03/19/2007, page 44.)

b. Autonomous Mode is not always very smart.

On April 25, 2006 the Predator UAV being used by the U.S. Customs and Border Protection agency to patrol the border crashed in Nogales, AZ. According to the NTSB report (NTSB Identification CHI06MA121) when the remote pilot switched from one console to another the Predator was inadvertently commanded to shut off its fuel supply and "With no engine power, the UAV continued to descend below line-of-site communications and further attempts to re-establish contact with the UAV were not successful." In other words, the Predator crashed because the system did not warn the remote pilot he had turned off the fuel supply and it was not smart enough to turn its fuel supply back on. (Note that this is the same Predator discussed in the article **Zone Ready for Drone** previously mentioned.)

SUMMARY OF THE INVENTION

[010] It is important when flying a UAV in an airspace shared with other aircraft, both civilian and military, that collisions during all phases of flight (including taking off and landing) not happen. The current method for accomplishing this is to place restrictions on all other traffic in an air corridor representing the path of the intended flight of the UAV, thereby inconveniencing other traffic and disrupting the National Airspace System.

Synthetic Vision

[011] One objective of the present invention is to allow UAVs to safely share airspace with other users by using synthetic vision during at least some of the phases of the UAV's flight so that changes required to existing FAA rules and regulations are minimized.

[012] This may be accomplished by requiring that during selected phases of the flight the UAV be flown by a remote pilot using a Synthetic Vision System such as the one taught by U.S. Patent 5,904,724 **Method and apparatus for remotely piloting an aircraft.** These selected phases include:

(a) When the UAV is within a selected range of an airport or other designated location and is below a first specified altitude. This first specified altitude may be set high enough that, for all practical purposes, it may be considered unlimited.

(b) When the UAV is outside the selected range of an airport or other designated location and is below a second specified altitude.

[013] Each UAV flown under these conditions must be under the direct control of a remote pilot whose sole responsibility is the safe operation of that UAV. The rules will be similar to those for operating piloted aircraft with automatic pilot systems including those with autoland capability.

[014] UAVs not flying in airspace where the use of a Synthetic Vision System is required may be flown autonomously using an Autonomous Control System (ACS) as long as the following conditions are met:

(a) A remote pilot monitors the operation of the UAV at all times.

(b) The ACS periodically transmits its identification, location, altitude, and bearing. This information may also be broadcast by UAVs when operated by remote pilots using Synthetic Vision.

[015] All UAVs must use Radar (either active or passive) or other device to detect the range and altitude of nearby aircraft in order to perform "see and avoid" actions.

[016] All UAVs must provide a means for Air Traffic Control (ATC) and the pilots of other aircraft to communicate directly with the remote pilot.

[017] The preferred method for flying a UAV from one airport to another, such as in ferrying UAVs, would be to have the remote pilot at the originating airport be responsible for taking off and flying the UAV to the specified altitude. A remote pilot at the arrival airport would be responsible for having the UAV descend and land. In between, once the UAV has reached the specified altitude and range the remote pilot monitoring the flight can be at any convenient location.

[018] Synthetic Vision may be enhanced by combining and/or overlaying it with the video from one or more video or infrared cameras or from synthetic aperture radar.

[019] The method described does not require material changes in the present air control system. It would also make UAV flights safer than most existing piloted flights where "see and avoid" is accomplished by looking out small windows providing a limited field of view and hoping you see any nearby aircraft in time to avoid a collision.

Communication Link Failures

[020] The exact cause of the failure of the communications link in the Polecat crash mentioned previously has not been made public. Technical details for UAVs are limited because the systems are developed by private industry which generally considers such information proprietary. In addition, these are mostly military programs which limits public disclosure even more. (Indeed, although the Polecat crash took place in December 2006, it was not publicly reported until March 2007.)

[021] One factor that may cause a communication link to fail is if it is a high-bandwidth link since a high-bandwidth link is more susceptible to interference from other signals than is a lower-bandwidth link. The use of a synthetic vision system allows a lower-bandwidth link to be used which improves its reliability

[022] Another factor that affects a digital communications link when digital packets are sent through a network (such as an Internet-style network) is that the latency of the data packets cannot be assured either because the path may change from packet to packet or because packets may be lost. When data packets are lost the destination server usually times out and a request to resend the packet is issued which further increases the latency. Packets may also be lost simply because the path to a server takes longer than the server's timeout period, causing the server to issue an unending series of requests to resend the packet. If a packet is lost, either outright or because the path is longer than the timeout period, transmission of data may stop entirely as most people who use the Internet have experienced.

[023] Because each data packet may take a different path, data packets may be received out-of-order. Standard Internet browsers such as Firefox and Microsoft Internet Explorer know to reassemble the packets in the correct order. A custom software application, such as that used to control UAVs, must do likewise to avoid becoming confused as to what is happening when.

[024] Some communications link failures may simply be due to the failure of the system to measure and adapt to the changing latency of the data packets. The importance of having the system measure and adapt to changing latencies is discussed in U.S. Patent 5,904,724 by the present inventor.

Minimizing Communications Link Failures

[025] Communications Link Failures can be minimized by, first of all, properly designing the communications link to prevent the obvious types of failures described above.

[026] The next step is to provide redundant communications links. In addition to the standard types of communications links, an emergency backup communications link can use the standard commercial cell phone network as long as precautions are taken to keep hackers out. Casual hackers can be kept out by using Caller ID so if the UAV receives a call from an unauthorized number it answers the line and immediately hangs up. The reason this keeps out only casual hackers is because PBXs (Private Branch Exchanges) can be programmed to deliver any Caller ID number the PBX operator desires. Once the UAV User is authenticated the ACS hangs up and calls one or more preprogrammed telephone numbers to establish a link to be used for communications. Because of the time needed to establish this link it may be desirable to keep the emergency backup communications link on hot standby during takeoffs and landings. Keeping this link on hot standby during all phases of flight also provides a backup method for tracking the UAV by using the cell phone tower triangulation method. As with the standard communications links all data must be securely encrypted and the User must be periodically authenticated.

What to Do if the Communication Link Fails

[027] If even the emergency backup Communications Link fails there is no choice but to go to the Autonomous Control System (ACS). What ACS does depends on the flight profile of the UAV.

a. If the UAV is on the runway on takeoff roll and is below V1 (the maximum abort speed of the aircraft) the takeoff is aborted.

b. If the UAV is between V1 and V2 (the minimum takeoff safety speed for the aircraft) the choice is nominally between aborting the takeoff (and overrunning the runway) and taking off. If all other UAV systems are operating properly, taking off is probably the better choice since it may be possible to re-establish the communications link once the UAV is in the air. However, if the UAV is equipped with a tailhook and the runway is equipped with arresting cables a suitable distance before the physical end of the runway, the UAV takeoff may still be safely aborted. The hook and arresting cable method is the standard method used on aircraft carriers for landing aircraft.

c. If the UAV is above V2 the UAV takes off and uses the takeoff profile that is assigned to each particular airport. It then climbs to an altitude high enough to avoid other traffic and, unless the communication link can be firmly established, flies to the nearest airport designated to receive UAVs in distress. Only in extreme cases should the ACS fly the UAV to a designated crash site.

Autonomous Mode is not always very smart or even bug-free

[028] As noted in the case of the Predator previously mentioned, it crashed because the system did not warn the remote pilot he had turned off the fuel supply and it was not smart enough to turn its fuel supply back on. This may have been a design oversight or it may have been a software bug. Complex computer programs always have bugs no matter how brilliant or motivated the programmer(s). Treating every software error as a mistake to be punished only leads to paralysis so that no code gets written. After a good faith effort is made to “get it right” the systems must be thoroughly tested. And they must be tested on the ground.

Testing

[029] Complex systems are difficult to test, especially when one of its parts is a flying machine which, itself, is made up of several systems. Simulation of the individual subsystems is not good enough. A simulation of the entire system is also not good enough because, despite the best efforts, a simulation might not completely characterize the actual hardware and how the different hardware systems act together. The answer is to use Hardware-in-the-Loop simulation where the actual hardware is used with simulated inputs. A good description of Hardware-in-the-Loop simulation can be found in the article **Hardware-in-the-Loop Simulation** by Martin Gomez in Embedded Systems Design (November 30, 2001). The example Mr. Gomez used was an autopilot.

[030] The Ground Station is already on the ground so the proper place to start is with an actual ground station. The simplest configuration is to use an actual ground station with a simulation port connected directly to a computer that simulates the UAV. (See Figure 3). That probably isn't good enough because it only really tests the ground station. The next step is to use a ground station with an actual communication link. (See Figure 4.) This tests the ground station and the communications link.

[031] Since the idea is to test the UAV without actually flying it, the idea of Hardware-in-the-Loop testing is to use as much of the UAVs hardware as possible by using a computer to read the system's output control signals and present the proper sensor input signals. In between is a simulation of the physical model of how the UAV interacts with the physical universe. The UAV lives in an analog universe where space and time are continuously variable, subject only to the Planck Distance and Planck Time. (The Planck length is the scale at which classical ideas about gravity and space-time cease to be valid, and quantum effects dominate. This is the 'quantum of length', the smallest measurement of length with any meaning, roughly equal to 1.6×10^{-35} m. The Planck time is the time it would take a photon traveling at the speed of light to cross a distance equal to the Planck length. This is the 'quantum of time', the smallest measurement of time that has any meaning, and is equal to 10^{-43} seconds.) The UAV's universe is also massively parallel, which is why simulating it with a single computer which is forced to perform different functions sequentially may not always produce accurate results. This can be ameliorated somewhat by oversampling and running the model faster than that required by Nyquist. (The Nyquist rate is the minimum; you don't have to settle for the minimum.)

[032] Ideally each sensor input and each actuator output should have its own processor and all the processors should be linked to a computer that contains the overall physical model of the UAV's universe (the Universe Processor). For example, the Universe Processor knows the location of the UAV, its attitude, its bearing, the air temperature and pressure, local weather, terrain, etc. This assumes that the sensors and actuators are completely characterized. If they are not, then the physical sensors and actuators can be used with devices that provide the proper physical stimulation to the sensors and measure the actual physical results of the actuators. The desired end result is that each device in the UAV flight hardware, especially if it contains software such as the Flight Control Computer, can be operated with its actual hardware and software. When the hardware or software is changed, the old device can be unplugged and the new version installed. This avoids the problem of relying on software that has been ported to hardware other than the hardware it runs on in the flight UAV. For example, the "C" programming language can be difficult to port to different computers because the definition of a "byte" in "C" can be different depending on the computer. Also note that the speed of the link connecting the sensors/actuators to the Universe Processor is determined by the speed of the fastest sensor/actuator, which also sets the minimum update rate of the Universe Processor.

[033] The type of operating system(s) used in simulation and testing is important. In particular, with a non-deterministic Operating System (such as Windows) you cannot count on getting the same result every time because the operating system includes random timing components. From the article "Basic concepts of real-time operating systems" by David Kalinsky (Nov. 18, 2003):

> The key difference between general-computing operating systems and real-time operating systems is the need for " **deterministic** " timing behavior in the real-time operating systems. Formally, "deterministic" timing means that operating system services consume only known and expected amounts of time. In theory, these service times could be expressed as mathematical formulas. These formulas must be strictly algebraic and not include any random timing components. Random elements in service times could cause random delays in application software and could then make the application randomly miss real-time deadlines – a scenario clearly unacceptable for a real-time embedded system.
>
> General-computing non-real-time operating systems are often quite non-deterministic. Their services can inject random delays into application software and thus cause slow responsiveness of an application at unexpected times. If you ask the developer of a non-real-time operating system for the algebraic formula describing the timing behavior of one of its services (such as sending a message from task to task), you will invariably not get an algebraic formula. Instead the developer of the non-real-time operating system (such as Windows, Unix or Linux) will just

> give you a puzzled look. Deterministic timing behavior was simply not a design goal for these general-computing operating systems.

This means you may not be able to duplicate a failure. If you cannot duplicate a failure you cannot fix it. And, needless to say, the use of a non-deterministic Operating System in any part of the UAV flight hardware will result in a system that can never be completely trusted.

[034] Failure to do proper ground-based simulation can lead to expensive and/or embarrassing incidents such as this one reported by Aviation Week & Space Technology (02/26/2007, page 18):

> The F-22 continues to encounter bumps in its first air expeditionary force deployment to Okinawa. The 12 aircraft from Langley AFB, Va., spent an unscheduled week at Hickam AFB, Hawaii, after the leading four had to abort the trip's last leg. As the Raptors reached the International Date Line, the navigation computers locked up so the aircraft returned to Hickam until a software patch was readied. "Apparently we had built an aircraft for the Western Hemisphere only," says a senior U.S. Air Force official. When the F-22s arrived at Kadena AB, Okinawa, some Japanese citizens held a protest against the aircraft's noise.

Although the F-22 is not a UAV the principle is the same.

[035] Testbeds can be used for more than just verifying that the system works as designed. They can also be used to verify that the system is designed properly for the User.

[036] In military programs, operational procedures can be developed and military personnel can be ordered to follow them. And they will follow them to the best of their ability because their careers are on the line. That doesn't change the fact that people operating poorly designed systems are more likely to make mistakes.

[037] Producing UAVs for the commercial market requires a different mindset. Civilians cannot be ordered to use a system whose design makes mistakes likely or maybe even inevitable. Civilians have the option to not buy the product if they don't like it. They also have the option to sue the manufacturer of a system whose design makes mistakes inevitable. Civilians injured on the ground also have the option to sue the manufacturer of a system whose design makes mistakes inevitable.

[038] Perhaps the UAV Industry can learn from the Video Game Industry where the standard practice is to hold focus groups early in the game's development using real video game players. Game Designers may not like the players' comments about their game but the players represent the game's ultimate customers. In addition, the video game companies employ people whose sole job is to extensively play the game before it is released and take careful notes of bugs, which are then passed on to the Game Developers. Although it is tempting to cut short the time devoted to testing in order to get the product out the door, a game released with too many bugs will be rejected by the marketplace and will fail.

[039] UAV manufacturers making UAV systems for the Government are protected from liability under the Supreme Court's 1988 decision in *Boyle v. United Technologies Corp*, 487 U.S. 500 (1988), where the Court held that if a manufacturer made a product in compliance with the government's design and production requirements, but it was defective and caused injury, the victim could not sue the manufacturer.

[040] Since UAV manufacturers making UAV systems for the civilian market do not have this protection they should consider who their customers really are. Although civilian UAV systems will probably be operated by civilian-rated pilots (at least initially), in a sense the UAV manufacturers are really designing their systems to meet the requirements of the Insurance Industry and doing proper on-ground testing is essential in making UAVs that will fly safely in civilian airspace. Military UAVs should meet the same standard because the crash of a military UAV that injures or kills civilians could ignite a political firestorm that would ground the entire UAV fleet.

<u>The Reasons For Using Synthetic Vision during at least Takeoffs and Landings</u>

[041] There are several reasons why the use of synthetic vision during at least takeoffs and landings can minimize the risk to the public.

<u>a.</u> The ACS must be programmed to deal with every possible problem in every possible situation that might arise. This is probably not possible until computers become sentient.

Even after 100 years of aviation, pilots still encounter situations and problems that have not been seen before. The way they deal with new situations and problems is to use their experience, judgment, and even intuition. Pilots have been remarkably successful in saving passengers and crew under extremely difficult conditions such as when parts of their aircraft fall off (the top of the fuselage peels off) or multiply-redundant critical controls fail (no rudder control). Computers cannot be programmed to display judgment. They can only be programmed to display judgment-like behavior under conditions that have already been anticipated. UAVs should not be allowed to fly over people's houses until they are at least smart enough to turn on their own fuel supply.

Even so, this assumes the computer program has no bugs.

b. Complex computer programs always have bugs no matter how brilliant or motivated the programmer(s). As an example, look at almost every computer program ever written.

(See the article **Embedded Experts: Fix Code Bugs Or Cost Lives** by Rick Merritt in EE Times, April 10, 2006, as well as the article **Entries from the Software Failure Hall of Shame, Part 1** by Tom Rhinelander in **g2zero**, July 6, 2006. g2zero at *www.g2zero.com* is a community dedicated to discussing and advocating ways to improve software quality.)

While adding a sense-and-avoid capability to existing UAV systems is necessary it will increase the code complexity and increase the number of bugs in the software.

c. An Unmmaned Combat Aerial Vehicle (UCAV) will have little chance against one flown by an experienced pilot using Synthetic Vision until Artificial Intelligence produces a sentient, conscious Being. At that point, all bets will be off because a superior sentient artificial Being may decide that war is stupid and refuse to participate. It may also decide that humans are obsolete or fit only to be its slaves.

Acceptable Risk

[042] Since it is impossible to anticipate every possible problem that might arise and it is impossible to write completely bug-free code it comes down to what is an acceptable risk.

[043] When a military aircraft is engaged in a military operation, a great deal of risk may be acceptable, especially if it is on a critical mission.

It is unacceptable to expose civilian aircraft flying in civil airspace, as well as the public on the ground, to this same level of risk except under truly exceptional circumstances.

[044] Synthetic Vision puts a human directly in the loop and makes flying a UAV in civilian airspace at least as safe as flying an aircraft with the pilot onboard.

BRIEF DESCRIPTION OF THE DRAWINGS

[045] The invention may best be understood by referring to the following description and accompanying drawings which illustrate the invention. In the drawings:

[046] FIG. 1 is a general illustration showing a circular area of Range 102 around Airport 101.

[047] FIG. 2 is a general illustration showing the airspace around Airport 101 where UAVs must be flown by a remote pilot using synthetic vision. This airspace is represented by the hatched areas.

[048] FIG. 3 shows the simplest system for simulating the UAV system where an actual ground station is connected directly to a simulation computer that simulates the UAV.

[049] FIG. 4 shows a system for simulating the UAV system that includes an actual communications link.

DETAILED DESCRIPTION

[050] In the following description, numerous specific details are set forth to provide a thorough understanding of the invention. However, it is understood that the invention may be practiced without these specific details. In other instances well-known circuits, structures, and techniques have not been shown in detail in order not to obscure the invention.

[051] Figure 1 shows a Distance Range 102 around Airport 101. While a circular area is shown for convenience any area whose shape can be defined may be used such as a square, rectangle, or other polygon. While Figure 1 shows the area around an airport any other designated location may be specified. Figure 2 shows an altitude profile of the airspace surrounding Airport 101. When the UAV is within Distance Range 102 of Airport 101 at an altitude below Selected Altitude 201 the UAV must be flown by a remote pilot using a Synthetic Vision System such as the one taught by U.S. Patent 5,904,724 **Method and apparatus for remotely piloting an aircraft.** When the UAV is outside Distance Range 102, within Distance Range 203, and is below Selected

Altitude 202 the UAV must also be flown by a remote pilot using a Synthetic Vision System. The airspace where the UAV must be flown by a remote pilot using a Synthetic Vision System is represented by the hatched areas in Figure 2.

[052] Each UAV flown under these conditions must be under the direct control of a remote pilot whose sole responsibility is the safe operation of that UAV. The rules will be similar to those for operating piloted aircraft with automatic pilot systems including those with autoland capability.

[053] UAVs flying beyond Distance Range 102, within Distance Range 203, and above Altitude 202 may be flown autonomously using an Autonomous Control System (ACS) as long as the following conditions are met:

(a) A remote pilot must monitor the operation of the UAV at all times. A remote pilot may monitor several UAVs simultaneously once it is established that this practice may be safely performed by a single pilot. For example, it may be preferable to have two remote pilots work as a team to monitor ten UAVS than to have each remote pilot separately monitor a group of five UAVs.

(b) The ACS must periodically transmit its identification, location, altitude, and bearing. This may be done through the use of a speech synthesis system on a standard aircraft communications frequency. This is for the benefit of pilots flying aircraft sharing the airspace. It may also be done through an appropriate digital system such as the one taught in U.S. Patent 5,153,836 **Universal dynamic navigation, surveillance, emergency location, and collision avoidance system and method** adopted by the FAA as ADS-B. This information may also be broadcast by UAVs when operated by remote pilots using Synthetic Vision.

[054] All UAVs must use radar (either active or passive) to detect the range and altitude of nearby aircraft in order to perform "see and avoid" actions. An example of a passive radar system is taught by U. S. Patent 5,187,485 **Passive ranging through global positioning system**. Other devices for detecting the range and altitude of nearby aircraft may also be used.

[055] All UAVs must provide a means for Air Traffic Control (ATC) and the pilots of other aircraft to communicate directly with the remote pilot. This may be accomplished by having the communication link between the remote pilot and the UAV relay communications with a standard aircraft transceiver onboard the UAV.

[056] Distance Range 203 extends to where it meets the area covered by another designated location such as another airport. The entire area covered by Distance Range 203 is termed a Designated Area. Another type of Designated Area is a large body of open water where the minimum safe altitude is determined by the height of a large ship riding the crest of a large wave.

[057] The preferred method for flying a UAV from one airport to another, such as in ferrying UAVs, would be to have the remote pilot at the originating airport be responsible for taking off and flying the UAV to the specified altitude. A remote pilot at the arrival airport would be responsible for having the UAV descend and land. This is similar to the longstanding practice of using Harbor Pilots to direct the movement of ships into and out of ports. In between the originating airport and destination airport, once the UAV has reached the specified altitude and range the remote pilot monitoring the flight can be at any convenient location.

[058] Long delays in the communications link (such as through geosynchronous satellites) make flying the UAV by direct control using synthetic vision more difficult and should be avoided.

[059] The method described does not require material changes in the present air control system. It would also make UAV flights safer than most existing piloted flights where "see and avoid" is accomplished by looking out small windows providing a limited field of view and hoping you see any nearby aircraft in time to avoid a collision.

[060] While preferred embodiments of the present invention have been shown, it is to be expressly understood that modifications and changes may be made thereto.

CLAIMS

What is claimed is:

1. A system for safely flying an unmanned aerial vehicle in civilian airspace comprising:

(a) a ground station equipped with a synthetic vision system;

(b) an unmanned aerial vehicle capable of supporting said synthetic vision system;

(c) a remote pilot operating said ground station;

(d) a communications link between said unmanned aerial vehicle and said ground station;

(e) a system onboard said unmanned aerial vehicle for detecting the presence and position of nearby aircraft and communicating this information to said remote pilot;

whereas said remote pilot uses said synthetic vision system to control said unmanned aerial vehicle during at least selected phases of the flight of said unmanned aerial vehicle, and during those phases of the flight of said unmanned aerial vehicle when said synthetic vision system is not used to control said unmanned aerial vehicle said unmanned aerial vehicle is flown using an autonomous control system.

2. The system of claim 1 whereby said selected phases of the flight of said unmanned aerial vehicle comprise:

(a) when said unmanned aerial vehicle is within a selected range of an airport or other designated location and is below a first specified altitude;

(b) when said unmanned aerial vehicle is outside said selected range of an airport or other designated location and is below a second specified altitude.

3. The system of claim 1 further comprising a system onboard said unmanned aerial vehicle for periodically transmitting the identification, location, altitude, and bearing of said unmanned aerial vehicle.

4. The system of claim 1 further comprising a system onboard said unmanned aerial vehicle for providing a communications channel for Air Traffic Control and the pilots of other aircraft to communicate directly with said remote pilot.

5. A system for safely flying an unmanned aerial vehicle in civilian airspace comprising:

(a) a ground station equipped with a synthetic vision system;

(b) an unmanned aerial vehicle capable of supporting said synthetic vision system;

(c) a remote pilot operating said ground station;

(d) a communications link between said unmanned aerial vehicle and said ground station;

(e) a system onboard said unmanned aerial vehicle for detecting the presence and position of nearby aircraft and communicating this information to said remote pilot;

whereas said remote pilot uses said synthetic vision system to control said unmanned aerial vehicle during at least selected phases of the flight of said unmanned aerial vehicle, and during those phases of the flight of said unmanned aerial vehicle when said synthetic vision system is not used to control said unmanned aerial vehicle said unmanned aerial vehicle is flown using an autonomous control system, and

whereas the selected phases of the flight of said unmanned aerial vehicle comprise:

(a) when said unmanned aerial vehicle is within a selected range of an airport or other designated location and is below a first specified altitude;

(b) when said unmanned aerial vehicle is outside said selected range of an airport or other designated location and is below a second specified altitude.

6. The system of claim 5 further comprising a system onboard said unmanned aerial vehicle for periodically transmitting the identification, location, altitude, and bearing of said unmanned aerial vehicle.

7. The system of claim 5 further comprising a system onboard said unmanned aerial vehicle for providing a communications channel for Air Traffic Control and the pilots of other aircraft to communicate directly with said remote pilot.

8. A method for safely flying an unmanned aerial vehicle as part of a unmanned aerial system equipped with a synthetic vision system in civilian airspace comprising the steps of:

(a) using a remote pilot to fly said unmanned aerial vehicle using synthetic vision during at least selected phases of the flight of said unmanned aerial vehicle, and during those phases of the flight of said unmanned aerial vehicle when said synthetic vision system is not used to control said unmanned aerial vehicle an autonomous control system is used to fly said unmanned aerial vehicle;

(b) providing a system onboard said unmanned aerial vehicle for detecting the presence and position of nearby aircraft and communicating this information to said remote pilot.

9. The method of claim 8 whereby said selected phases of the flight of said unmanned aerial vehicle comprise:

(a) when said unmanned aerial vehicle is within a selected range of an airport or other designated location and is below a first specified altitude;

(b) when said unmanned aerial vehicle is outside said selected range of an airport or other designated location and is below a second specified altitude.

10. The method of claim 8 further comprising the step of providing a system onboard said unmanned aerial vehicle for periodically transmitting the identification, location, altitude, and bearing of said unmanned aerial vehicle.

11. The method of claim 8 further comprising the step of providing a system onboard said unmanned aerial vehicle for providing a communications channel for Air Traffic Control and the pilots of other aircraft to communicate directly with said remote pilot.

12. A method for safely flying an unmanned aerial vehicle as part of a unmanned aerial system equipped with a synthetic vision system in civilian airspace comprising the steps of:

(a) using a remote pilot to fly said unmanned aerial vehicle using synthetic vision during at least selected phases of the flight of said unmanned aerial vehicle, and during those phases of the flight of said unmanned aerial vehicle when said synthetic vision system is not used to control said unmanned aerial vehicle an autonomous control system is used to fly said unmanned aerial vehicle;

(b) providing a system onboard said unmanned aerial vehicle for detecting the presence and position of nearby aircraft and communicating this information to said remote pilot;

whereas said selected phases of the flight of said unmanned aerial vehicle comprise:

(a) when said unmanned aerial vehicle is within a selected range of an airport or other designated location and is below a first specified altitude;

(b) when said unmanned aerial vehicle is outside said selected range of an airport or other designated location and is below a second specified altitude.

13. The method of claim 12 further comprising the step of providing a system onboard said unmanned aerial vehicle for periodically transmitting the identification, location, altitude, and bearing of said unmanned aerial vehicle.

14. The method of claim 12 further comprising the step of providing a system onboard said unmanned aerial vehicle for providing a communications channel for Air Traffic Control and the pilots of other aircraft to communicate directly with said remote pilot.

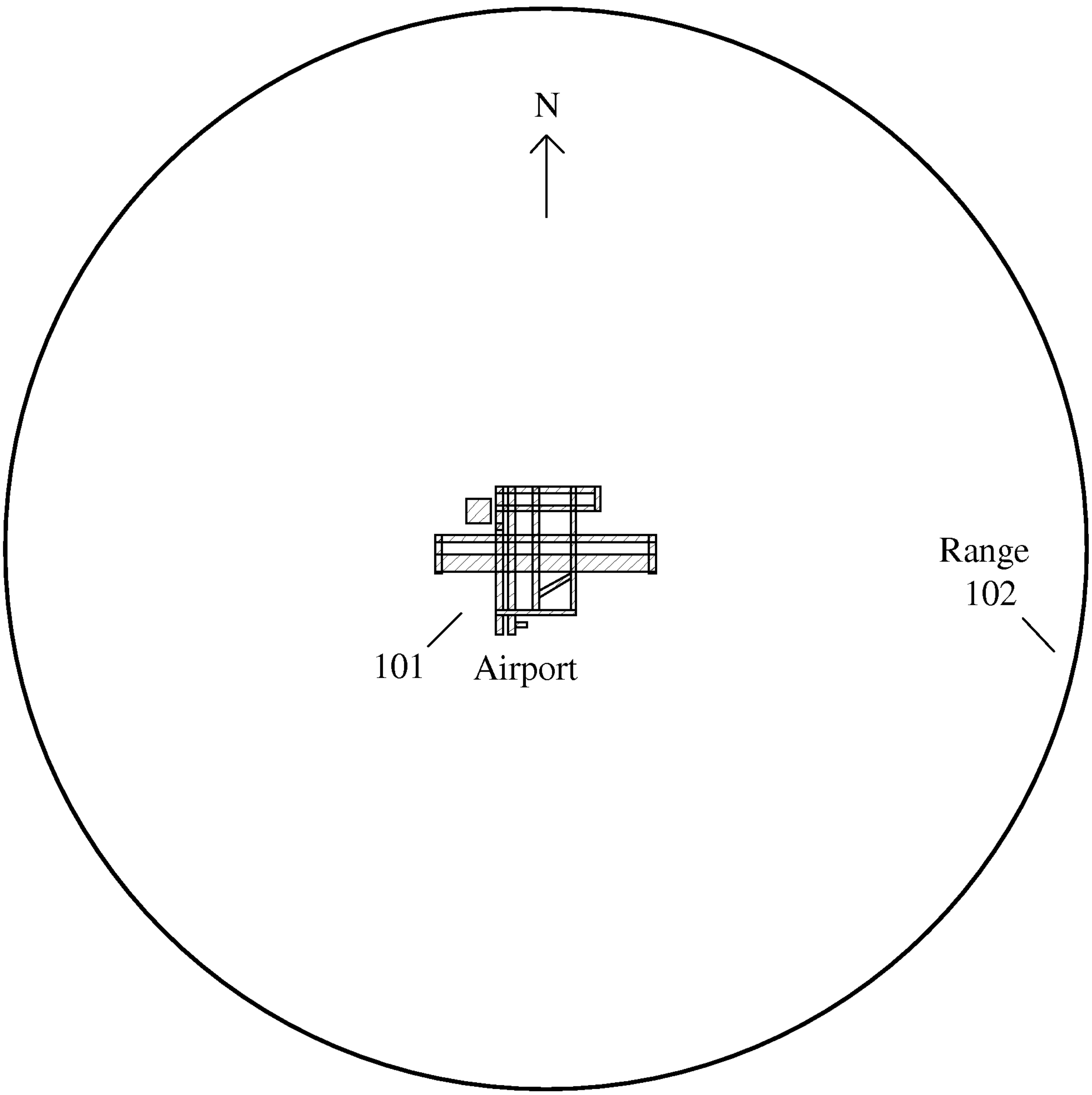

Fig. 1

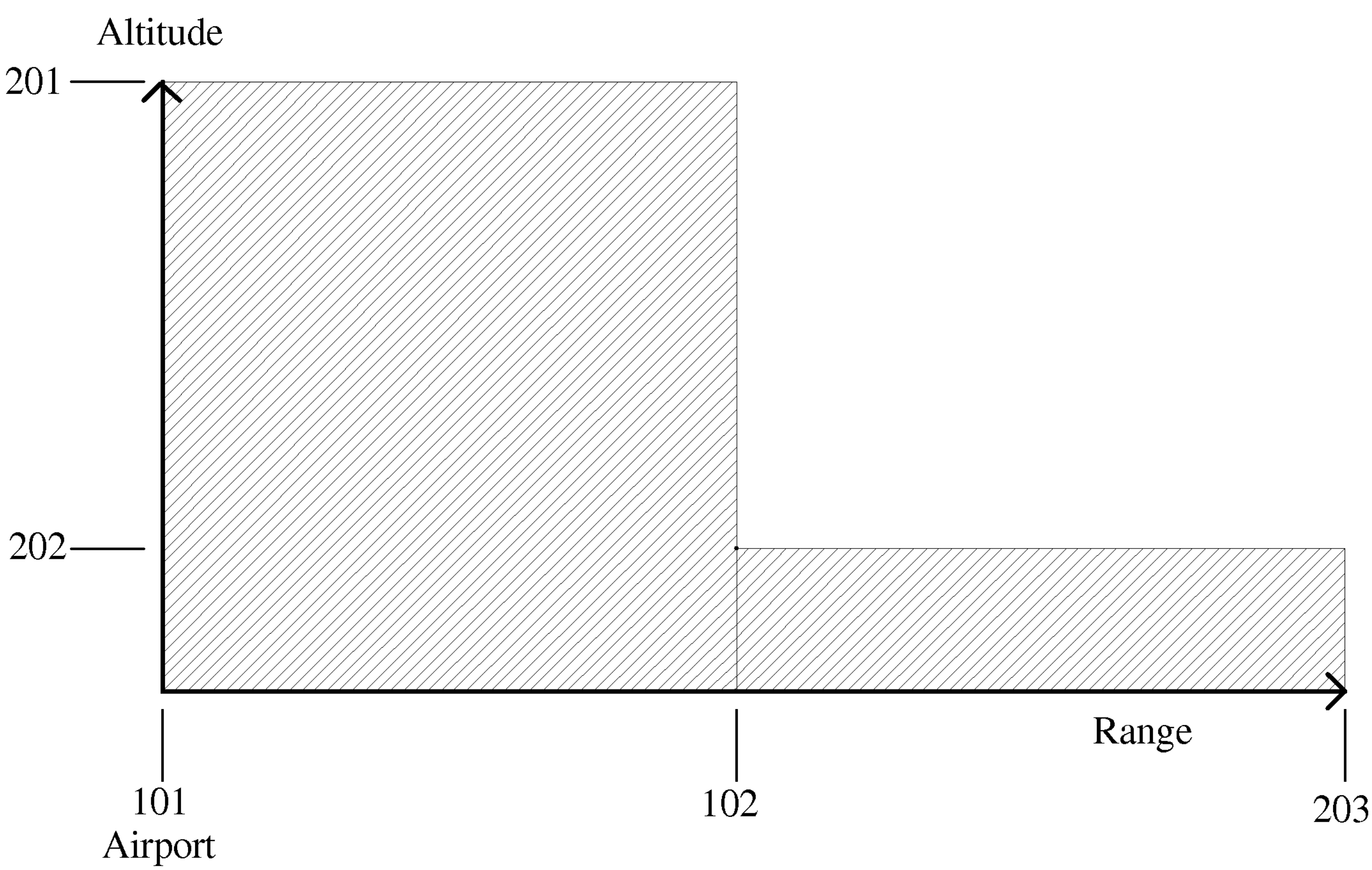

Fig. 2

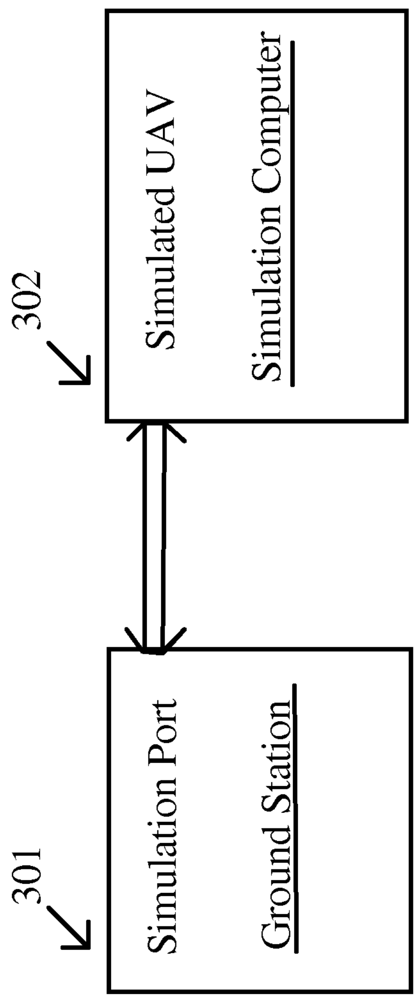
302
Simulated UAV
Simulation Computer
301
Simulation Port
Ground Station

Fig. 3

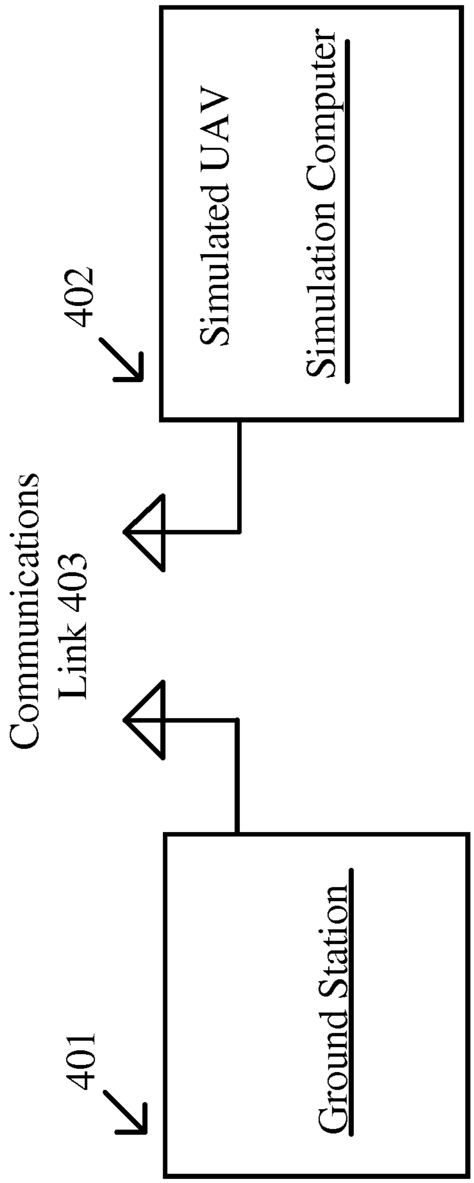
402
Simulated UAV
Simulation Computer
Communications Link 403
401
Ground Station

Fig. 4

PTO/SB/08a (09-06)
Approved for use through 03/31/2007. OMB 0651-0031
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Substitute for form 1449A/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet 1 of 3

Complete if Known	
Application Number	
Filing Date	
First Named Inventor	Jed Margolin
Art Unit	
Examiner Name	
Attorney Docket Number	

U. S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number / Number-Kind Code[2] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		US- 5,153,836	10-06-1992	Fraughton, et al.	
		US- 5,187,485	02-16-1993	Tsui, et al.	
		US- 5,904,724	05-18-1999	Margolin	
		US- Publication Number 20060174221	08-03-2006	Kinsella, et al.	Paragraphs 0018, 0019, and 0042
		US-			
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Examiner Initials*	Cite No.[1]	Foreign Patent Document: Country Code[3] - Number[4] - Kind Code[5] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T[6]

Examiner Signature		Date Considered	

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PTO/SB/08b (09-06)
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Substitute for form 1449B/PTO				Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT				*Application Number*	
				Filing Date	
				First Named Inventor	**Jed Margolin**
				Art Unit	
(Use as many sheets as necessary)				*Examiner Name*	
Sheet	**2**	of	**3**	*Attorney Docket Number*	

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No.[1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[2]
		Sensing Requirements for Unmanned Air Vehicles, AFRL's Air Vehicles Directorate, Control Sciences Division, Systems Development Branch, Wright-Patterson AFB OH, June 2004, www.afrlhorizons.com/Briefs/Jun04/VA0306.html	
		Presentation: **Developing Sense & Avoid Requirements for Meeting an Equivalent Level of Safety** given by RUSS WOLFE, Technology IPT Lead, Access 5 Project at UVS Tech 2006. (January 18, 2006)	
		Presentation: **Integration into the National Airspace System (NAS)** given by JOHN TIMMERMAN of the FAA's Air Traffic Organization (July 12, 2005)	
		Zone Ready for Drone , April 7, 2006 on the web site for the FAA's Air Traffic Organization Employees, www.ato.faa.gov/DesktopDefault.aspx?tabindex=4&tabid=17&itemid=937&mid=103	
		Virtual Cockpit Window for a Windowless Aerospacecraft NASA Tech Brief, January 2003 page 40. www.nasatech.com/Briefs/Jan03/MSC23096.html	
		Press Release from Rapid Imaging Software, Inc. www.landform.com/pages/PressReleases.htm **"On December 13th, 2001, Astronaut Ken Ham successfully flew the X-38 from a remote cockpit ... "**	

Examiner Signature		Date Considered	

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[1] Applicant's unique citation designation number (optional). [2] Applicant is to place a check mark here if English language Translation is attached.

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

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Sheet	3	of	3

Complete if Known	
Application Number	
Filing Date	
First Named Inventor	Jed Margolin
Art Unit	
Examiner Name	
Attorney Docket Number	

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No.[1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[2]
		Article: **Flying UAVs in Civil Airspace By Using Synthetic Vision** JED MARGOLIN, www.jmargolin.com/todo/uavs.htm	
		NTSB Incident Report on crash of Predator on April 25, 2006, northwest of Nogales, NM. NTSB Identification **CHI06MA121**	
		Lockheed's Polecat UCAV Demonstrator Crashes Aviation Week & Space Technology, AMY BUTLER, 03/19/2007, page 44	
		The F-22 Continues to Encounter Aviation Week & Space Technology, 02/26/2007, page 18	
		Gulf of Mexico Helo Ops Ready for ADS-B Aviation Week & Space Technology, FRANCES FIORINO, 02/26/2007, page 56	
		Embedded Experts: Fix code bugs or cost lives, RICK MERIT, EE Times, 04/10/2006 www.eetimes.com/showArticle.jhtml?articleID-184429901	
		Entries from the Software Failure Hall of Shame, Part 1, TOM RHINELANDER, July 06, 2006, www.g2zero.com/2006/07/notable_entries_from_the_softw_1.html	
		Hardware-in-the-Loop Simulation, MARTIN GOMEZ, Embedded Systems Design, 11/30/01, www.embedded.com/shoArticle.jhtml?articleID=15201692	
		Supreme Court Decision, Boyle v. United Technologies Corp., **487 U.S. 500 (1988)**	
		Basic Concepts of real-time operating systems, DAVID KALINSKY (Nov. 18, 2003) http://linuxdevices.com/articles/AT4627965573.html	

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.
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Sensing Requirements for Unmanned Air Vehicles

Engineers develop requirements and metrics to ensure integration of future autonomous unmanned aircraft into manned airspace.

AFRL's Air Vehicles Directorate, Control Sciences Division, Systems Development Branch, Wright-Patterson AFB OH

Engineers from the Air Vehicles Directorate transferred unmanned air vehicle (UAV) sensing system requirements for airspace operations to civilian UAV users and developers. These requirements represent design goals on which to base future sensing subsystem designs, filling an omission in UAV technology planning. Directorate engineers are continuing to develop the technologies that will enable future UAVs to coexist with manned aircraft in both military and civilian airspace. Incorporating these requirements will ensure that engineers design future UAVs to detect possible conflicts, such as midair collisions or runway incursions, and take action to avoid them.

Present UAVs cannot detect manned aircraft and conflict situations and, therefore, they cannot share airspace with manned aircraft. To overcome this obstacle, UAVs need to sense the presence of other aircraft in their operating environment (see figure on next page). In other words, UAVs need to at least replicate a human pilot' s ability to see and avoid problems before they will be accepted into the national air space (NAS). Since some aircraft do not have air traffic transponders, UAVs must use onboard sensors to detect aircraft and coordinate that information with available transponder information. With this level of capability, UAVs and operators will have the situational awareness of the airspace around the vehicle to ensure safety at the same level as manned aircraft.

With this goal in mind, directorate engineers worked with Northrop Grumman Corporation (NGC) engineers to establish, iterate, and finalize sensing system performance requirements for the broad range of future Air Force missions. During this collaborative process, directorate engineers noted that many mission elements were similar to civilian airspace operations tasks, and that the requirements they were developing were directly applicable to civilian UAV technology. They also found no report that defined and expressed these requirements for nonmilitary use. To help fill this void, directorate engineers coordinated their research results with the American Institute for Aeronautics and Astronautics UAV airspace operations' focal point, North Atlantic Treaty Organization' s Standards Committees, the National Aeronautics and Space Administration, and industry organizations working the same topics from the civilian side. Incorporation of the directorate' s technology into civilian requirements' definitions and standards will directly impact airspace operations' sensing systems for current and future UAVs.

The coordinated effort of directorate and NGC engineers that resulted in the sensing system requirements represents the first stage of work on the Autonomous Flight Control Sensing Technology (AFCST) program. This program' s long-term goal is to develop the upfront portion of the UAV virtual pilot capability. During this first phase, NGC engineers analyzed midair and near-midair collision data, along with runway incursion data, to generate lessons learned. Then, the NGC engineers combined the lessons learned from aircraft mishap data with sensing performance specifications and good engineering judgment to establish conventions for operating aircraft in the NAS. Next, they examined airspace tasks for operation in NAS and grouped them into deconfliction, collision avoidance, autonomous landing, and ground operations. The UAV functional requirements resulting from this effort are shown in the table.

As shown in the table, the threshold values represent the nearterm requirements (year 2007), while objective values are far-term requirements (year 2013). Engineers consider the forward vision threshold values equivalent to or slightly better than human performance. Federal Aviation Administration data indicates the dominant cause for midair collision is when an aircraft is overtaken by a faster aircraft because a pilot' s position in the cockpit limits rear visibility. In the UAV, rear visibility is not restricted because designers can locate sensors anywhere on the aircraft. Objective values contain UAV rear vision capability to improve safety in this scenario.

Directorate and NGC engineers are currently working on the second phase of AFCST– the preliminary design of the sensor hardware architecture. The AFCST design strategy for all UAV situational awareness functions is to minimize hardware and software quantity and maximize use of multifunction sensors and common image processing software components. Most of the design efforts are completed satisfactorily. NGC engineers are continuing detailed sensor reliability analyses, capturing the individual and combined effects of sensor field-of-view coverage, sensor failure rates, and exposure rates.

During the final stage of the AFCST program, engineers will run simulations emphasizing landing and collision avoidance-tasks with demanding sensing and processing requirements. The engineers will develop landing and see-and-avoid strategies of operation as well as a detailed software architecture design. The simulations should determine if the preferred electrooptic/ infrared and radar sensors meet the specifications identified in the first phase of the AFCST program and the number of false alarms and false negatives that will be encountered. The engineers will also compare various image-processing solutions to determine the most reliable. The ideal system design will be free of nuisance faults caused by system error and will include software designed to minimize such faults. Reliability analysis studies will eventually combine software reliabilities with hardware reliabilities to meet the overall UAV system reliability.

In the near future, directorate and NGC engineers plan to publish the results of the detailed sensor reliability analysis. Program managers are also planning a follow-on hardware-in-the-loop simulation effort to address and demonstrate the integrated system design. In this realistic simulation, engineers will study concepts such as the integration of AFCST sensors with instrument flight rules avionics for see-and-avoid maneuvers, landing, and automated traffic collision avoidance. Real-time simulation will stress the detailed sensor architecture design, allowing the engineers to assess its adequacy and determine its readiness for technology transition to flight test. These efforts will ensure the safe incorporation of UAVs into the NAS.

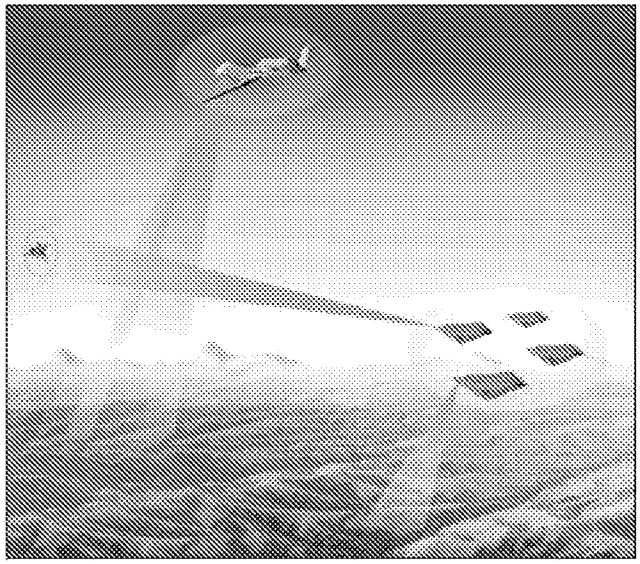

Figure. UAV senses presence of other aircraft

AIRSPACE OPERATIONS SENSING REQUIREMENTS FOR UAVs		
Functional Requirements	Threshold Values	Objective Values
Field of View	Azimuth: 60˚ Elevation: 30˚	4 π steradians
Field of Regard	Azimuth: +/-100˚ Elevation: +30˚, -90˚	4 π steradians
Ranging	0.5 ft CEP* @ 100 ft 700 ft CEP* @ 6 nm	0.25 ft CEP* @ 100 ft 770 ft CEP* @ 13.2 nm
Imaging	Varies from 30 ft to 3 nm	Varies from 30 ft to 13.2 nm
Data Rate	30 Hz	60 Hz
Weather Capability	Visual Meteorological Capability	Visual and Instrument Meteorological Capability
Criticality	Safety Critical	Safety Critical
Emission Constraints	Various Federal Aviation Administration Limitations	Various Federal Aviation Administration Limitations
	*CEP = circular error probability	

Table. Near- and far-term UAV sensing requirement

Mr. Tom Molnar and Mr. Bruce Clough, of the Air Force Research Laborator y' s Air Vehicles Directorate, and Mr. Won-Zon Chen, of Northrop Grumman Corporation, wrote this article. For more information contact TECH CONNECT at (800) 203-6451 or place a request at http://www.afrl.af.mil/techconn/index.htm. Reference document VA-03-06

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Developing Sense & Avoid Requirements for Meeting an Equivalent Level of Safety

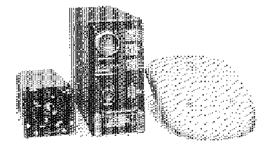
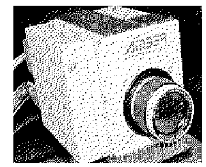
UVS Tech 2006
Salon-de-Provence, France
17-19 January 2006

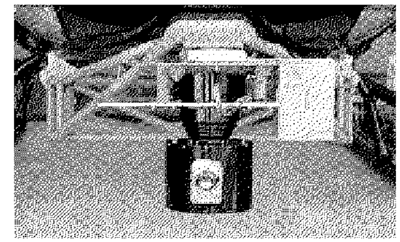
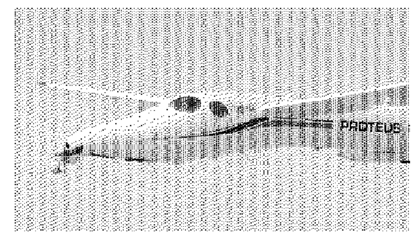
Presenter: Russell Wolfe
Access 5 Technology IPT Lead
Modern Technology Solutions, Inc

UAS Collision Avoidance Initiatives

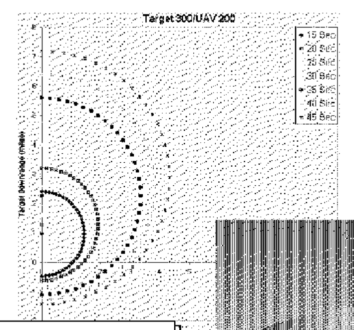
NASA Dryden Flight Research Center

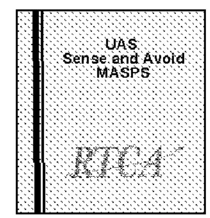
- ERAST: 1993 - 2003
  - Sensor Requirements
  - Sensor Concept Development
  - Flight Test Demonstrations
    - Cooperative
    - EO / IR
    - Radar

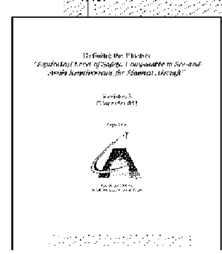
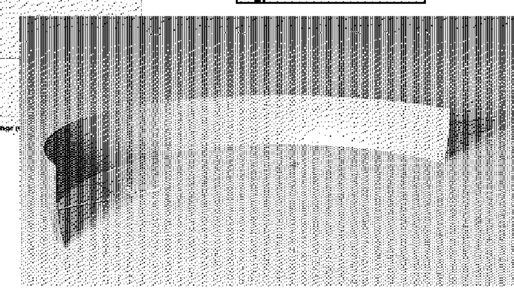



- ACCESS 5: 2004 - present
  - Requirements Development
  - Safety Analysis
  - Simulation Tools
  - Flight Test Demonstrations
  - Standards Development

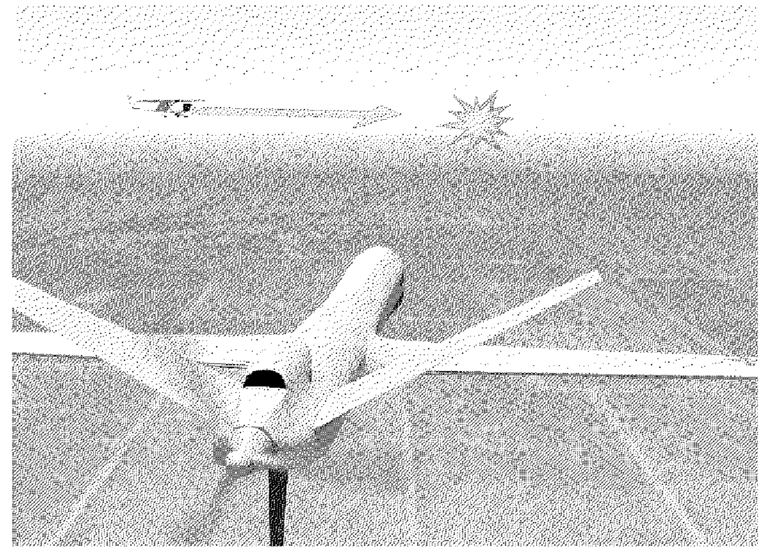




ACCESS 5
Collision Avoidance Work Package

- Work Package Objectives:
  - Define Equivalent Level of Safety (ELOS) for Sense and Avoid.
  - Develop collision avoidance (CA) requirements for Unmanned Aircraft Systems (UAS); validated through analysis, simulation, and flight demonstration.
  - Provide inputs to the FAA and RTCA Special Committee 203 "Unmanned Aircraft Systems"

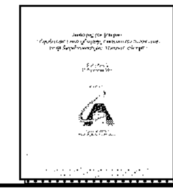


- Team Members:
  - NASA Dryden & Langley
  - Northrop Grumman
  - Lockheed Martin (Ft. Worth)
  - MITRE
  - Modern Technology Solutions
  - Aurora Flight Sciences
  - Federal Aviation Administration

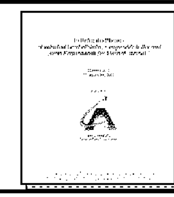
ACCESS 5 Collision Avoidance Work Package

5 Major Task Areas

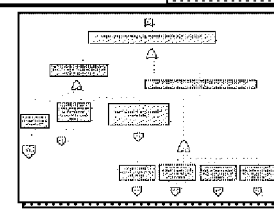
– <u>CA Task 1</u>:
Define ELOS for See & Avoid



– <u>CA Task 2:</u>
Develop CA Requirements

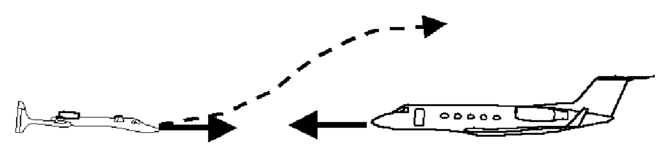


– <u>CA Task 3:</u>
Perform CA Safety Analysis



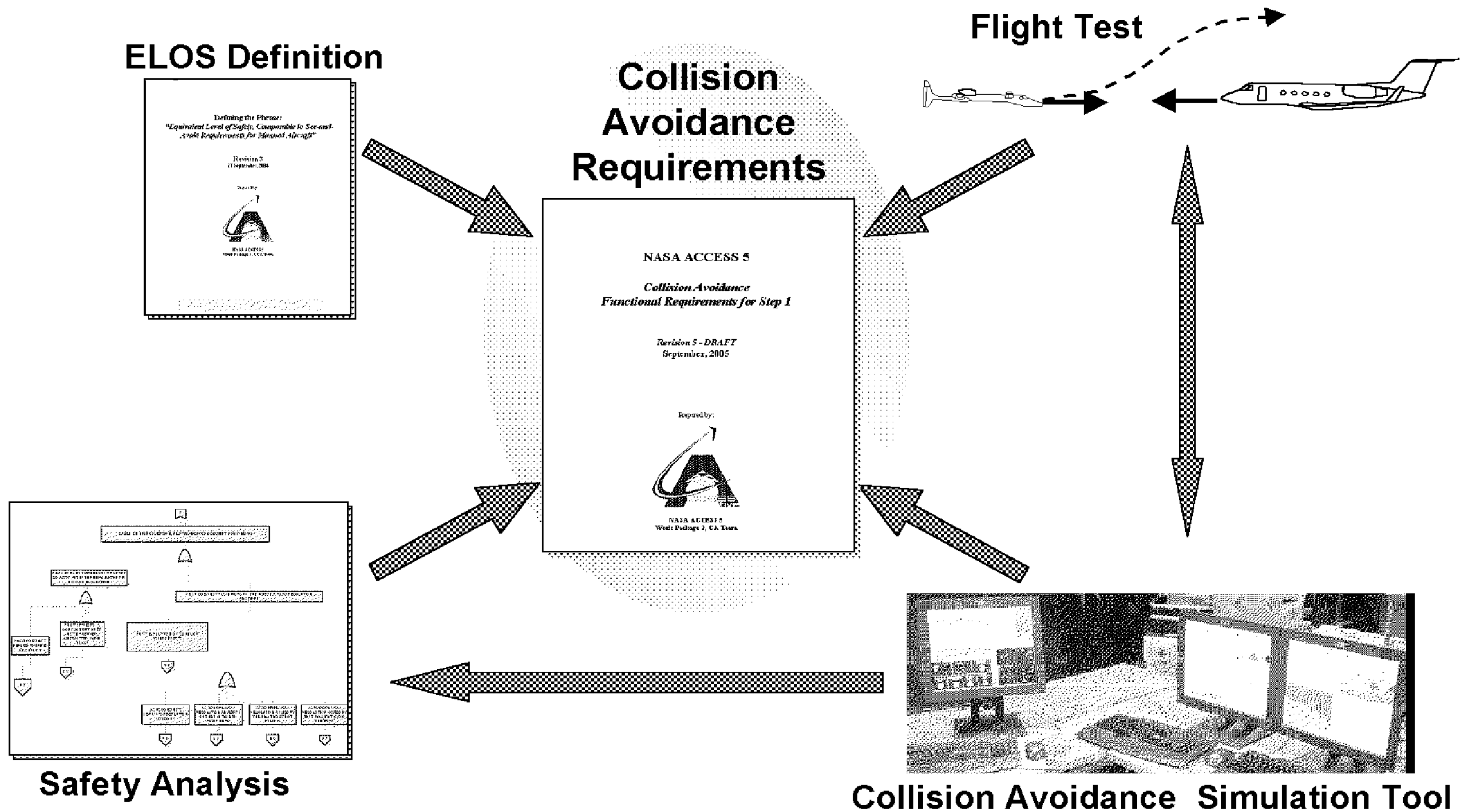
– <u>CA Task 4:</u>
Develop CA Simulation Tool

– <u>CA Task 5:</u>
Perform CA Flight Test



Collision Avoidance Work Package

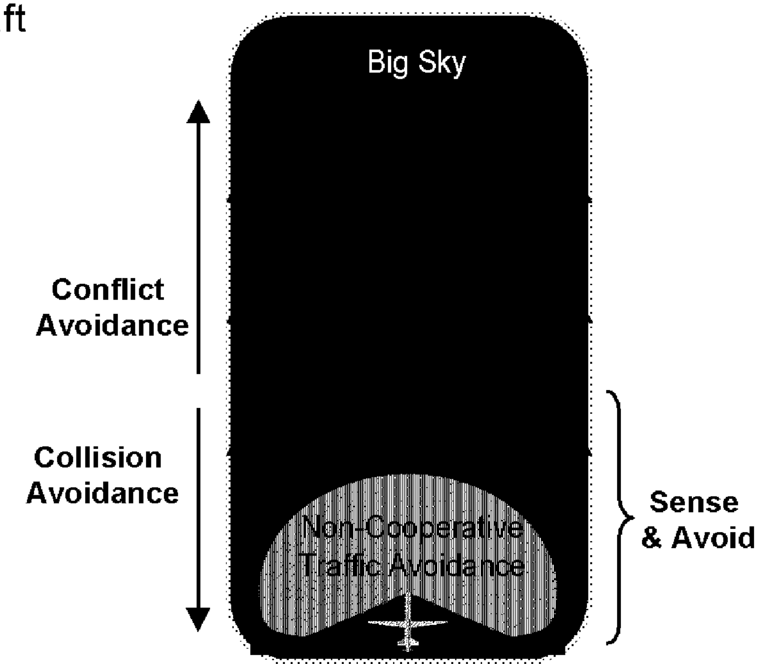
Task Relationships



Task 1: ELOS Definition Document

- Objective: To present a recommended approach for defining an equivalent level of safety, as it pertains to see and avoid.
- Deliverable Content:
  - Current regulatory / operational environment
    - 14 CFR 91.113(b), Right of Way Rules
    - 14 CFR 91.111, Operating near other aircraft
  - Basis for having to meet an Equivalent Level of Safety
    - 14 CFR 21.21(b), Certification Procedures
    - FAA Order 8110.4C, Equivalent Level of Safety Findings
  - Potential Approaches & Methodologies for defining ELOS
    - 1) Statistical Approach
    - 2) Performance / Rule Based Approach
  - Recommended Definition and Measures of Performance for Sense and Avoid ELOS

Methods used today to avoid collision



- Status: Delivered to FAA on 23 Nov 2004

Task 1: ELOS Definition Document

Definition and Measures of Performance

- Definition: *"Equivalent level of safety to manned aircraft see-and-avoid" is the capability to provide situational awareness with adequate time to detect conflicting traffic and the ability to take the appropriate action necessary to avoid collisions."*

- Measures of Performance:

ELOS for See & Avoid

Surveillance
- Minimum Detect Time
- Field of Regard
- Track Capability
- . . .

Avoidance
- Minimum Miss Distance
- Miss Distance Probability
- System Reaction Time
- . . .

System Quality
- System Integrity
- System Continuity
- System Interoperability
- . . .

Task 2: Develop Collision Avoidance Reqmts

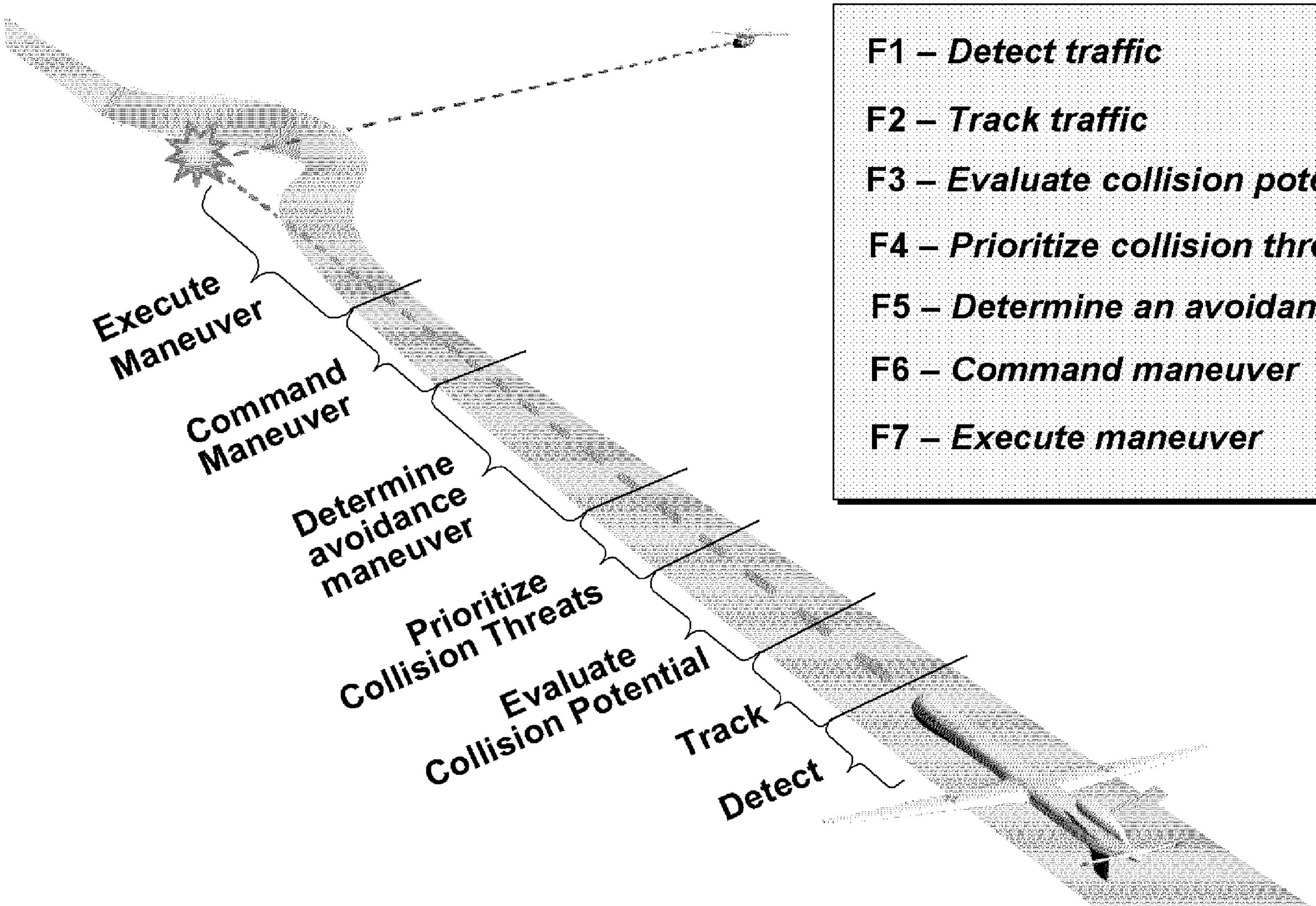
- Objective: To develop the collision avoidance operational, functional, and performance requirements for HALE UAS.

- Deliverable Content:
  - Notional CA Subsystem Description
    - Subsystem Architecture
    - Interfaces
  - Operational Requirements
  - Functional Analysis
    - List of Collision Avoidance Functions
    - Functional Flow Block Diagram
    - Functional Requirements
  - Performance Requirements
    - Design Guidelines
    - Performance Trade-offs
  - Verification Method (Analysis, Inspection, Simulation/Modeling, Demo, Test)

- Status: Intend to release Revision 6.0 in February 2006
  (All previous revisions have included FAA input and review)

Task 2: Develop Collision Avoidance Reqmts

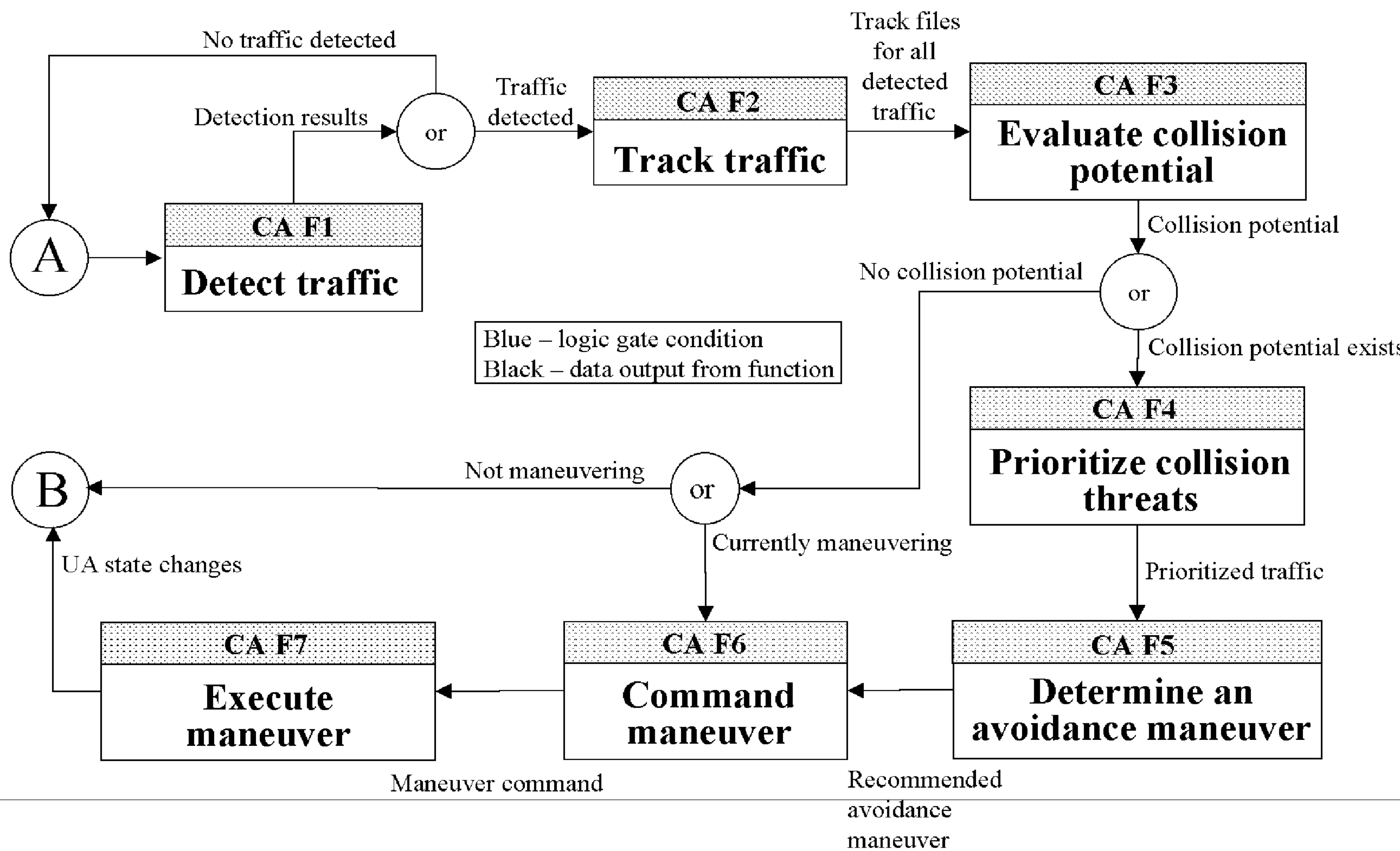
Collision Avoidance Functions



- F1 – *Detect traffic*
- F2 – *Track traffic*
- F3 – *Evaluate collision potential*
- F4 – *Prioritize collision threats*
- F5 – *Determine an avoidance maneuver*
- F6 – *Command maneuver*
- F7 – *Execute maneuver*

Task 2: Develop Collision Avoidance Reqmts

Functional Flow Block Diagram



Task 2: Develop Collision Avoidance Reqmts

Function 1: Detect Traffic Requirements (Example)

- **F1: Detect Traffic - The UAS shall detect traffic within its surveillance volume.**
  - **F1.1: Minimum Detect Time** - The CAS shall detect traffic with sufficient time remaining for successful performance of all required collision avoidance functions.
  - **F1.2: Detection Range** - The CAS shall detect cooperative traffic at a range of at least xx nautical miles. (*see Table F1.2*)
  - **F1.3: Azimuth Field of Regard** - The CAS shall detect cooperative traffic within an azimuth FOR of at least +/-110° referenced from the flight path of the UA.
  - **F1.4: Elevation Field of Regard** - The CAS shall detect cooperative traffic within an elevation FOR of at least +/-15° referenced from the flight path of the UA.
  - **F1.5: Detection Probability** - The CAS shall detect cooperative traffic in the surveillance volume at a rate that supports the track probability guideline (*see F2.3*).
  - **F1.6: Detection Rate** - The average CAS detection rate shall be equal to or greater than xx hertz. (*see Table F1.6*)
  - **F1.7: Detection Accuracy** - The CAS shall detect cooperative traffic with an accuracy of TBD ft for range determinations, and TBD ft for altitude determinations
  - **F1.8: False Detection/Nuisance** - False detections shall account for less than TBD% of all detected traffic.

Task 3: Perform Safety Analysis

- Objective: To develop a method for evaluating the safety of collision avoidance for UAS.
  - Establish equivalent level of safety to manned aircraft using event/fault trees and logic risk ratios

$$\text{Risk Ratio} = \frac{P(\text{collision UAS})}{P(\text{collision manned AC})} \leq 1$$

- Accomplishments:
  - Developed visual acquisition model based on Lincoln Lab's SEE1 model
  - Developed surveillance error models for GPS/ADS-B
  - Performed multiple assessments using results from the CA simulation tool for the primary event tree probabilities.
  - Supported requirements development in the areas of Surveillance, Effectiveness, Detection Accuracies, Detection times, Reaction times, Maneuver times, etc.

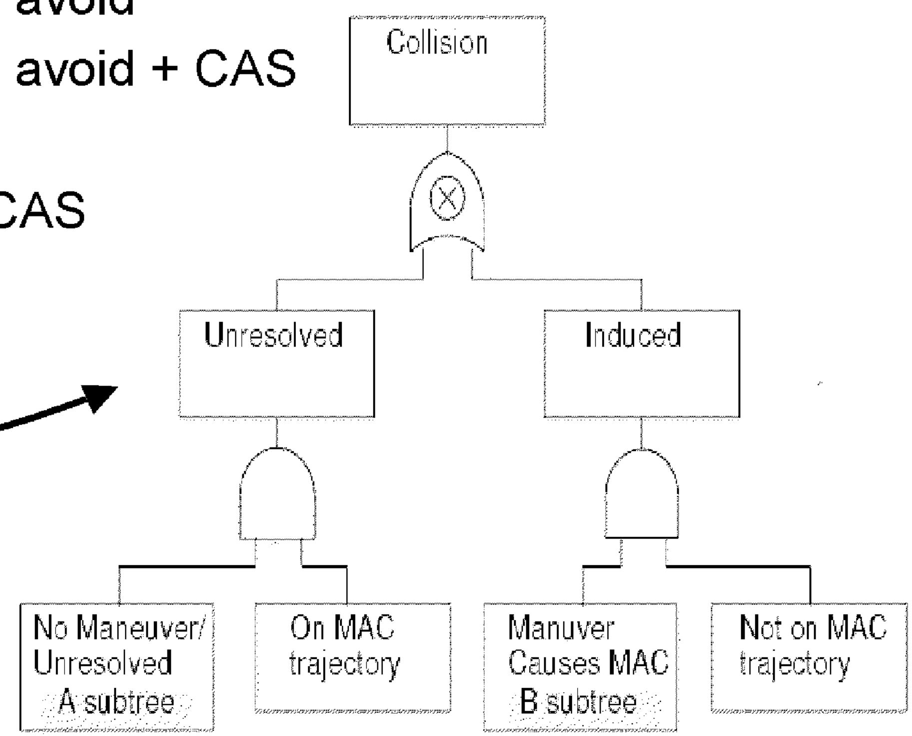
- Status: Currently finalizing final report and lessons learned

Task 3: Perform Safety Analysis

Generic Event/Fault Tree for Collision Probability Estimation

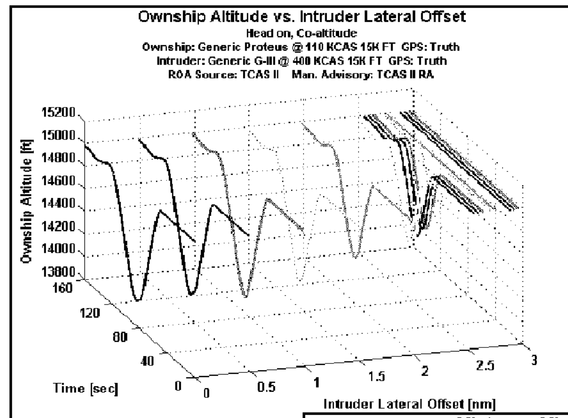
- Generic Event/Fault Tree established to provide a consistent basis for comparison:
  - 1. Manned aircraft using see & avoid
  - 2. Manned aircraft using see & avoid + CAS
  - 3. UAS with Sense & Avoid
  - 4. UAS with Sense & Avoid + CAS

Simplified Fault Tree
(actual tree is several pages long)

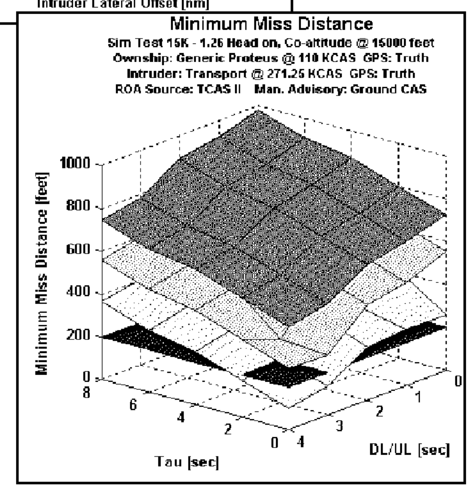


Task 4: Develop CA Simulation Tool

- Objective: To assess the validity of the proposed CA Functional Requirements via Simulation as well as support the CA Flight Test activities.
  - Allows characterization of:
    - Ownship Vehicle Dynamics
    - CA Equipment and Software
    - Encounter Scenarios



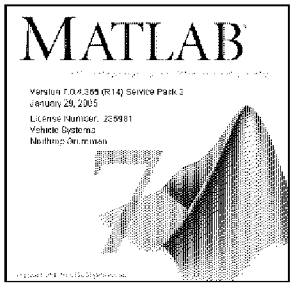
- Accomplishments:
  - Duplicated Tech Demo Scenarios
    - Flight Test Risk Reduction
    - Improve Probability of Obtaining Useful Data
  - Validated Against the System Integration Lab (SIL)
    - Flight Test Risk Reduction
    - CCA Component Models
  - Sensitivity Analyses performed

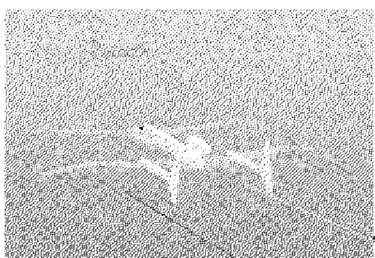


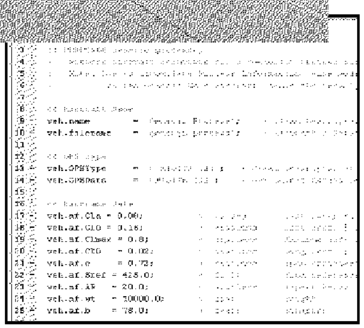
- Status: Currently analyzing flight test data and validating the CA simulation tool.

Task 4: Develop CA Simulation Tool

Simulation Features



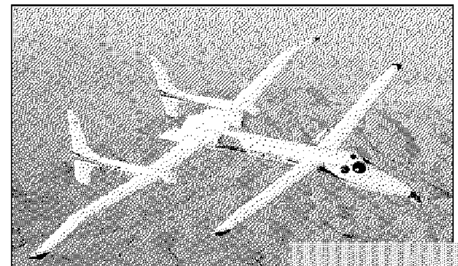




- MATLAB™/Simulink® Simulation Environment
- Multi-Vehicle Simulation (4 Aircraft Max)
- Generic Aircraft Models Represent Any Fixed Wing Aircraft
  - Each Aircraft = 1 Parameter File
  - Scripts Trim & Initialize Aircraft to Any Encounter Geometry
- Modular Components
  - Blocks Can be Copied and/or Swapped Out for Software Upgrades (e.g. CA Sensors, Maneuver Advisory)
- Capable of Batch Runs for Parametric Variation Studies
  - Uses Microsoft Excel Input Dataset
  - Multiple Plot Outputs Available
- PC Portable (< 37 MB)
- Can Run in Both Fast Sim-Time & Soft Real-Time

Task 5: Perform CA Flight Test

OPV - Proteus



Intruder – Gulfstream III

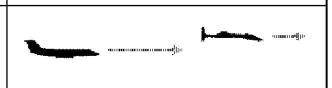
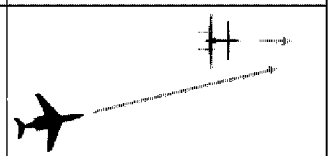
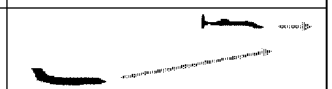
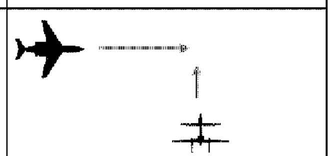
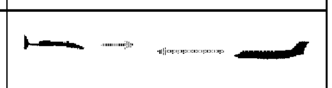
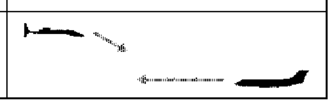
- Objective: To collect cooperative collision avoidance data to validate the CA simulation tool

- Accomplishments:
  - Developed Interface Control Document
  - Developed System Integration Lab (SIL)
  - Developed CA algorithms
  - Developed CA software and human interface tool
  - Procured CA sensors and integrated them onto Proteus platform
  - Developed CA scenarios and test cards
  - Post-processed flight data and prepared for data analysis effort

- Status: Successfully completed over 50 collision scenarios during the last two weeks of September 2005.

Task 5: Perform CA Flight Test

Test Scenarios

	HOST	INTRUDER		PICTORIAL
Scenario #	Climb Rate (fpm)	Δψ (degrees)	Climb Rate (fpm)	
1	0	0	0	
2	0	10	0	
3	0	0	500	
4	0	-90	0	
5	0	180	0	
6	-500	180	0	

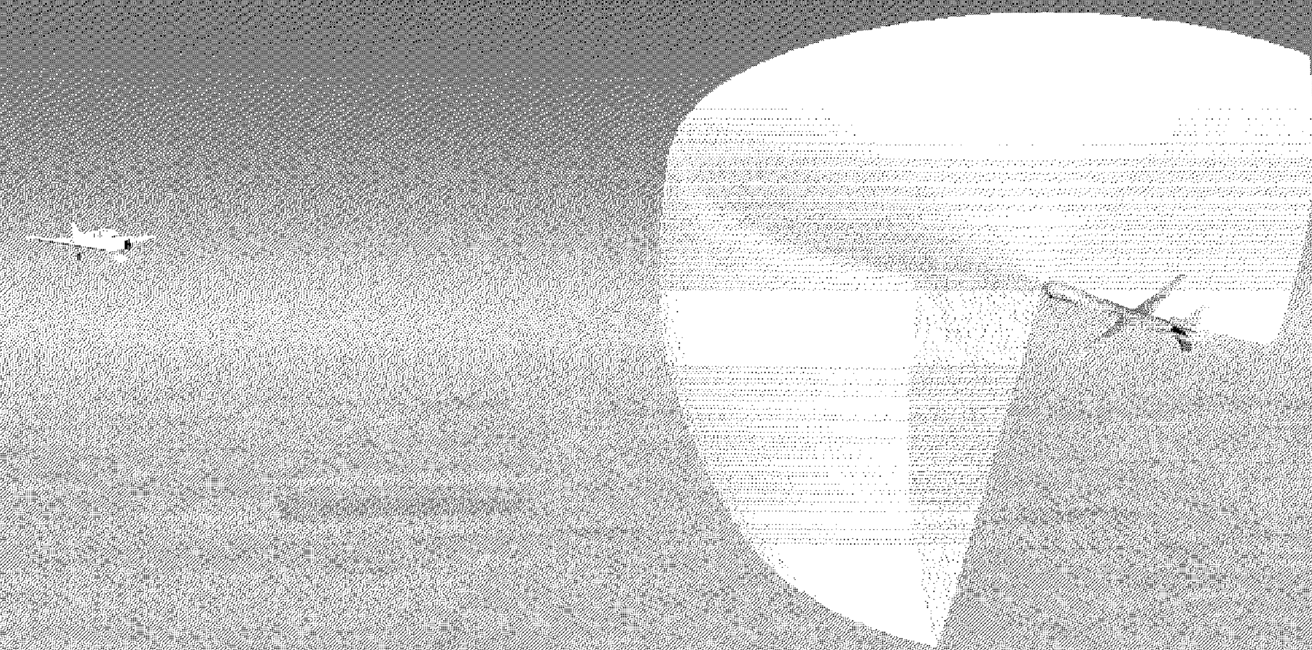
- Test scenarios included multiple collision geometries:
  - Co heading, Intruder overtaking
  - Low aspect, co-altitude
  - Co heading, Intruder climbing
  - Abeam, co-altitude
  - Head-on, co-altitude
  - Head-on, descending

	Configuration						
	TGC & AGA					TRT	
Buffer	6	4	2	0	4	0	0
Link Delay	0	0	0	0	2	0	2
Scenario							
1. Co-Heading, Co-Alt, Intruder Overtaking				1		2	
2. Low Aspect, Co-Alt				1		2	
3. Co-Heading, Intruder Climbing				1		2	
4. Abeam, Co-Alt	1	1	1	2	1	1	1
5. Head-On, Co-Alt	1	1	1	2	1	1	1
6. Head-On, Descending	1	1	1	2	1	1	1

Next Steps

- Document the results and lessons learned from the Safety Analysis and Flight Test Activities
- Complete validating the CA Simulation tool
- Derive practical values/ranges for the TBDs in the performance requirements
  - Utilize the validated CA Simulation tool
  - Utilize the safety analysis results
- Begin Non-cooperative Collision Avoidance Activities
  - Derive unique Non-cooperative performance requirements
  - Perform Trade Studies and Concept Assessments
  - Conduct Non-cooperative Simulation Runs and Flight Demos
- Support RTCA SC-203 on developing the Sense & Avoid Minimum Aviation System Performance Standards (MASPS)

QUESTIONS ?



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Zone Ready for Drone

(from FAA Air Traffic Organization Employees web site)

April 7 – The desolate landscape of the southwestern U.S. border with Mexico is widely known for illegal and unseen nocturnal activity. Now, the Department of Homeland Security is keeping watch from restricted airspace between 14,000 and 16,000 feet that extends from Organ Pipe Cactus National Monument in Arizona to New Mexico's Potrillo Mountains. Their unprecedented vantage point is the result of close cooperation with the FAA and the controllers who will keep the sky clear for a remote roving eye.

Since March 29, a temporary flight restriction (view the pdf) has limited access to the airspace along almost 350 miles of the border, expanding an earlier TFR near Nogales. The restriction is in effect nightly from 6 p.m. to 9 a.m., although that time can be expanded by issuance of a Notice to Airmen. Aircraft wishing to fly in the TFR when it is active must receive authorization from air traffic control prior to entry. Once in, pilots are required to maintain two-way communication with ATC and transmit a discrete transponder code.

Though not stated outright in the NOTAM that created the restriction, the reason behind the TFR is no secret. For some time both the White House and the Department of Homeland Security have advocated the use of unmanned aerial systems to increase the Secure Border Initiative's surveillance capability. The TFR makes it possible to fit the operation of those UASs into airspace traditionally occupied by manned military and civilian aircraft.

Predator-B, UAS. Photo: General Atomics Aeronautical Systems

"This is an extreme situation that has been presented to us," states Stephen Glowacki, a Systems Safety and Procedures specialist with the FAA's Air Traffic Organization, stressing the nation's security. "We have been working with U.S. Customs and Border Protection to try and answer this situation."

Inserting UASs into the National Airspace System is not a simple feat. According to Glowacki, the technology and certification that will permit unmanned aircraft to "see and avoid" other air traffic is still eight to ten years away. In the mean time, a carefully controlled environment is needed.

Until the advent of this TFR and its smaller forerunner, border surveillance using UASs was limited to airspace in restricted military areas. Tests conducted there helped develop the procedures now being used to safely conduct flights within the TFRs in New Mexico and Arizona.

Keeping a Homeland Security UAS separated from manned aircraft not participating in its mission requires positive control of aircraft movement within the restricted airspace. In the weeks leading up to the original TFR's issuance, ATC personnel at Albuquerque ARTCC and Tucson ATCT were briefed on procedures for handling UAS operations in airspace that includes non-participating aircraft. IFR control standards are applied and no change in separation minima is involved.

Controllers maintain communication with all manned aircraft operating in the TFR, while simultaneously monitoring the path of the UAS and talking to its ground-based pilot. The controllers' focus is on keeping non-participating aircraft away from the UAS, which flies under an IFR clearance within the TFR boundaries. Should the need arise to temporarily re-direct the UAS, the directions are delivered through secure communication with its pilot.

Although the TFR's Notice to Airmen states that ATC may provide flight advisories concerning UAS operation in the TFR, doing so is neither desired nor expected to be necessary. Only aircraft with ATC permission are allowed to enter the TFR, making it possible to control non-participating aircraft in ways that eliminate the need for such an advisory.

The TFR was not created without opposition. Even though the impact of its presence is expected to be minimal, the Aircraft Owners and Pilots Association feels that long-term operations are inappropriate for temporary restrictions. The TFR is in effect until Feb. 28, 2007. At the local level, airport management at Nogales International Airport reported a drop in business after the first, smaller TFR was created in January. However, because the restrictions are at an altitude well above that flown by aircraft using the airport, pilots may have been avoiding the area out of fear based on misunderstanding the restriction's boundaries.

ATO's Glowacki points out that the TFR was designed to cause the least amount of impact to pilots. The restricted airspace is relatively narrow vertically and is active primarily at night. Aircraft that operate at night are required to have all the equipment needed to communicate with ATC and transmit a discrete beacon code. All that is required for a pilot to enter the airspace, beyond that equipment, is permission from ATC. By flying above or below the restricted altitudes, pilots don't have to worry about what's going on in the TFR.

"It has been an amazing and ingenious way of temporarily resolving an incredible situation," Glowacki says. "Airspace studies and known aviation operations were reviewed and balanced against national security needs."

Now the challenge is to ensure safety while a relatively new technology is introduced to the NAS. Long-term TFRs like those along the southern border allow DHS time to carefully plan missions, without interruption or unexpected changes to the rules that govern them. However, fine tuning may be needed as the program continues. TFRs are flexible enough to be changed quickly based on anything new that is learned, unlike more rigid airspace restrictions such as Air Defense Identification Zones.

As Glowacki says, "the TFR is the best tool to fit the situation."

Related Information:

- Temporary Flight Restriction (PDF)

"Virtual Cockpit Window" for a Windowless Aerospacecraft

A software system processes navigational and sensory information in real time to generate a three-dimensional-appearing image of the external environment for viewing by crewmembers of a windowless aerospacecraft. The design of the particular aerospacecraft (the X-38) is such that the addition of a real transparent cockpit window to the airframe would have resulted in unacceptably large increases in weight and cost.

When exerting manual control, an aircrew needs to see terrain, obstructions, and other features around the aircraft in order to land safely. The X-38 is capable of automated landing, but even when this capability is utilized, the crew still needs to view the external environment: From the very beginning of the United States space program, crews have expressed profound dislike for windowless vehicles. The well-being of an aircrew is considerably promoted by a three-dimensional view of terrain and obstructions. The present software system was developed to satisfy the need for such a view. In conjunction with a computer and display equipment that weigh less than would a real transparent window, this software system thus provides a "virtual cockpit window."

The key problem in the development of this software system was to create a realistic three-dimensional perspective view that is updated in real time. The problem was solved by building upon a pre-existing commercial program — LandForm C3 — that combines the speed of flight-simulator software with the power of geographic-information-system software to generate real-time, three-dimensional-appearing displays of terrain and other features of flight environments. In the development of the present software, the pre-existing program was modified to enable it to utilize real-time information on the position and attitude of the aerospacecraft to generate a view of the external world as it would appear to a person looking out through a window in the aerospacecraft. The development included innovations in realistic horizon-limit modeling, three-dimensional stereographic display, and interfaces for utilization of data from inertial-navigation devices, Global Positioning System receivers, and laser rangefinders. Map and satellite imagery from the

National Imagery and Mapping Agency can also be incorporated into displays.

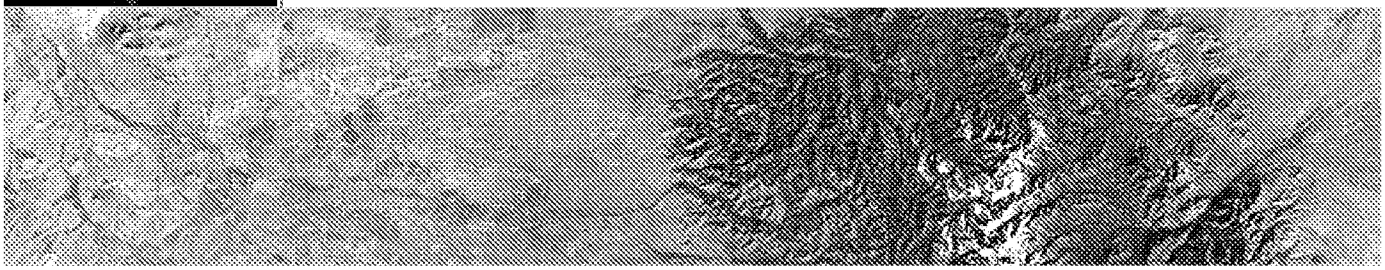
After further development, the present software system and the associated display equipment would be capable of providing a data-enriched view: In addition to terrain and obstacles as they would be seen through a cockpit window, the view could include flight paths, landing zones, aircraft in the vicinity, and unobstructed views of portions of the terrain that might otherwise be hidden from view. Hence, the system could also contribute to safety of flight and landing at night or under conditions of poor visibility.

In recent tests, so precise was the software modeling that during the initial phases of the flight the software running on a monitor beside the video camera produced nearly identical views.

This work was done by Michael F. Abernathy of Rapid Imaging Software, Inc., for **Johnson Space Center**. *For further information, please contact Michael F. Abernathy, Rapid Imaging Software, Inc., 1318 Ridgecrest Place S.E., Albuquerque, NM 87108.*

MSC-23096

LandForm Situation Awareness Software



See what the press and the industry are saying about LandForm 3D Real-Time Terrain Modeler Products.

Joint FAA/NASA/RIS Flight Test Utilizes SmartCam3D/SmartTopo technology

March 2nd, 2006 - Ellington Field Houston, TX

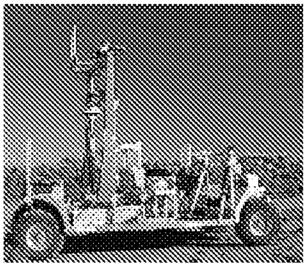
The FAA, NASA, and RIS conducted a flight test of a 3 panel version of SmartCam3D aboard an FAA aircraft today. The test will study ways in which aviation data types can be used to support advanced pilot displays, including as part of a UAV Glass Cockpit using SmartCam3D. The SmartTopo technology is being studied for its utility in runway approach inspection. You can download a video of the flight from this location as a QuickTime movie.

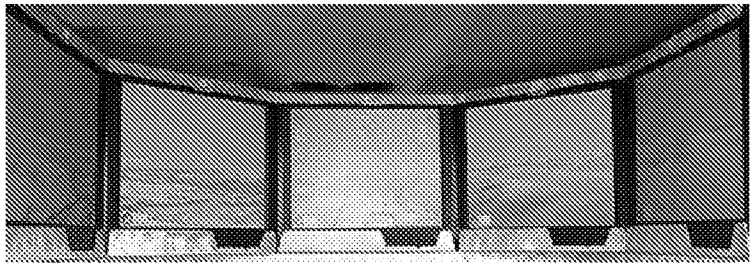
http://landform.com/NASA.FAA.RIS V3.mov

Here is a link to the QuickTime player in case you don't already have it on your machine, you can download it.
http://www.apple.com/quicktime/download/win.html

NASA Tele-Operates SCOUT Rover using SmartCam3D

September 15th, 2005 - Meteor Crater, AZ

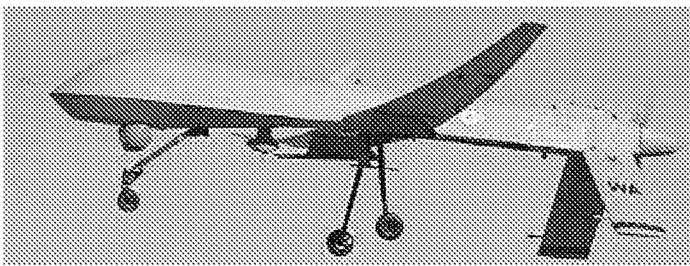




NASA remotely operated the SCOUT rover using SmartCam3D in a 5 panel configuration at Meteor Crater this week. The ACES advanced cockpit evaluation system was used for test and performed beautifully operating the vehicle over the course of several miles. The ACES uses SmartCam3D in a panoramic display mode which provides the operator with a 180 degree field of view.

USAF UAV BattleLab and AFRL Evaluate SmartCam3D on Predator

September 1st, 2005 - Indian Springs AFAF, AZ



The USAF UAV BattleLab and AFRL are conducting a study of the human effectiveness benefits of SmartCam3D for USAF Predator aircrews, in support of USAF Air Combat Command. These studies involve installing SmartCam3D in Predator Ground Control Segments and flying numerous sorties using the technology.

NDIA Awards SmartCam3D Top5 Software of the Year

April 19th, 2005 - Salt Lake City, UT

The National Defense Industries Association identifies SmartCam3D as one of the TOP5 US software programs of the year. Mike Abernathy from RIS and Francisco Delgado from NASA accepted the dual awards for this program.

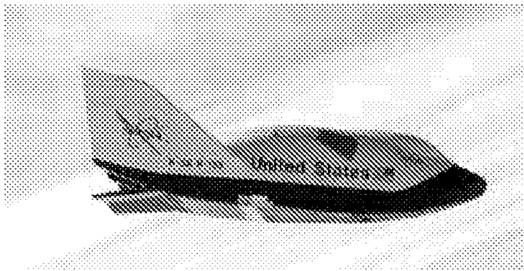
SmartCam3D is Awarded NASA JSC Exceptional Software of the Year

June 2004 - Houston, TX

Dr. Janis White and Rapid Imaging Software, Inc. received the NASA Johnson Space Center Exceptional Software of the Year award for the SmartCam3D situation awareness software system. The award was presented by General Howell in a ceremony Houston, Texas. The SmartCam3D software was also first runner up for NASA agency-wide software of the year. Well done, Janis and team!

LandForm® Guides X-38 Pilot in Successful Flight!

December 13th, 2001 - Edwards Air Force Base, CA



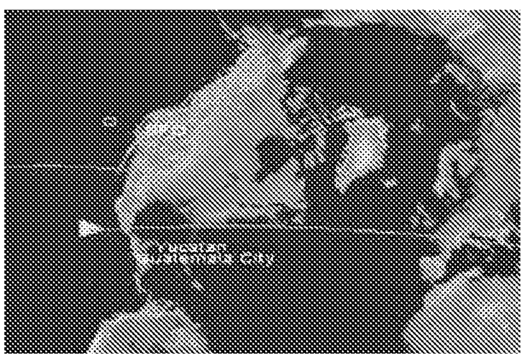
On December 13th, 2001, Astronaut Ken Ham successfully flew the X-38 from a remote cockpit using LandForm VisualFlight as his primary situation awareness display in a flight test at Edwards Air Force Base, California. This simulates conditions of a real flight for the windowless spacecraft, which will eventually become NASA's Crew Return Vehicle for the ISS. We believe that this is the first test of a hybrid synthetic vision system which combines nose camera video with a LandForm synthetic vision display. Described by astronauts as "the best seat in the house", the system will ultimately make space travel safer by providing situation awareness during the landing phase of flight.

Read more about LandForm in this AviationWeek article

LandForm® Develops New Map Projection for Planetary Exploration

September 29th, 2000 - Albuquerque, NM

Rapid Imaging Software announced the development of a new map projection which will aid astronauts in navigating earth, as well as other moons and planets. The new method to display maps is very beneficial to astronauts and planetary explorers because it displays the surface of the planet with minimum distortion nearest the spacecraft path, making landing site selection much more intuitive.



Since planets tend to be spherical in shape, any mapping algorithm must distort the curved surface in order to display it on a flat map. Traditional Plate Caree' (or Plane Charts) distort least near the equator which is the central axis of the map. The new projection called LandForm Orbital Projection uses the line of the satellite orbit, instead of the equator, as the maps central axis with the result that the satelite appears to move in a more or less straight down the center of the chart. This provides the viewer with a much more natural understanding of the terrain near the path of the satellite.

LandForm C3 Demonstrates Real-time Networked Flight Visualization

July 9th, 1999 - NASA Johnson Space Center, Houston, TX.

NASA engineers in Houston watched the X-38 flight test live as it occurred at Edwards, AFB using the LandForm C3 software. LandForm displayed the flight of the vehicle above terrain in real-time via a network link.

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Flying UAVs in Civil Airspace By Using Synthetic Vision

Jed Margolin

Introduction

Companies and Government are starting to deal with the problem of safely flying UAVs in civil airspace, especially now that they are beginning to see the potential civilian uses for UAVs.

What makes any solution difficult is that it has to work within the existing system run by the FAA which operates the national airspace system and has been slow to adopt technological advances.

The companies involved (AeroVironment, Aurora Flight Sciences, Boeing, General Atomics, Lockheed Martin, and Northrop Grumman) are taking the problem/opportunity seriously enough to spend some of their own money on a solution.

Unfortunately, they do not seem to realize that this is an opportunity to improve the national airspace system for all users and not just UAV operators.

The solution discussed in this report requires the use of Synthetic Vision as taught by my U.S. Patent 5,904,724 **Method and apparatus for remotely piloting an aircraft**.

Current Activity

From Aviation Week & Space Technology, 08/02/2004, page 54
Michael A. Dornheim Los Angeles

> ***UAV Safety Access 5 Project Seeks To Fly Drones in Civil Airspace***
> To carry out quick-reaction civil missions like wildfire spotting, UAVs must be part of the FAA system. Challenge is to make safety for others on the ground and in the air affordable.
>
> .
> .
> .
>
> In early 2002 six manufacturers--AeroVironment, Aurora Flight Sciences, Boeing, General Atomics, Lockheed Martin and Northrop Grumman--formed the UAV National Industry Team (Unite) to gain access for high-altitude long-endurance (HALE) drones. HALE aircraft were chosen because they fly above most commercial traffic, usually over sparsely populated areas, and present the lowest-risk initial step. Dann is also president and co-founder of Unite.
>
> Unite approached NASA in August 2002 because it was running the Environmental Research Aircraft and Sensor Technology drone program, and the two signed a joint sponsored research agreement. This formed Access 5, so-called because of the original optimistic goal of gaining airspace access in five years. The FAA became involved as an adviser, and the Defense Dept. joined the discussion. By February

2003, Unite members had contributed $3-4 million and NASA had a similar amount in its budget, Bauer said.

Steps 1 and 2 are funded with $101 million from NASA that became available in May, covering the five years from Fiscal 2004-08, and Unite will make in-kind contributions worth at least $25 million.

Access5 has their own web site at www.access5.org .

They are planning on spending $126 million ($101 million from NASA and $25 million from Unite) for the Fiscal period 2004-08 to apply a band aid to a system that has been broken for a long time.

From Aviation Week & Space Technology, 09/13/2004, page 59 (Inside Avionics):

NORTHROP GRUMMAN IS WORKING

Aviation Week & Space Technology
09/13/2004, page 59
Edited by Bruce D. Nordwall

NORTHROP GRUMMAN IS WORKING with the U.S. Air Force to fuse data from a variety of sensors as a basis for collision-avoidance systems for unmanned aerial vehicles. The concept is to create an autonomous "see and avoid" system that would permit UAVs and manned aircraft to operate safely in the same airspace. Work under this contract from the Air Force Research Laboratory in Dayton, Ohio, aims to verify, through simulation, a sensing architecture designed under a previous award. The concept is to combine data from electro-optical charge-coupled-device cameras and mid-wave infrared sensors to create an integrated view of the environment, which the UAV's flight control system could use to adjust the aircraft's vector to avoid a midair collision. The simulation model will be based on the attributes of radar, traffic-alert and collision avoidance systems (TCAS) and automatic dependent surveillance-broadcast. Separately, the company is working with NASA, the Defense Dept., the Homeland Security Dept. and six industry partners to develop the policy and procedures to give UAVs access to U.S. airspace within five years.

From Aviation Week & Space Technology, 03/01/2004, 05:08:05 PM:

UAVs Increase in Importance
By Steven J. Zaloga
UAVs remain the most dynamic segment of the aerospace market. They stole the limelight from more established technologies at the 2003 Paris air show. Nevertheless, they are still a relatively small segment of the aerospace market, about $1.25 billion in research and production funding in 2003. What attracts so much attention is the potential for a major expansion.

And, at the end of the article:

CIVILIAN UAV APPLICATIONS
UAVs have been used extensively for civilian scientific research, but this has not transitioned to much serial production. Scientific applications can be easily

envisioned for UAVs such as environmental monitoring, weather/atmospheric data collection, oceanographic data collection, agricultural monitoring and high-altitude geological mapping of magnetic, radiological and gravimetric data. Some of these research applications could become commercial. For example, the U.S. Defense Dept. has discussed contracting private firms to operate research UAVs over the Pacific to collect weather data.

From Aviation Week & Space Technology, 08/02/2004, page 50:

General Atomics, Northrop Grumman Set To Battle Over Pentagon UAV Projects
David A. Fulghum
Farnborough

Competition flares for a new category of survivable, high-altitude jet UAVs
Running Hot

Competition has just caught fire for a new category of unmanned aircraft, with an estimated market of $16-45 billion over the next 10-15 years.

General Atomics Aeronautical Systems started the blaze with the still unannounced construction start of an all-jet Predator C, and Northrop Grumman is fanning the flames with advanced planning for a competing aircraft that's expected to be a departure in design from the more sophisticated Global Hawk.

According to an article in Aerospace Daily & Defense Report 10/13/2004 09:13:12 AM "Use Of UAVs In War On Terror Expanding, Weatherington Says":

"The DOD plans to spend $2.2 billion on UAVs in fiscal year 2005 and $13 billion total from FY '04 through FY '09, with strike UAVs accounting for half of that number. Annual UAV spending is projected to reach about $3 billion by FY '08-09. The Pentagon's latest UAV roadmap (DAILY, June 3) is expected to be released early next year."

My Proposed Solution

Definitions

Unmanned Aerial Vehicle (UAV) is an aerial vehicle without an onboard human pilot.

Problem

Flying (including taking off and landing) a UAV in an airspace shared with other independent aircraft, both civilian and military, which are not under the direct control of the entity controlling the UAV, and avoiding midair collisions during all phases of flight.

Proposal

1. UAVs flying beyond a specified range from a Terminal Control Area (TCA) or other designated area and flying above a specified altitude may be flown autonomously using an Autonomous Control System (ACS) as long as the following conditions are met:

(a) A remote operator must monitor the operation of the UAV at all times. A remote operator may monitor several UAVs simultaneously once it is established that this practice may be safely performed by a single operator. For example, it may be preferable to have two remote operators to work as a team to monitor ten UAVS than to have each remote operator separately monitor a group of five UAVs.

(b) The ACS must use radar (either active or passive) to detect the range and altitude of nearby aircraft in order to perform "see and avoid" actions. An example of a passive radar system is taught by Reference 2 [U. S. Patent 5,187,485 **Passive ranging through global positioning system**].

(c) The ACS must periodically transmit its identification, location, altitude, and bearing. This may be done through the use of a speech synthesis system on a standard aircraft communications frequency. This is for the benefit of pilots flying aircraft sharing the airspace. It may also be done through an appropriate digital system such as the one taught in Reference 3 [U.S. Patent 5,153,836 **Universal dynamic navigation, surveillance, emergency location, and collision avoidance system and method**.]

(d) The ACS must provide a means for the pilots of other aircraft to communicate directly with the remote operator. This may be accomplished by having the communication link between the remote operator and the UAV relay communications with a standard aircraft transceiver onboard the UAV.

2. UAVs flying below a specified altitude or within a specified range from a TCA or other designated area (at any altitude) must be flown using a synthetic vision system as taught in Reference 1 [U.S. Patent 5,904,724 **Method and apparatus for remotely piloting an aircraft**].

Each UAV flown under these conditions must be under the direct control of a remote operator/pilot whose sole responsibility is the safe operation of that UAV. The rules will be similar to those for operating piloted aircraft with automatic pilot systems including those with autoland capability.

The preferred method for flying a UAV from one airport to another, such as in ferrying UAVs, would be to have the remote operator/pilot at the originating airport be responsible for taking off and flying the UAV to the specified altitude. A remote operator/pilot at the arrival airport would be responsible for having the UAV descend and land. In between, once the UAV has reached the specified altitude the remote operator monitoring the flight can be at any convenient location.

Long delays in the communications link (such as through geosynchronous satellites) make flying the UAV by direct control using synthetic vision more difficult and should be avoided.

The method described does not require any changes in the present air control system. It would also make UAV flights safer than most existing piloted flights where "see and avoid" is accomplished by looking out small windows providing a limited field of view and hoping you see any nearby aircraft in time to avoid a collision.

Patent References

[Ref 1] U.S. Patent 5,904,724 **Method and apparatus for remotely piloting an aircraft**, Jed Margolin, May 18, 1999. Link to patent at USPTO website

The patent teaches the use of synthetic vision to remotely pilot an aircraft.

[Ref 2] U. S. Patent 5,187,485 **Passive ranging through global positioning system**, Tsui, et al., February 16, 1993. Assignee: The United States of America as represented by the Secretary of the Air Force. Link to patent at USPTO website

The patent teaches a method for determining the distance from a target to an observation station, using four GPS satellites as radiation sources, and a GPS receiver at the observation station to form a bistatic radar system, wherein an angle of arrival (AOA) of the target to the observation station has been measured first.

[Ref 3] U.S. Patent 5,153,836 **Universal dynamic navigation, surveillance, emergency location, and collision avoidance system and method**, Fraughton, et al., October 6, 1992. Link to patent at USPTO website

Each vehicle continuously transmits its location, identification, and other information, so everybody with the appropriate receiver knows where everybody else is. {The patent is 135 pages long.}

Jed Margolin
San Jose, CA
May 8, 2005

NTSB Identification: **CHI06MA121**
14 CFR Public Use
Accident occurred Tuesday, April 25, 2006 in Nogales, AZ
Aircraft: General Atomics Predator B, registration: None
Injuries: 1 Uninjured.

This is preliminary information, subject to change, and may contain errors. Any errors in this report will be corrected when the final report has been completed.

On April 25, 2006, at approximately 0341 mountain standard time, an unregistered Predator B aircraft, collided with the terrain approximately 30 statute miles northwest of Nogales, Arizona. The unmanned aerial vehicle (UAV) was registered to the U.S. Customs and Border Protection agency. The public use flight was operating in visual meteorological conditions. An instrument flight rules flight plan had been filed and activated for the flight. The UAV sustained substantial damage. There were no injuries to persons on the ground. The flight originated from the Libby Army Airfield (HFU), Sierra Vista, Arizona.

The flight was being flown from a ground control station (GCS) located at HFU. The GCS contains two nearly identical consoles, pilot payload operator (PPO)-1, and PPO-2. During a routine mission, a certified pilot controls the UAV from the PPO-1 console and the camera payload operator (typically a U.S. Border Patrol Agent) controls the camera from PPO-2. The aircraft controls (flaps, stop/feather, throttle, and speed lever) on PPO-1 and PPO-2 are identical. However, when control of the UAV is being accomplished from PPO-1, the controls at PPO-2 are used to control the camera.

The pilot reported that during the flight the console at PPO-1 "locked up", prompting him to switch control of the UAV to PPO-2. Checklist procedures state that prior to switching operational control between the two consoles, the pilot must match the control positions on the new console to those on the console, which had been controlling the UAV. The pilot stated in an interview that he failed to do this. The result was that the stop/feather control in PPO-2 was in the fuel cutoff position when the switch over from PPO-1 to PPO-2 occurred. As a result, the fuel was cut off to the UAV when control was transferred to PPO-2.

The pilot stated that after the switch to the other console, he noticed the UAV was not maintaining altitude but did not know why. As a result he decided to shut down the GCS so that the UAV would enter its lost link procedure, which called for the UAV to climb to 15,000 feet above mean sea level and to fly a predetermined course until contact could be established. With no engine power, the UAV continued to descend below line-of-site communications and further attempts to re-establish contact with the UAV were not successful.

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World News & Analysis

Lockheed's Polecat UCAV Demonstrator Crashes

Aviation Week & Space Technology
03/19/2007, page 44
Amy Butler
Washington

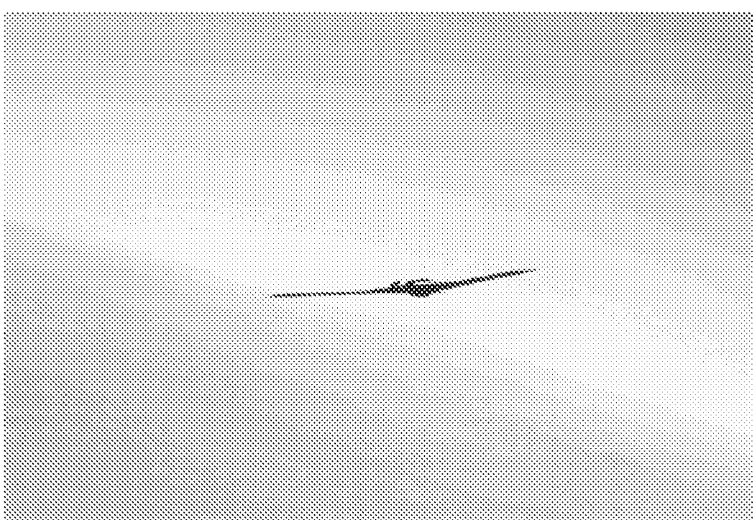
Polecat UAV has been labeled a total loss after December crash

Printed headline: **Roadkill**

Lockheed Martin's Polecat unmanned aerial vehicle demonstrator has crashed months after accomplishing only three flight tests.

The incident takes the steam out of the company's strategy to fund its own project to keep pace with--and potentially surpass--work at Northrop Grumman and Boeing on government-funded *UAV* programs. Northrop Grumman and Boeing have been beneficiaries of the Pentagon's multibillion-dollar on-again off-again program to develop a combat UAV for the Navy and Air Force. And, both companies have flying demonstrators of varying maturity as a result of this support.

Lockheed Martin has no major government funding for its UAV efforts. But, company officials said that with Polecat they hoped to surpass the knowledge base of the nascent UAVs at rival companies and secure a foothold in the next-wave of Pentagon purchasing in this area--particularly for the Air Force's future bomber.



Lockheed Martin officials took months to acknowledge the crash of its Polecat UAV development aircraft.   Credit: LOCKHEED MARTIN

THE POLECAT CRASH occurred Dec. 18, 2006, at the Air Force's Nevada Test and Training Range. Lockheed Martin officials say they could not discuss the crash any earlier due to a then-ongoing Air Force-led investigation that was only recently completed. The company notes that it had no formal customers for Polecat, but was restricted by government rules from discussing the incident since it occurred on a federal test range.

The 90-ft. wingspan demonstrator, which cost them more than $30 million to develop, was declared a total loss as a result of the crash. The company is attributing the incident to an "irreversible unintentional failure in the flight termination ground equipment," though it was unable to say whether human error or a technical malfunction was a cause. The aircraft was, however, "in full control and performing well" when its automatic "fail-safe flight termination mode" activated, according to a Lockheed Martin statement. A company official says a failsafe, which prevented operators from recovering control of the UAV, initiated "in seconds," rendering them powerless as the aircraft dove to the ground.

"The fail-safe mode is designed to irreversibly terminate flight to ensure that systems do not deviate from the range into civilian airspace," according to a company statement. "There was an irreversible unintentional failure in the flight termination ground equipment at the Nevada Test and Training Range. We believe the test range has corrected the potential for a similar circumstance to occur again." Company officials say the Polecat validated rapid prototyping methods and that aerodynamic performance was "better than expected." They add, the flight termination software "performed exactly as expected."

The incident is an embarrassment for Lockheed Martin, which has been criticized for ignoring the UAV business and focusing too much on its booming manned fighter work on the F-22 and F-35. The company's efforts to conduct *UAV* testing fizzled after the termination of its DarkStar UAV program; one of its prototypes crashed in April 1996.

Yet, the company is not alone when it comes to embarrassing UAV incidents. Early in the development of the Global Hawk, a Northrop Grumman UAV, operators at one test range inadvertently engaged a self-destruct code that was picked up by a prototype UAV flying at a different range. The aircraft's extraordinarily high altitude gave it line-of-sight to both range sites. So, the *UAV* wound up in a self-destruct spiral and was declared a total loss.

For Lockheed Martin, Polecat's unveiling was the high point of the aeronautics sector's news briefings during last year's Farnborough air show in the U.K. (AW&ST July 24, 2006, p. 64). Frank Cappuccio, executive vice president for Lockheed Martin Skunk Works, showed a video clip during that briefing to reporters of the early Polecat flights. He touted the air vehicle as a demonstrator for new technologies in the areas of composites, fabrication and twisting strut designs to morph the UAV's wings in flight.

Polecat was the first public attempt by a company to demonstrate the effectiveness of a tailless Horton-wing design at altitudes in excess of 60,000 ft. The design, similar to the B-2's, is inherently stealthy because it lacks a tail. Skunk Works had wanted to experiment with it in high altitudes where the air is thin. Yet, with only three flights under its belt, the aircraft never climbed above 15,000 ft. to prove itself at high altitudes as planned.

Contrail suppression is also a problem the company hoped to tackle via its work on Polecat. Despite its high altitude, the U-2 has been plagued by contrails during its decades of operation. And, effective visible contrail suppression will augment the stealth qualities afforded through design and coatings. Polecat was not coated with stealthy materials, but the tailless design and angled engine inlets provided stealthy qualities to the demonstrator.

Frank Mauro, director of Lockheed Martin's unmanned systems at Skunk Works, said last year that work on Polecat would feed into the company's evolving designs for the Air Force long-range strike aircraft concept as well as needs beyond Northrop Grumman's Global Hawk for a future high-altitude UAV for intelligence collection. "Many lessons learned on this project will be applicable to future efforts, including Long Range Strike," according to the company statement.

The aircraft was designed to hoist 1,000 lb. of payload. It was powered by two FJ44-3E Williams International engines. Work began on Polecat in 2003 and it was ready for flight 18 months later.

News Breaks
Americas

The F-22 continues to encounter

Aviation Week & Space Technology
02/26/2007, page 18

The F-22 continues to encounter bumps in its first air expeditionary force deployment to Okinawa. The 12 aircraft from Langley AFB, Va., spent an unscheduled week at Hickam AFB, Hawaii, after the leading four had to abort the trip's last leg. As the Raptors reached the International Date Line, the navigation computers locked up so the aircraft returned to Hickam until a software patch was readied. "Apparently we had built an aircraft for the Western Hemisphere only," says a senior U.S. Air Force official. When the F-22s arrived at Kadena AB, Okinawa, some Japanese citizens held a protest against the aircraft's noise.

Heli-Expo 2007

Gulf of Mexico Helo Ops Ready for ADS-B

Aviation Week & Space Technology
02/26/2007, page 56
Frances Fiorino
Washington

HAI members and FAA work to adapt next-gen 'backbone' in Gulf of Mexico

Printed headline: **Helo Ops Ready for ADS-B**

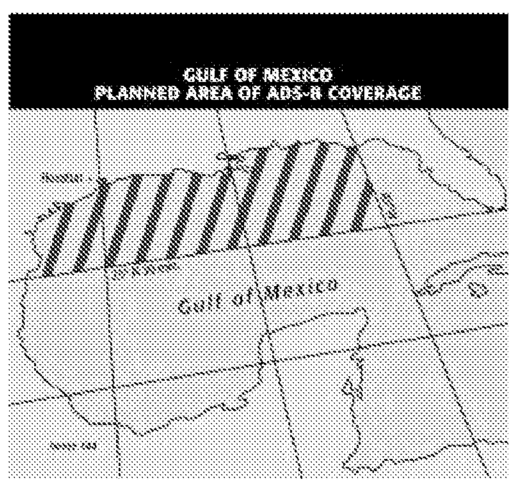
Helicopter operators are moving closer to reaping the benefits of ADS-B--a system that will "take the National Air Space and extend it out over the Gulf of Mexico."

At least that's how Vincent Capezzuto likes to describe the capability of Automatic Dependent Surveillance-Broadcast, which the FAA calls "the backbone" of the Next-Generation Air Transportation System. Capezzuto is FAA program manager for the FAA's national ADS-B office. For Gulf of Mexico operators, ADS-B means real-time ATC surveillance, communications and weather data--which, in effect, translate to conducting safe, low-altitude IFR operations in the gulf.

That's in sharp contrast to current operating conditions in the region, an area roughly 994 mi. (1,600 km.) east to west and 559 mi. from north to south, with a surface area spanning 579,153 sq. mi. Thousands of rigs offshore mine oil and gas riches round-the-clock in water with an average depth of 1,615 meters.

Approximately 650 helicopters and 2,000 pilots operate 7,500 shore-to-platform trips daily to fulfill their primary mission of ferrying personnel and equipment to thousands of platforms located about 150-200 mi. out from the Texas, Louisiana, Mississippi coastline. And all of this is accomplished while flying below 5,000 ft.

Once the flights leave the shore, "They operate in an environment devoid of the normal infrastructure found over land," says Helicopter Assn. International President Matt Zuccaro.



Radars cannot be installed on oil platforms, Capezzuto says. "It's a very harsh environment. Electromechanical devices don't like the salt water."

And Houston Center, which provides coverage of what is now classified as Oceanic airspace, can't see or talk to the helicopter operators--and as a result cannot provide direct surveillance, adds Zuccaro. Nor can pilots obtain real-time weather services.

But that will change. Under a May 2006 Memorandum of Agreement (MOA) with the FAA, the Gulf region, Louisville, Ky., Juneau, Alaska, and Philadelphia were selected to participate in "Segment One" ADS-B implementation. This involves initial installation of ground infrastructure that will support the system--and for which the FAA requested $80 million in the Fiscal 2007 budget.

Implementation committees are now assessing ground infrastructure and equipment and fielding of services. Zuccaro says the first platform site, conducted this month, was successful. Certain oil platforms will house ADS-B receivers. Under ADS-B , satellites provide GPS information to the aircraft avionics, which emit the data to ground-based receivers. Then these would couple the information to shore--in this case, Houston Center controller automation platforms. Eventually, weather-sensing devices will be installed on the platforms.

By the end of 2010, FAA expects to have the ADS-B system tested and operationally acceptable for the NAS, with Houston Center providing services in the Gulf region. By 2013, all of the U.S. is scheduled to be covered with ground infrastructure.

The avionics installation will take longer, says Capezzuto, because we will be dealing with a larger aircraft population--20,000 or more general aircraft and about 35,000 transport aircraft, all of which will have to be retro- or forward-fitted with ADS-B equipment (AW&ST Feb. 17, 2006, p. 52).

Subsequent program phases include HAI members voluntarily equipping aircraft with traffic display capability so pilots can self-separate from other aircraft. This ability, according to Capezzuto, leads to shared pilot-controller situational awareness, and therefore enhanced safety.

"The Gulf is probably the perfect implementation area for ADS-B. It's a clean slate. There's nothing down there," says Zuccaro. "Segment One is 'the true test' of ADS-B implementation in an area without support or infrastructure."

The Gulf of Mexico's area of coverage will extend to 25 deg. N. Lat. in the Gulf (see map). In about 5-10 years, it will extend to 26 deg. N. Lat., based on planned expansion of oil platform infrastructure, according to the FAA.

Zuccaro says that in the next decade activities in the gulf are expected to grow 25%, move into deeper water and extend toward the Florida coastline.

"This is a win-win situation for all stakeholders," says Capezzuto. "The operators not only get [ADS-B] service, [they also] provide FAA with data required to validate the service and get it certified."

ADS-B's precision is also seen as a way to improve capacity in the future NAS via streamlining separation standards. "Today's established standards--3 mi. to terminal and 5 mi. en route--are based on the traditional radars' infrastructure," says Capezzuto. "The reality is, everyone puts a little buffer around it . . . and the FAA is interested in removing those buffers. Its hope is to project forward as air traffic increases and start looking at reducing those separation standards," he says.

To accomplish that wouldn't require more air traffic controllers, Capezzuto says. Rather, ADS-B would increase situational awareness of pilots by putting information in the cockpit, and controllers can then shift more toward air traffic management function.

The nation's more crowded airspace of the future could and would be kept safe under current infrastructure, but ATC would not be able to accommodate traffic at the times airlines want to fly, says Capezzuto. And the Next-Gen system must be able to handle future growth.

Under the MOA, the FAA will fund, install and operate the ADS-B network in the gulf. The helicopter industry and platform operators will prove platform space for installation of system equipment. HAI's efforts in a 20-year period to provide transportation of personnel to the platform, along with power and telecommunications as well as the voluntary installation of the avionics equipment for their IFR fleet, is valued at more than $100 million.

The minimum equipment required on the aircraft would be a transmitter, which would allow ATC to "see" and control the aircraft. The next upgrade, the display unit, would open up available uplink data so pilots can visually monitor traffic on the panel and self-separate. When that will occur will depend on the completion of the evaluation of transmitters and equipment operation.

Louisville, Philadelphia and Juneau were selected for Segment One because they all pose a unique set of problems. Each Tracon or Center has different computer interfaces with the NAS, which would require the FAA to build and test new infrastructure to interface with various automation platforms.

The challenge at Philadelphia, a UPS hub, is in validating ADS-B within terminal airspace that has a high RF interference environment. The New York-Philadelphia region is rife with various types of radars and other devices that emit RF energy, says Capezzuto.

Louisville, UPS's main hub, is a "petri dish" in which the FAA will validate separation standards involving a large number of UPS aircraft operating within certain timeframes, similar to most major hubs.

Juneau offers the challenge of a mixture of equipment including multiple types of transponder devices, not to mention robust mountainous areas where radars are especially challenged.

Some general aviation sectors are exercising caution in fully embracing ADS-B. The National Business Aviation Assn. is in support of the system, but wants the FAA to set a firm plan for certification of equipment. The Aircraft Owners and Pilots Assn. also supports implementation of ADS-B, but is concerned about the affordability of equipment.

Embedded experts: Fix code bugs or cost lives

Rick Merritt
(04/10/2006 10:00 AM EDT)
URL: http://www.eetimes.com/showArticle.jhtml?articleID=184429901

San Jose, Calif. — The Therac 25 was supposed to save lives by zapping tumors with targeted blasts of radiation. Instead, the device delivered massive overdoses that killed three patients and injured several others because of software glitches by a lone programmer whose code was never properly inspected and tested.

The Therac 25 was just one of dozens of examples cited by speakers at last week's Embedded Systems Conference here to drive home a point: People's lives as well as millions of dollars in investments often depend on software engineering, but too many projects fail for lack of good programming discipline and management support.

And the problems may get worse as programmers face the additional challenges of handling multicore devices. Indeed, an annual survey of several thousand embedded engineers polled recently by EE Times and Embedded Systems Design magazine showed that the need for better software debug tools is a major concern, with test and debug taking up more time than any step in a project development.

"This is the only industry left where we can ship products with known defects and not get sued. How long do you think that will last?" asked Jack Ganssle, a consultant and author who presented a class on lessons learned from embedded-software disasters.

"We aren't afraid of software, but we need to be, because one wrong bit out of 100 million can cause people to die," said Ganssle, who said he has worked on more than 100 embedded projects, including the White House security system.

"As embedded systems grow in complexity, the software becomes an ever more important piece. Right now, 50 percent of our DSP spending is on the software side," said Gerald McGuire, general manager of the DSP group at Analog Devices Inc. (Norwood, Mass.), which employs more than 200 software engineers.

As software grows in importance, it is not necessarily becoming more reliable. According to one report, 80 percent of software projects fail because they are over budget, late, missing key features or a combination of factors. Another report suggests that large software systems of more than a million lines of code may have as many as 20,000 errors, 1,800 of them still unresolved after a year.

"We can't get rid of faults," said Lorenzo Fasanelli, a senior embedded-software specialist for Ericsson Labs in Italy. But engineers can speak up about faults, learn from them and rewrite code to proactively find and minimize them, he added.

"We cannot advance the state of the art without studying failure," said Kim Fowler, an author and systems architect who delivered an ESC talk called "Fantastic Failures."

War stories

There are plenty of failures from which to learn. Ganssle cited another radiation system that killed 28 people in a series of tests in Panama in May 2001 before the U.S. Food and Drug Administration shut down the company that made it. Inspections of software after the crash of a U.S. Army Chinook helicopter revealed 500 errors, including 50 critical ones, in just the first 17 percent of code tested.

"Why did they inspect software only after people died?" asked Ganssle, who said a court case on the crash is still in litigation.

Some pacemakers have stimulated hearts to beat at rates of 190 beats a minute, prompting companies to provide software updates delivered to the implanted devices using capacitive coupling. Unfortunately, other pacemaker patients have had their devices inadvertently reprogrammed when walking through metal detectors. In 2003, the pacemaker of a woman in Japan was accidentally reprogrammed by her rice cooker.

A Thai politician had to have police bust the windows on his BMW 745i after a software glitch caused the electric doors and windows to freeze in a locked state, trapping him inside. Ford recalled some models of its 2000 Explorer because lights and wipers would not work in some circumstances. And the 2004 Pontiac Grand Prix faced a software recall for a leap-year fault.

Part of the problem lies in poor engineering discipline, such as a lack of adequate testing, improper error handling and inherently sloppy languages. Management issues, including a demand for ever more features in compressed schedules, and tight budgets are also to blame.

"We need to test everything up front and integrate testing into the design process. Then we need to believe the data we get when we do test," said Ganssle.

When engineers make a change because of a failed test, they often neglect to go back to the beginning of the test suite to make sure the changes haven't introduced new errors, said Dave Stewart, chief technology officer of Embedded Research Solutions Inc. (Annapolis, Md.) in an ESC session on the top problems in real-time software design.

Engineers need to create error-handling modes in their programs, and the modes must exist as just another state for their systems and treat errors as one of many possible inputs, Stewart added.

Fasanelli of Ericsson gave a detailed prescription for how to find, report and minimize faults in embedded software. Programmers must make it a standard practice to classify all inputs and states of a system and note any illegal inputs or edge states, whether or not they affect a program's ability to run, he said.

In addition, programs should routinely track and report their own performance, idle times and memory integrity. Creating such debug features may affect a system's cost, but that will be offset by reduced maintenance, Fasanelli said.

"Exception handling is particularly hard to test because it's hard to generate the exceptions. These tend to be the most poorly tested parts of code," said Ganssle.

Riding a rough C
Ironically, today's most popular programming languages, C and C++, are among the most error prone. That's because C compilers have plenty of latitude to compile and link — without providing any diagnostics — code that can produce serious run-time errors, especially when ported to a new processor.

"There are a lot of little goodies in C that programmers are not fully aware of," said Dan Saks, an author who has documented nearly 40 "gotchas" he presented in a session at ESC. "The lesson is to understand what you can assume and what you can't."

For instance, C doesn't define the number of bits in a byte, though header files can query a processor and adjust the program if the CPU does not support the usual 8-bit byte. Likewise, the common practice of subtracting pointers can result in creating a character of an undefined type, said Saks, president of consulting firm Saks & Associates (Springfield, Ohio).

"The use of C is really criminal," said Ganssle. "C will compile a telephone directory, practically. I guess we use C because we think debugging is fun."

For every 1,000 lines of code, C can generate 500 errors in a worst case, 167 errors on average or 12.5 mistakes for automatically generated code, said Ganssle. That compares with 50 errors worst case, 25 average and 4.8 for auto-generated code using the Ada language, he said. The Spark language emerging from Europe is even better, generating just four errors on average per 1,000 lines of code, he claimed.

C is used in half the development projects done today, according to the results from the 2006 Embedded Market Survey, the 14th such annual poll of engineers working on embedded-design projects. The survey showed that the C++ programming language is gaining in acceptance, however.

ESD editor-in-chief Jim Turley, who presented the annual embedded-market survey results last week, said fully half of the respondents cited C as their primary programming language. Nonetheless, support for C was down from the 2005 survey, albeit only by 3 percent. By contrast, the C++ language gained this year, coming in at 28 percent, and respondents predicted a 4 percent increase in C++ adoption next year.

The survey showed that relatively few engineers — just a few percent — use Java. Matlab, LabView and UML are used about as frequently for embedded projects, although Java garners more attention because of its use in the graphical user interface portion of many systems.

"Almost every language is losing ground to C++," said Turley, who suggested that many design teams have evaluated Java but found it lacking in performance and development tools.

Asked about tool selection, 53 percent of embedded engineers said the quality of the debugger was their most important criterion in choosing a development suite. Only about 13 percent said open-source content is an important selection criterion.

When it comes to operating systems, however, open-source OSes such as Linux are gaining significant support. Fully 20 percent of respondents said they use an open-source OS, with many design teams relying on a commercially distributed form of Linux.

Turley said that one reading of the operating system responses would suggest Linux is gaining support quickly, since "just five years ago the very term 'open source' didn't mean anything." However, other survey questions showed that a declining number of respondents, compared with the 2005 survey, are considering Linux, prompting Turley to conclude that "that the charm of Linux has cooled."

Management must take its share of the blame for the software situation. "Often we are in an overconstrained situation. We have too many features to deliver in too short a time frame," said Fowler at his "Fantastic Failures" session. "The problem is, adding features requires lots of regression testing. The thing to do is ask whether the feature can be saved for the next upgrade — [otherwise] you are just setting yourself up for failure.

"We as engineers need to come up with persuasive ways to warn management" by relating stories of past failures or the implications of long feature lists and tight budgets and schedules, he added.

Tired engineers were a factor in several aerospace disasters in which programmers worked 60- to 80-hour weeks in the months before a launch, Ganssle said.

Skimpy budgeting is another factor in failures, as seen most clearly in civil-engineering disasters. In 1940, officials found a way to build the Tacoma Narrows Bridge for half an initial estimate and did so, but the bridge famously collapsed in high winds after just four months in service. Likewise, the MGM Grand Hotel in Las Vegas saved $200,000 by not using sprinklers but paid out more than $200 million in court and rebuilding costs after a disastrous fire, Ganssle said.

In the confines of a software project, "spending $2,000 on tools might save you $100,000 in programming effort," said Stewart of Embedded Research Solutions.

Multicore effort

Activity on the ESC show floor demonstrated that embedded-software tool vendors are increasingly dealing with issues arising from multicore and multithreading architectures. Both Mentor Graphics Corp. and Green Hills Software Inc. said they have added support for the MIPS32 34K multithreading processor core family, for example. Green Hills, which announced its support for Texas Instruments Inc.'s DaVinci architecture earlier this year, rolled out MIPS32 34K support with its Multi development tools. Green Hills also added support for the single-core MIPS32 24KE family.

QNX Software Systems Ltd. last week announced support for DaVinci, which combines ARM and DSP cores in order to support digital audio and video applications. To help maximize performance, QNX will support an interface layer between the cores based on TI's DSP/BIOS Link technology. This makes it possible to offload media processing to the DSP, freeing up the ARM core for other applications.

The Ottawa company launched a multicore initiative last fall, said Dave Curley, vice president of marketing at QNX. Using the company's Neutrino real-time operating system (RTOS) and the

Momentics IDE, this initiative supports asymmetric, symmetric and bound multiprocessing (BMP). The latter capability, Curley said, is unique, and it lets programmers assign threads to a given processor.

"One of the challenges of multicore is to understand how to work in a multithreaded environment," Curley said. "With BMP, you can tie legacy code to one processor without a rewrite."

QNX's Multi-Core Expedite Program, announced last week, provides 120-day free evaluations of the QNX Neutrino multicore technology development kit and dual-core Intel Pentium processor extreme edition.

Virtutech Inc., a provider of virtual platforms for early software development, claimed last week to have the first simulation model of the Freescale Semiconductor Inc. MPC8641D dual-core processor. Wind River is using this simulation model in its engineering department to develop multicore versions of its own products.

"Multicore is a complete revolution for software people," said Paul McLellan, vice president of marketing at Virtutech (San Jose). "You turn off interrupts for one core, but another core carries on." He noted that Virtutech's Simics environment lets users freeze the entire system when a breakpoint is hit, unlike real hardware, where processors would take some period of time to shut down.

ARM Ltd. said in a press release that its new RealView 3.0 development suite adds a debug engine with "multicore DSP awareness." Bryn Perry, general manager for development systems at ARM, clarified that ARM has the "potential" to support DSP debugging. ARM is working with DSP processor vendors but has not yet announced support for a specific digital signal processor Perry said.

As of today, RealView can connect ARM and DSP debuggers and synchronize them. But some customers want a single debug view of the entire system, and for that ARM needs to partner with DSP vendors, Perry noted.

The MIPS32 34K family is technically not a multicore solution, but it's touted as a multitasking architecture that can provide the benefits of multicore. Mentor Graphics announced last week that its Nucleus RTOS and Eclipse-based Edge tool suite now support that family. In the 34K device, one instance of the Nucleus Plus RTOS runs in each of two virtual processing elements (VPEs). The Nucleus Plus on the first VPE initializes the second and controls all peripheral resources.

— Additional reporting by Richard Goering and David Lammers

http://www.g2zero.com/2006/07/notable_entries_from_the_softw_1.html

July 06, 2006

Entries from the Software Failure Hall of Shame, Part 1

If your organization is lucky and competent enough to have a popular or high profile software project or offering, it may be only a latent defect or unknown security vulnerability away from global notoriety. There are hundreds of examples of software-related failures, some minor and some catastrophic and resulting in the loss of millions of dollars and even deaths.

The point is that in hindsight, organizations responsible for buggy software projects would have preferred to invest in improved quality tools and processes rather than face the backlash, market loss, and business disruption caused by the defects.

Examples of some of the more notable software failures from a wide variety of industries include:

- **The Toyota Prius engine management flaw.** In October of 2005, the Toyota Motor Company voluntarily recalled 75,000 of its hybrid vehicles because a software glitch that may have shut down the engine. Given the high price of gasoline at the time and the rising interest from consumers in hybrid vehicles, the recall could have been a major blow to the manufacturer. However, due to Toyotas quick response, most consumers never experienced the flaw, and while the company may have suffered slightly from the negative publicity, it managed to avoid having its defect become permanently associated with the vehicle line or with hybrid safety.

- **Failing Sony televisions.** As in the Toyota example, Sony wasn't sure how many of its 400,000 LCD and rear-projection TVs would show signs of a software defect, but the company decided it had to upgrade each of the sets. The software bug and remediation effort, reported in February of 2006, meant that in many cases Sony would have to send a technician to manually update the TVs. By proactively addressing the issue, Sony has so far managed to avoid intense media scrutiny or customer backlash.

- **Incredibly cheap US Airways tickets.** In April of 2005, the ticketing system for US Airways issued incorrect fares for several hours. Some tickets were offered for under $2. The system was quickly fixed, but the airline felt compelled to honor the drastically reduced fares. While this may have been the right decision from a public relations standpoint, the loss of revenue certainly didn't help the company as it struggled to work its way out of bankruptcy.

- **Numerous FAA issues.** In November 2005, the Federal Aviation Administration rolled out software patches to Boston and other airports to improve ground-based radar systems. The software it was replacing had a defect that didn't allow the system to see two planes approaching each other on the runways. In another example, a software failure from a backup system that was designed to handle planned server downtime resulted in a three-hour loss of air traffic control communication between over 800 planes, with five near misses.

- **The Marines' Osprey crashes.** In December 2000, the US Marine Corps' new hybrid plane-helicopter, known as the V-22 Osprey, crashed, killing four Marines. The accident was the result of a failure in a hydraulic line, compounded by a software error. The report on the accident stated that the software defect caused “rapid and significant changes to prop-rotor pitch," which were compounded as the pilot continued to reset the system as trained, resulting in an increasingly unstable aircraft. While the Osprey program continues, this and other crashes leads many to believe that the V-22 is an inherently flawed aircraft.

- **The Mars Climate Orbiter loss.** In 1999, NASA lost contact with one of its well-publicized unmanned spacecraft, the Mars Orbiter. During the subsequent investigation into its loss, many issues that lead to its demise were uncovered. However, the final cause was later determined to be a result of a problem within a software application that was responsible for converting differing units of measurement. Specifically, “The 'root cause' of the loss of the spacecraft was the failed translation of English units into metric units in a segment of ground-based, navigation-related mission software.” Other recent successes, such as the longer than expected life of the two new Martian robot rovers, have pushed the Orbiter loss to the periphery, although you can bet that NASA software engineers will always check their conversion code for all future spacecraft.

- **The destruction of an Ariane 5 rocket.** In 1996, a new version of the Ariane rocket exploded on its maiden flight. This was exactly the opposite outcome that the European rocket consortium responsible for the rocket had hoped for, as its fiery demise was and is the type of high profile disaster story that the media latches onto. The panel that investigated the explosion’s cause determined that a faulty computer program was to blame. The loss was attributed to software that shut down because of an internal variable exceeding a limit imposed by the underlying code.

- **The USS Yorktown ends up adrift.** With all the threats to modern military ships, from missiles to mines to more exotic weapons, the least appealing way to have a ship disabled would be an internal software glitch. But that is just what happened to a prototype US Navy ship in the fall of 1997. When attempting to adjust a valve setting, a sailor entered a zero into a database field. The result? The ship was out of action for two hours. The fault was traced to an internal system, running on 27 remote terminals with Windows NT front ends, which did not have the proper data field level validation. For the Navy and the software company that wrote the computer code, the embarrassment was tempered only by the fact that the error occurred during testing, not during a military engagement.

  Interesting, this, like many other software failures, often spawns a variety of damaging urban legends, in this case impacting the reputation of Microsoft. A common version of the story among IT professionals is that a Windows bug disabled a Navy ship. While Microsoft has been at the center of many reports and discussion of software quality, in this instance, a contractor’s sloppy programming, not its software, was to blame.

- **The WMF bug.** There are many instances in which Microsoft software has failed; particularly security vulnerabilities that have given the company a reputation for buggy code. The ways the vendor has reacted to it real and reported software defects in its high profile flagship products like Windows and Office illustrate how the issue of responding to software defects is now a major challenge. In late 2005, a security vulnerability in a ubiquitous component of Windows became widely discussed in the trade press and technical forum and blog world. Since the code was present even in up-to-date products and the potential for malicious exploitation was believed to be high, the desire for a quick patch was strong.

When the official patch was seen as taking too long to arrive, a non-Microsoft developer took it upon himself to write, and then release his own patch. The non-official patch garnered major IT industry publicity when some security firms suggested companies test and then install it in lieu of the official remedy.

What is so intriguing about this event is that the Microsoft response was not slow, but due to the global spread of information and exploit code, many felt that waiting two weeks was too long. Now, not only the defects, but the reaction to a software problem, requires serious attention by software providers.

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Posted by Admin on July 6, 2006 10:03 AM | Permalink

Embedded.com

Hardware-in-the-Loop Simulation

By Martin Gomez, Courtesy of Embedded Systems Design
Nov 30 2001 (8:21 AM)
URL: http://www.embedded.com/showArticle.jhtml?articleID=15201692

Expensive, fragile, and unique systems are hard to test. You know the first releases of the software embedded in them will fail, but how? Hardware-in-the-loop simulation can substantially lower the cost of finding out.

Perhaps you've encountered a situation similar to this: you've created a system using an embedded computer, and you've started testing it by feeding it artificial inputs. If the inputs were analog signals, perhaps you wired a potentiometer, or a power supply, into the inputs to allow you to enter any value you like. While varying the inputs, you measured the outputs, to determine if they were appropriate for the present value of the input.

So far, this is not a particularly challenging scenario for an embedded software engineer, even if armed only with a voltmeter and a power supply. Suppose, however, that the embedded system you're testing is a bit more sophisticated. There are plenty of systems, after all, in which the output is not simply a function of the present inputs, but is instead a function of the present inputs and some combination of past inputs. Equally common are systems in which the outputs are both numerous and each a function of several inputs.

How do you conduct meaningful tests of such a system? In many cases, you can put breakpoints into the software so that it pauses after each cycle through the calculations. You can compare the actual outputs against the value you expected, given all the present and past inputs. You're still faced with the challenge, however, of giving it combinations of inputs that make sense, both relative to one another, and relative to their past values. After all, of all the possible combinations of inputs, only some are "legal." How do you generate those legal test vectors?

You may have additional challenges. How do the digital delays in your software affect the operation of the actual system? You can't easily measure such effects if you insert breakpoints with a debugger. To further complicate things, perhaps your system includes a peripheral, sensor, or actuator, which itself has an embedded computer in it. Can you stop it to measure the output while it's stationary? Probably not. It's part of the "world" as far as your embedded system is concerned, and you'll have to deal with it in real time.

An example

Many airplanes, missiles, and unmanned aerial vehicles have sophisticated autopilots. In most modern applications, autopilots are implemented in software. The inputs to a typical autopilot might be the airplane's current airspeed, the desired or commanded airspeed, the pitch angle (the angle of the nose above or below the horizontal), normal acceleration (commonly known as "g-force"), and pitch rate (the angular velocity at which the nose is rising or falling). The output (simplistically) might be the deflection of the elevator (the flap-like surface that pushes up or down on the tail). The control law written into the software is designed (in this example) to hold the airspeed at a desired value. In other words, if the airplane is flying too slowly, the autopilot will try to lower the nose by deflecting the elevator downwards, and vice versa. Note that the laws of physics will enforce certain relationships between airspeed, pitch rate, and so on. For example, pitch rate is the time derivative of pitch angle, pitch rate times airspeed equals normal acceleration, and so on.

The relationship between these five inputs and the output is non-trivial. For one thing, the controls engineer is very likely to include an integrator into the control law. This means that if the actual airspeed differs from the desired airspeed, the difference is integrated over time, and a deflection proportional to the integral is applied to the elevator output. This complicates testing. If you turn the system on in the lab with any fixed value of the airspeed other than the commanded one, the elevator will slowly ramp up or down until it reaches the end of its travel. Therefore, you cannot easily measure the elevator deflection and compare it to what you thought it ought to be, because it's constantly changing.

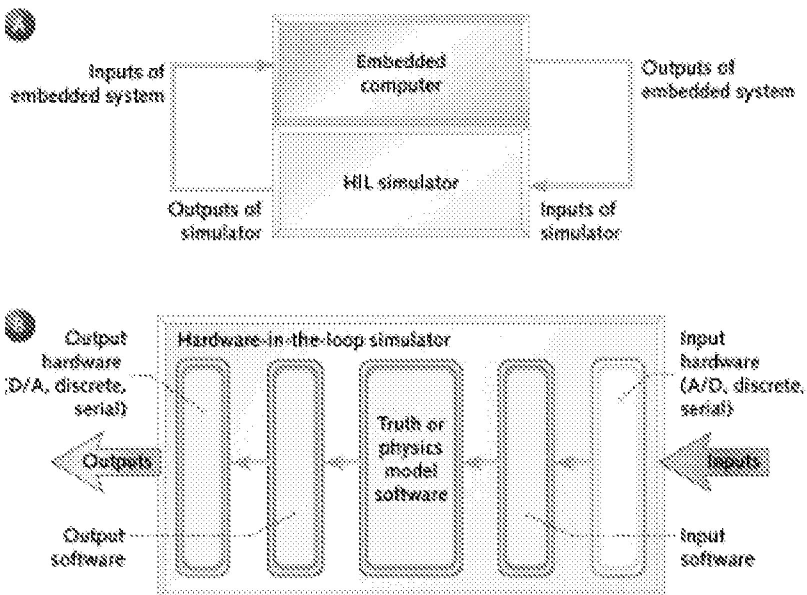

Figure 1
a) Block diagram of embedded system connected to a hardware- in-the-loop simulator;
b) Components of a simple hardware-in-the-loop simulator

A powerful tool often used in this situation is a hardware-in-the-loop simulator (HILS). A HILS is a device that fools your embedded system into thinking that it's operating with real-world inputs and outputs, in real-time. In the autopilot example, it fools the aircraft into thinking it's flying. Figure 1a shows a simple block diagram of an embedded system being tested using a HILS. Figure 1b shows the components of a simple HILS.

The outputs of the embedded system-the elevator deflection, to continue the previous example-are measured by the simulator's electronics. Let's postpone discussion of how that's done, because it's a major architectural decision in the design of a HILS. For now, let's assume that the simulator simply measures the voltage that the autopilot computer would send to the elevator servo, if it were in actual operation.

The software running on the HILS calculates what the airplane's reaction to that elevator deflection would be. It must therefore include a physics model (also known as a "truth model"), which "knows" the airplane's mass, moment of inertia, and aerodynamic characteristics, as well as the equations of motion. The results of that calculation-the new value of the airspeed, pitch, pitch rate, and normal acceleration-are turned into analog signals, and fed back to the embedded computer. I'm using analog signals in this example, but there is no reason why they can't be serial data streams. Indeed, many aerospace applications use MIL-1553, ARINC-429, RS-422, or other protocols for box-to-box connections. Figure 2 shows the block diagram of the resulting system. Note that the commanded airspeed is a user input; it is not driven by the simulator. When testing the autopilot, the test engineer would drive this input to "tell the autopilot what to do," and use the simulator's data logging features to determine how well it did it.

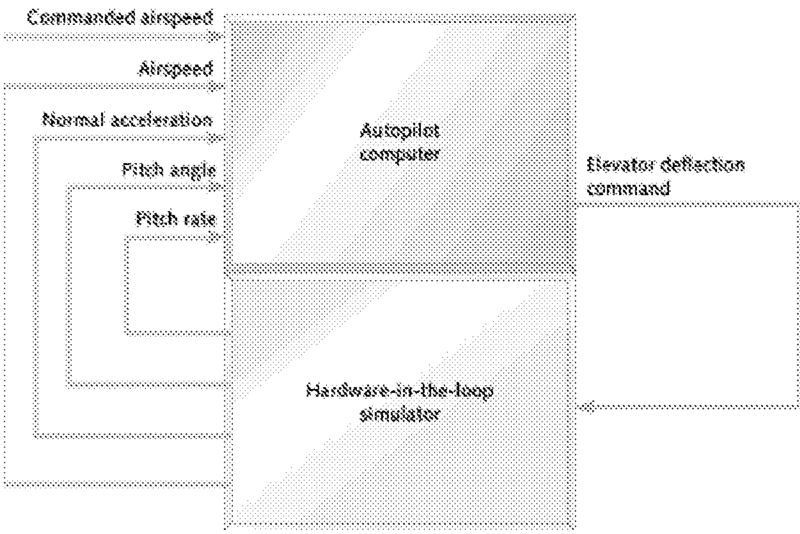

Figure 2 Autopilot being tested using a HILS

Why "hardware-in-the-loop"?

Now that we have PCs on every engineer's desktop, simulation has become a common tool. Many engineers will either write a custom program to simulate the behavior of their product, or use an off-the-shelf tool. For instance, the controls engineer who designs the autopilot's control algorithm will very likely simulate it in MATLAB, or with a custom C program running much faster than the real system on his PC. Similarly, many embedded software engineers first test the embedded code by running a reasonable facsimile of it on a desktop PC before porting it to the final 8-bit microcontroller (or whatever). They "fake" the embedded system's I/O and environment with custom code executing on their PC. There are three key differences between such a simulation and a HILS. First, the output of simulations are just squiggly lines plotted on a graph, not hardware signals. Second, the HILS runs in real time, and third, in a HILS the embedded software runs on the "real" hardware that you will eventually build into your product, not a workstation.

Digitizing and iteration rate

An experienced embedded software engineer, upon looking at Figure 2, will immediately jump to the correct conclusion: the HILS software has to iterate faster than the system under test, and the analog signals have to be digitized with a higher resolution than the system under test uses. How much faster? Hint: it's not just twice as fast. That myth is due to an incomplete reading of the sampling theorem. The "twice the rate of the highest frequency component" rule requires that you take each sample and multiply it by a scaled and shifted sin(wt)/wt function.1 In practice, try iterating five to 10 times as fast as the embedded system iterates. Given the fast computers you can buy nowadays, it's seldom worth doing all the extra math required by the sampling theorem. There are exceptions to this, but fortunately, I've never had to deal with one. Your controls engineer will doubtless express strong opinions on the subject.

Implementation

Now that we understand what a HILS is, and why you might need one, how do you make one? Unfortunately, "make" is the key word-I've never seen an off-the-shelf HILS for sale, although as we'll see, a couple of products come close. In the mid '90s, I led a team that designed a HILS from scratch for our company's internal use. It cost slightly over $100,000 to design and build the first unit. It had approximately 100 inputs and outputs and could iterate a fairly sophisticated model at 70Hz. The second identical unit cost about $25,000 to build. This was considered a bargain compared to the multi-million dollar unmanned aerial vehicles (UAVs) we were developing-if the HILS prevented the crash of just one UAV, the company would get its money's worth. There was another, even more valuable benefit: a HILS allows software to be developed and tested without waiting for all of the actual hardware to be built (or in this case, built and flown).

Start with the signal list of your embedded product. This is a list that includes all the inputs and outputs that the embedded system has and describes their range, resolution, and sample rate. (As an aside, a signal list is not a bad place to start any embedded project, since it forces the software and hardware folks to have a long, sincere chat.) Table 1 is a typical example.

Table 1 Signal list for the autopilot example

Signal Name	Range (V)	Range (physical units)	Resolution (units)	Sample Rate (Hz)	Input or Output
Airspeed	0-10	0-200 (m/s)	0.1 m/s	5	Input
Commanded _airspeed	0-10	0-250 (m/s)	0.25 m/s	10	Input
Pitch_rate	0-10	-2-2 (rad/s)	0.004 rad/s	10	Input
Pitch	0-10	0-2p (rad)	0.006 rad	10	Input
Norm_accel	0-10	-10-10 (g)	0.02 g	10	Input
Elev_cmd	0-5	-25-25 (deg)	0.05 deg	10	Output

Table 2 Signal list for a HILS to test the autopilot

Signal Name	Range (V)	Range (physical units)	Resolution (units)	Sample Rate (Hz)	Input or Output
Airspeed	0-10	0-250 (m/s)	0.06 m/s	50	Output
Commanded _airspeed	0-10	0-300 (m/s)	0.08 m/s	50	Output
Pitch_rate	0-10	-2.5-2.5 (rad/s)	0.001 rad/s	50	Output
Pitch	0-10	0-2p (rad)	0.002 rad	50	Output
Norm_accel	0-10	-15-15 (g)	0.008 g	50	Output
Elev_cmd	0-5	-30-30 (deg)	0.02 deg	50	Input

The HILS's signal list should end up being a "mirror image" of our embedded system's signal list. Table 2 shows that. Note that the simulator's inputs and outputs have a slightly wider range than the autopilot's outputs and inputs, and that they have better resolution.

The choice of hardware platform is dictated by a host of factors. Is there legacy software you want to reuse? For instance, do you already have a simulation up and running that simply lacks the hardware I/O? Are there ruggedness or environmental issues? How much I/O is available? By and large, a HILS is a laboratory device, so environmentals are often not a driving factor. These tools are usually operated by knowledgeable staff-the developers of the embedded system's hardware and software-so ease of use is also a secondary concern.

I've seen simulators built on PC, VMEBus, and proprietary platforms. Each has its advantages; to recommend one here would be meaningless. As with many such decisions, logistical, political, and administrative factors carry at least as much weight as the technical issues, and these vary from one organization to the next.

Two somewhat off-the-shelf platforms are worth mentioning: dSpace and National Instruments' LabView. dSpace (www.dSpace.de) provides what is essentially a PC chassis with one or more of Texas Instruments' DSPs plugged into the backplane. The PC runs the user interface and data logging code, and the DSP runs your simulation and the analog I/O. If you need to run a very fast hardware-in-the-loop simulation, the number-crunching power of a DSP will fit the bill. There are plenty of applications that have to iterate at a kilohertz or more. A Pentium, PowerPC, or other general-purpose processor is hard-pressed to compete with a dedicated DSP at such rates. dSpace has connections to MATLAB and Simulink, which your controls engineer will appreciate. These connections allow a simulation to be written in MATLAB on the PC and then run in real time on the DSP with much less hand-coding than if you wrote it from scratch in C.

LabView (www.ni.com) is a popular front-end for a large family of analog and digital I/O boards. Using a graphical user interface, you can build virtual instruments, and then connect them to simulate the world that your device-under-test lives in.

I refer to dSpace and LabView as "somewhat off-the-shelf" because you still have to customize them to your embedded system's I/O, and you still have to write the simulation code, albeit at a higher level than if you were doing it strictly in C.

Usability

One issue to consider, regardless of the platform, is reusability. Yours may not be the last project to use a HILS. Perhaps many of the requirements are common across projects. All will require analog I/O, discrete I/O, a fast processor, and so on. Why not try to make the common parts, well, common? In my HILS, this was taken a step further. The I/O portions of the code, as well as the interprocess communication mechanism, were common across all versions of the simulator, and were borrowed from the UAV flight computer's software, which was, in turn, shared by the ground station software. The same HILS was used to test four vastly different UAVs, with only minor changes to its software.

The details of reusability are best left to another article, but I must stress one key element: I/O drives a simulator design. No matter what you're simulating and testing, you will have to read the device-under-test's outputs and drive its inputs. They won't be the same from project to project, so your simulator's design should be reconfigurable. Consider designing the simulator such that the mapping of hardware channels to internal software variables is configurable. For example, on our current project, channel 3 of the HILS's D/A converter might drive the embedded system's airspeed input. On the next project, it might drive a pressure input, or a temperature input, and so on. It would be nice, therefore, if the I/O portions of the simulator's code were table-driven, so that you didn't have to recode them. To extend this wish list, remember that the calibration of the HILS's I/O will vary from project to project too. On today's project, the airspeed signal might be mapped as follows: 1V = 0 knots and 8V = 150 knots. Next time, you may have to test a system with a very different calibration. Again, this can be table-driven. If you do this thoroughly, all you need to do to adapt the HILS's I/O to the next project is change the table. If your simulator hardware also allows itself to be reconfigured (SBS/GreenSpring's IndustryPacks work wonders for this), your simulator will earn its keep across many projects.

Architecture

When designing a hardware-in-the-loop simulator, an important question is "how much hardware do we put in the loop?" At a minimum, the embedded system's computer has to be in the loop, since its software is being tested. In many cases, however, that will not be enough. As with many design decisions in our profession, this one requires hardware versus software trade-offs. If you want the embedded software to see real inputs, to "think" that it's operating in the real world, and to have the world react properly to its outputs, you have to either include or simulate any hardware that stands between the embedded system and that world.

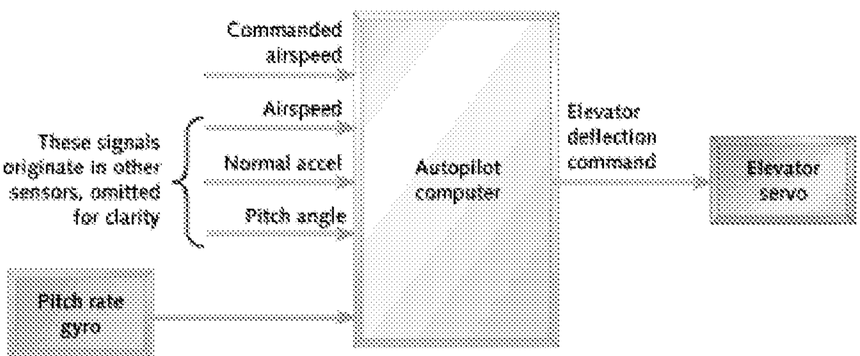

Figure 3 Block diagram of simple autopilot under test

This is best illustrated by continuing with our autopilot example. Let us consider what other components are built into our autopilot system in addition to the computer that runs our embedded software. In Figure 3, we've expanded the previous block diagram by including a sensor (the pitch rate gyro) and an actuator (the elevator servo). We'll omit the other sensors for simplicity.

The pitch rate gyro consists of a sensor that measures the aircraft's rate of rotation about one axis, in this case the pitch axis. How it works is not relevant to this discussion, but let's assume that the gyro's behavior can be characterized as follows:

- It has no noise in the frequency band of interest.
- Its output is mostly linear-it produces a voltage proportional to the pitch rate.

- Its only nonlinearity is a small bias-the output is a small non-zero number when the actual pitch rate is zero.
- To compensate for the bias (which would cause an autopilot to perpetually try to correct a non-existent rotation), the manufacturer has included a high-pass filter. This allows the pitch rate due to turbulence or maneuvers to pass, but blocks the DC bias.
- Its bandwidth is more than enough to sense the rotation of our hypothetical airplane.

The elevator servo is a bit more complicated. It consists of a motor, which uses cables and pulleys to deflect the elevator up and down. It also has a feedback mechanism, consisting of a potentiometer that tells a servo amplifier the elevator's current position. The servo amplifier will command the motor to deflect the elevator until it's at the position the autopilot commands. Let's assume that the elevator servo can be characterized as follows (and yes, all of these assumptions may stretch your imagination a bit, but bear with me-this article is about HILS design, not autopilot design):

- It is mostly linear-it produces a deflection proportional to the input voltage.
- It has a bit of a deadband-in other words, it doesn't actually move until the commanded deflection differs from the present deflection by a small amount.
- It has a finite slew rate-it can only move so many degrees per second.
- It has a finite small-signal bandwidth-if asked to move back and forth a degree or so, it can only do it so fast.
- It has a great deal of torque, so much so that there's no question of it being capable of deflecting the elevator under any conceivable load.

Our hypothetical controls engineer does not think he can write a model of the elevator servo with enough fidelity to do the job. Even if he could, it has enough non-linear behavior (finite slew rate, deadband) that it would take quite a bit of effort to model it in software. He does think, however, that the gyro can be adequately modeled. Depending on how much the servo costs, it might then make sense to include an actual servo in the hardware-in-the-loop simulation, and to model the gyro in software. Figure 4 shows the block diagram of this configuration.

Figure 4 Block diagram of a mix of real and simulated components

View full size image

Before you scoff at the notion of including expensive hardware in a software simulation, consider the relative costs. We're assuming that this HILS is a tool, not a product, so we're only going to make a handful of them-we're not considering mass production. Thus the labor to implement a servo model in software might cost more than simply including the servo hardware in the simulation. (This philosophy is admittedly biased by my career in the U.S. When I worked in Argentina, salaries were very low and hardware was frightfully expensive, so the decision there might have been different.)

As shown in Figure 4, the HILS must now read the deflection of the servo from the feedback pot, rather than from the autopilot computer's output, as it did in Figure 2. This allows the servo's hardware to display all of the characteristics we're interested in: slew rate, bandwidth, deadband, and so on.

However, because we chose not to incorporate an actual gyro into the simulation, we must include software to model one. Not only is this a fairly easy device to model (given the simplifying assumptions we made about its behavior), but it's a lot cheaper than the alternative. Remember, the gyro senses rotation, so to physically stimulate it would require that you purchase or build a device that will rotate the gyro under command from your HILS. You can buy such a machine-known as a rate table or gimbal-from a number of companies, for a small fortune.

A portion of the software, therefore, will be devoted to turning the simulated airplane's pitch rate (the "truth model") into a sensor output, given the behavior we've assumed for the gyro. It may be wise to make this a modular block of code, since you can then use the simulator to test various sensors, without changing the simulation code itself. The HILS would then have a block of software for every sensor (and, if we choose to model the actuators, for every actuator).

Both of these decisions-to model the sensor in software, and to incorporate the actuator hardware-involve trade-offs. For one thing, no software model is perfect. The equations that govern even a simple device can be very complex, and there will always be effects-hopefully small-that the model either doesn't incorporate or calculates inaccurately. On the other hand, including the hardware in the simulation is no panacea either. Does the device work the same on your lab bench as it will in real life? We assumed our servo would have a huge amount of torque, but in real life the torque is finite and the load is large, because the actuator has to move a massive object and overcome aerodynamic forces. Thus it will not move the same in flight as it does in the lab.

Data logging

The purpose of the HILS is to test an embedded system. The proof that the embedded system passed its test is that its outputs were correct for the inputs that it was given. The HILS ought, therefore, to provide data logging capabilities. One easy way to do that, if the required throughput is not excessive compared to the computer's throughput, is the following: at the end of every cycle, write the simulation's state to a file. By "state" I mean all the inputs to your simulation, its outputs, and any internal values it generates that are used to calculate the next cycle's outputs. If a hard disk is too slow to keep up with your real-time requirements, a RAM disk may be large enough to do the job. In this case, you might want to incorporate a means of starting and stopping data logging (much like the trigger mechanism on a scope or logic analyzer) so that you don't fill the data log with meaningless data. At the end of the test, transfer the file to a program such as Excel or MATLAB and analyze the results. You did build Ethernet into your simulator, didn't you? The volume of data generated can easily exceed what you'd happily transfer with floppy disks. This is an area where an off-the-shelf environment like dSpace or LabView can save you some development effort.

Limitations of a HILS

Lest you leave with the impression that a HILS is a silver bullet, let's list what it can't do. It cannot easily stop-if you pause the hardware-in-the-loop simulator, all the components that it's attached to, including the embedded program in your system-under-test, keep running. We could, of course, put breakpoints or a pause-on-command feature in our embedded software, but that's rather intrusive. If we did that, we would not be testing what we intend to ship. Even then, in the autopilot example above, the elevator servo has a dumb analog control loop built in. It won't stop just because the simulator or our embedded software stops.

A HILS cannot tell you what's going on inside your embedded software; it's not a replacement for an in-circuit emulator, a logic analyzer, or a software debugger. It can only read the embedded system's outputs. When the embedded software goes awry, there may or may not be enough information contained in those few outputs to determine what portion of the software was executing, or what the values of the internal variables were.

Other applications

The vast majority of embedded software engineers work in fields other than aerospace. However, with a little imagination, you can see how a HILS can be applied in other areas. For instance, machine control and motion control are two areas where it's hard to completely test the software before the expensive, fragile, and often unique machine is built.

Before I joined the aerospace field, I designed software for vacuum equipment used in the production of semiconductors. These were million-dollar machines equipped with pumps, valves, robot arms, and vacuum chambers. It would have been relatively straightforward, had I known about hardware-in-the-loop simulation back then, to sense the state of the pump and valve commands coming out of the embedded computer, and then calculate what the pressures in the various chambers would do. We had no such capability, however. Instead, I wrote the software, and tested it as best I could using more manual methods. When the machine was finally coming together mechanically on the shop floor, the schedule was starting to get tight. There were many hardware tests that needed to be performed. Problems with the hardware had to be fixed. Everybody knows "software is much easier than hardware," so it's okay to leave software testing until the very end, right? There ensued a few weeks of late nights, three shifts per day, twice-daily Gantt charts, hourly visits to the shop floor by anxious managers, and all-around misery.

Avoiding the all-too-frequent integration crunch is reason enough to invest in a hardware-in-the-loop simulator. esp

Martin Gomez is a software engineer at Johns Hopkins University's Applied Physics Lab, where he is presently developing flight software for the STEREO spacecraft. He has been working in the field of embedded software development for 17 years. Martin has a BS in aerospace engineering, an M.Eng. in electrical engineering, and is a part time graduate student in Applied Physics at JHU. He may be reached at martin.gomez@jhuapl.edu.

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U.S. Supreme Court

BOYLE v. UNITED TECHNOLOGIES CORP., 487 U.S. 500 (1988)

487 U.S. 500

BOYLE, PERSONAL REPRESENTATIVE OF THE HEIRS AND ESTATE OF BOYLE v. UNITED TECHNOLOGIES CORP.
CERTIORARI TO THE UNITED STATES COURT OF APPEALS FOR THE FOURTH CIRCUIT
No. 86-492.

Argued October 13, 1987 Reargued April 27, 1988
Decided June 27, 1988

David A. Boyle, a United States Marine helicopter copilot, drowned when his helicopter crashed off the Virginia coast. Petitioner, the personal representative of the heirs and estate of Boyle, brought this diversity action in Federal District Court against the Sikorsky Division of respondent corporation (Sikorsky), alleging, inter alia, under Virginia tort law, that Sikorsky had defectively designed the helicopter's copilot emergency escape-hatch system. The jury returned a general verdict for petitioner, and the court denied Sikorsky's motion for judgment notwithstanding the verdict. The Court of Appeals reversed and remanded with directions that judgment be entered for Sikorsky. It found that, as a matter of federal law, Sikorsky could not be held liable for the allegedly defective design because Sikorsky satisfied the requirements of the "military contractor defense."

Held:

> 1. There is no merit to petitioner's contention that, in the absence of federal legislation specifically immunizing Government contractors, federal law cannot shield contractors from liability for design defects in military equipment. In a few areas involving "uniquely federal interests," state law is pre-empted and replaced, where necessary, by federal law of a content prescribed (absent explicit statutory directive) by the courts. The procurement of equipment by the United States is an area of uniquely federal interest. A dispute such as the present one, even though between private parties, implicates the interests of the United States in this area. Once it is determined that an area of uniquely federal interest is implicated, state law will be displaced only where a "significant conflict" exists between an identifiable federal policy or interest and the operation of state law, or the application of state law would frustrate specific objectives of federal legislation. Here, the state-imposed duty of care that is the asserted basis of the contractor's liability is precisely contrary to the duty imposed by the Government contract. But even in this situation, it would be unreasonable to say that there is

always a "significant conflict" between state law and a federal policy or interest. In search of a limiting principle to identify when a significant [487 U.S. 500, 501] conflict is present, the Court of Appeals relied on the rationale of Feres v. United States, 340 U.S. 135 . This produces results that are in some respects too broad and in some respects too narrow. However, the discretionary function exception to the Federal Tort Claims Act does demonstrate the potential for, and suggest the outlines of, "significant conflict" between federal interest and state law in this area. State law is displaced where judgment against the contractor would threaten a discretionary function of the Government. In sum, state law which imposes liability for design defects in military equipment is displaced where (a) the United States approved reasonably precise specifications; (b) the equipment conformed to those specifications; and (c) the supplier warned the United States about dangers in the use of the equipment known to the supplier but not to the United States. Pp. 504-513.

2. Also without merit is petitioner's contention that since the Government contractor defense formulated by the Court of Appeals differed from the instructions given by the District Court to the jury, the Seventh Amendment guarantee of jury trial requires a remand for trial on the new theory. If the evidence presented in the first trial would not suffice, as a matter of law, to support a jury verdict under the properly formulated defense, judgment could properly be entered for respondent at once, without a new trial. It is unclear from the Court of Appeals' opinion, however, whether it was in fact deciding that no reasonable jury could, under the properly formulated defense, have found for petitioner on the facts presented, or rather was assessing on its own whether the defense had been established. The latter would be error, since whether the facts established the conditions for the defense is a question for the jury. The case is remanded for clarification of this point. Pp. 513-514.

792 F.2d 413, vacated and remanded.

SCALIA, J., delivered the opinion of the Court, in which REHNQUIST, C. J., and WHITE, O'CONNOR, and KENNEDY, JJ., joined. BRENNAN, J., filed a dissenting opinion, in which MARSHALL and BLACKMUN, JJ., joined, post, p. 515. STEVENS, J., filed a dissenting opinion, post, p. 531.

Louis S. Franecke reargued the cause for petitioner. With him on the briefs was John O. Mack.

Philip A. Lacovara reargued the cause for respondent. With him on the briefs were Lewis T. Booker, W. Stanfield Johnson, and William R. Stein.

Deputy Solicitor General Ayer reargued the cause for the United States as amicus curiae urging affirmance. With him on the brief were Solicitor General Fried, Assistant [487 U.S. 500, 502] Attorney General Willard, Deputy Assistant Attorneys General Spears and Willmore, and Christopher J. Wright. *

[Footnote *] Briefs of amici curiae urging reversal were filed for Edwin Lees Shaw by Joel D. Eaton and Robert L. Parks; and for Joan S. Tozer et al. by Michael J. Pangia.

Briefs of amici curiae urging affirmance were filed for the Chamber of Commerce of the United States by Herbert L. Fenster, Raymond B. Biagini, and Robin S. Conrad; for the Defense Research Institute, Inc., by James W. Morris III, Ann Adams Webster, and Donald F. Pierce; for Grumman Aerospace Corp. by James M. FitzSimons, Frank J. Chiarchiaro, Charles M. Shaffer, Jr., L. Joseph Loveland, and Gary J. Toman; for the National Security Industrial Association et al. by Kenneth S. Geller and Andrew L. Frey; and for the

Product Liability Advisory Council, Inc., et al. by Michael Hoenig, David B. Hamm, William H. Crabtree, and Edward P. Good.

Briefs of amici curiae were filed for the Association of Trial Lawyers of America by Robert L. Habush, Dale Haralson, and Denneen L. Peterson; for Bell Helicopter Textron Inc. by R. David Broiles, George Galerstein, and James W. Hunt; and for UNR Industries, Inc., by Joe G. Hollingsworth.

JUSTICE SCALIA delivered the opinion of the Court.

This case requires us to decide when a contractor providing military equipment to the Federal Government can be held liable under state tort law for injury caused by a design defect.

I

On April 27, 1983, David A. Boyle, a United States Marine helicopter copilot, was killed when the CH-53D helicopter in which he was flying crashed off the coast of Virginia Beach, Virginia, during a training exercise. Although Boyle survived the impact of the crash, he was unable to escape from the helicopter and drowned. Boyle's father, petitioner here, brought this diversity action in Federal District Court against the Sikorsky Division of United Technologies Corporation (Sikorsky), which built the helicopter for the United States. [487 U.S. 500, 503]

At trial, petitioner presented two theories of liability under Virginia tort law that were submitted to the jury. First, petitioner alleged that Sikorsky had defectively repaired a device called the servo in the helicopter's automatic flight control system, which allegedly malfunctioned and caused the crash. Second, petitioner alleged that Sikorsky had defectively designed the copilot's emergency escape system: the escape hatch opened out instead of in (and was therefore ineffective in a submerged craft because of water pressure), and access to the escape hatch handle was obstructed by other equipment. The jury returned a general verdict in favor of petitioner and awarded him $725,000. The District Court denied Sikorsky's motion for judgment notwithstanding the verdict.

The Court of Appeals reversed and remanded with directions that judgment be entered for Sikorsky. 792 F.2d 413 (CA4 1986). It found, as a matter of Virginia law, that Boyle had failed to meet his burden of demonstrating that the repair work performed by Sikorsky, as opposed to work that had been done by the Navy, was responsible for the alleged malfunction of the flight control system. Id., at 415-416. It also found, as a matter of federal law, that Sikorsky could not be held liable for the allegedly defective design of the escape hatch because, on the evidence presented, it satisfied the requirements of the "military contractor defense," which the court had recognized the same day in Tozer v. LTV Corp., 792 F.2d 403 (CA4 1986). 792 F.2d, at 414-415.

Petitioner sought review here, challenging the Court of Appeals' decision on three levels: First, petitioner contends that there is no justification in federal law for shielding Government contractors from liability for design defects in military equipment. Second, he argues in the alternative that even if such a defense should exist, the Court of Appeals' formulation of the conditions for its application is inappropriate. Finally, petitioner contends that the Court of Appeals erred in not remanding for a jury determination of whether the elements [487 U.S. 500, 504] of the defense were met in this case. We granted certiorari, 479 U.S. 1029 (1986).

II

Petitioner's broadest contention is that, in the absence of legislation specifically immunizing Government contractors from liability for design defects, there is no basis for judicial recognition of such a defense. We disagree. In most fields of activity, to be sure, this Court has refused to find federal pre-emption of state law in the absence of either a clear statutory prescription, see, e. g., Jones v. Rath Packing Co., 430 U.S. 519, 525 (1977); Rice v. Santa Fe Elevator Corp., 331 U.S. 218, 230 (1947), or a direct conflict between federal and state law, see, e. g., Florida Lime & Avocado Growers, Inc. v. Paul, 373 U.S. 132, 142 -143 (1963); Hines v. Davidowitz, 312 U.S. 52, 67 (1941). But we have held that a few areas, involving "uniquely federal interests," Texas Industries, Inc. v. Radcliff Materials, Inc., 451 U.S. 630, 640 (1981), are so committed by the Constitution and laws of the United States to federal control that state law is pre-empted and replaced, where necessary, by federal law of a content prescribed (absent explicit statutory directive) by the courts - so-called "federal common law." See, e. g., United States v. Kimbell Foods, Inc., 440 U.S. 715, 726 -729 (1979); Banco Nacional v. Sabbatino, 376 U.S. 398, 426 -427 (1964); Howard v. Lyons, 360 U.S. 593, 597 (1959); Clearfield Trust Co. v. United States, 318 U.S. 363, 366 -367 (1943); D'Oench, Duhme & Co. v. FDIC, 315 U.S. 447, 457 -458 (1942).

The dispute in the present case borders upon two areas that we have found to involve such "uniquely federal interests." We have held that obligations to and rights of the United States under its contracts are governed exclusively by federal law. See, e. g., United States v. Little Lake Misere Land Co., 412 U.S. 580, 592 -594 (1973); Priebe & Sons, Inc. v. United States, 332 U.S. 407, 411 (1947); National Metropolitan Bank v. United States, 323 U.S. 454 , [487 U.S. 500, 505] 456 (1945); Clearfield Trust, supra. The present case does not involve an obligation to the United States under its contract, but rather liability to third persons. That liability may be styled one in tort, but it arises out of performance of the contract - and traditionally has been regarded as sufficiently related to the contract that until 1962 Virginia would generally allow design defect suits only by the purchaser and those in privity with the seller. See General Bronze Corp. v. Kostopulos, 203 Va. 66, 69-70, 122 S. E. 2d 548, 551 (1961); see also Va. Code 8.2-318 (1965) (eliminating privity requirement).

Another area that we have found to be of peculiarly federal concern, warranting the displacement of state law, is the civil liability of federal officials for actions taken in the course of their duty. We have held in many contexts that the scope of that liability is controlled by federal law. See, e. g., Westfall v. Erwin, 484 U.S. 292, 295 (1988); Howard v. Lyons, supra, at 597; Barr v. Matteo, 360 U.S. 564, 569 -574 (1959) (plurality opinion); id., at 577 (Black, J., concurring); see also Yaselli v. Goff, 12 F.2d 396 (CA2 1926), aff'd, 275 U.S. 503 (1927) (per curiam); Spalding v. Vilas, 161 U.S. 483 (1896); Bradley v. Fisher, 13 Wall. 335 (1872). The present case involves an independent contractor performing its obligation under a procurement contract, rather than an official performing his duty as a federal employee, but there is obviously implicated the same interest in getting the Government's work done. 1

We think the reasons for considering these closely related areas to be of "uniquely federal" interest apply as well to [487 U.S. 500, 506] the civil liabilities arising out of the performance of federal procurement contracts. We have come close to holding as much. In Yearsley v. W. A. Ross Construction Co., 309 U.S. 18 (1940), we rejected an attempt by a landowner to hold a construction contractor liable under state law for the erosion of 95 acres caused by the contractor's work in constructing dikes for the Government. We said that "if [the] authority to carry out the project was validly conferred, that is, if what was done was within the constitutional power of Congress, there is no liability on the part of the contractor for executing its will." Id., at 20-21. The federal interest justifying this holding surely exists as much in procurement contracts as in performance contracts; we see no basis for a distinction.

Moreover, it is plain that the Federal Government's interest in the procurement of equipment is implicated by suits such as the present one - even though the dispute is one between private parties. It is true that where "litigation is purely between private parties and does not touch the rights and duties of the United States," Bank of America Nat. Trust & Sav. Assn. v. Parnell, 352 U.S. 29, 33 (1956), federal law does not govern. Thus, for example, in Miree v. DeKalb County, 433 U.S. 25, 30 (1977), which involved the question whether certain private parties could sue as third-party beneficiaries to an agreement between a municipality and the Federal Aviation Administration, we found that state law was not displaced because "the operations of the United States in connection with FAA grants such as these . . . would [not] be burdened" by allowing state law to determine whether third-party beneficiaries could sue, id., at 30, and because "any federal interest in the outcome of the [dispute] before us `[was] far too speculative, far too remote a possibility to justify the application of federal law to transactions essentially of local concern.'" Id., at 32-33, quoting Parnell, supra, at 33-34; see also Wallis v. Pan American Petroleum [487 U.S. 500, 507] Corp., 384 U.S. 63, 69 (1966). 2 But the same is not true here. The imposition of liability on Government contractors will directly affect the terms of Government contracts: either the contractor will decline to manufacture the design specified by the Government, or it will raise its price. Either way, the interests of the United States will be directly affected.

That the procurement of equipment by the United States is an area of uniquely federal interest does not, however, end the inquiry. That merely establishes a necessary, not a sufficient, condition for the displacement of state law. 3 Displacement will occur only where, as we have variously described, a "significant conflict" exists between an identifiable "federal policy or interest and the [operation] of state law," Wallis, supra, at 68, or the application of state law would "frustrate specific objectives" of federal legislation, Kimbell Foods, 440 U.S., at 728 . The conflict with federal policy need not be as sharp as that which must exist for ordinary pre-emption when Congress legislates "in a field which the States have traditionally occupied." Rice v. Santa Fe Elevator Corp., 331 U.S., at 230 . Or to put the point differently, the [487 U.S. 500, 508] fact that the area in question is one of unique federal concern changes what would otherwise be a conflict that cannot produce pre-emption into one that can. 4 But conflict there must be. In some cases, for example where the federal interest requires a uniform rule, the entire body of state law applicable to the area conflicts and is replaced by federal rules. See, e. g., Clearfield Trust, 318 U.S., at 366 -367 (rights and obligations of United States with respect to commercial paper must be governed by uniform federal rule). In others, the conflict is more narrow, and only particular elements of state law are superseded. See, e. g., Little Lake Misere Land Co., 412 U.S., at 595 (even assuming state law should generally govern federal land acquisitions, particular state law at issue may not); Howard v. Lyons, 360 U.S., at 597 (state defamation law generally applicable to federal official, but federal privilege governs for statements made in the course of federal official's duties).

In Miree, supra, the suit was not seeking to impose upon the person contracting with the Government a duty contrary to the duty imposed by the Government contract. Rather, it was the contractual duty itself that the private plaintiff (as third-party beneficiary) sought to enforce. Between Miree [487 U.S. 500, 509] and the present case, it is easy to conceive of an intermediate situation, in which the duty sought to be imposed on the contractor is not identical to one assumed under the contract, but is also not contrary to any assumed. If, for example, the United States contracts for the purchase and installation of an air-conditioning unit, specifying the cooling capacity but not the precise manner of construction, a state law imposing upon the manufacturer of such units a duty of care to include a certain safety feature would not be a duty identical to anything promised the Government, but neither would it be contrary. The contractor could comply with both its contractual obligations and the state-prescribed duty of care. No one suggests that state law would generally be pre-empted in this context.

The present case, however, is at the opposite extreme from Miree. Here the state-imposed duty of care that is the asserted basis of the contractor's liability (specifically, the duty to equip helicopters with the sort of escape-hatch mechanism petitioner claims was necessary) is precisely contrary to the duty imposed by the Government contract (the duty to manufacture and deliver helicopters with the sort of escape-hatch mechanism shown by the specifications). Even in this sort of situation, it would be unreasonable to say that there is always a "significant conflict" between the state law and a federal policy or interest. If, for example, a federal procurement officer orders, by model number, a quantity of stock helicopters that happen to be equipped with escape hatches opening outward, it is impossible to say that the Government has a significant interest in that particular feature. That would be scarcely more reasonable than saying that a private individual who orders such a craft by model number cannot sue for the manufacturer's negligence because he got precisely what he ordered.

In its search for the limiting principle to identify those situations in which a "significant conflict" with federal policy or interests does arise, the Court of Appeals, in the lead case [487 U.S. 500, 510] upon which its opinion here relied, identified as the source of the conflict the Feres doctrine, under which the Federal Tort Claims Act (FTCA) does not cover injuries to Armed Services personnel in the course of military service. See Feres v. United States, 340 U.S. 135 (1950). Military contractor liability would conflict with this doctrine, the Fourth Circuit reasoned, since the increased cost of the contractor's tort liability would be added to the price of the contract, and "[s]uch pass-through costs would . . . defeat the purpose of the immunity for military accidents conferred upon the government itself." Tozer, 792 F.2d, at 408. Other courts upholding the defense have embraced similar reasoning. See, e. g., Bynum v. FMC Corp., 770 F.2d 556, 565-566 (CA5 1985); Tillett v. J. I. Case Co., 756 F.2d 591, 596-597 (CA7 1985); McKay v. Rockwell Int'l Corp., 704 F.2d 444, 449 (CA9 1983), cert. denied, 464 U.S. 1043 (1984). We do not adopt this analysis because it seems to us that the Feres doctrine, in its application to the present problem, logically produces results that are in some respects too broad and in some respects too narrow. Too broad, because if the Government contractor defense is to prohibit suit against the manufacturer whenever Feres would prevent suit against the Government, then even injuries caused to military personnel by a helicopter purchased from stock (in our example above), or by any standard equipment purchased by the Government, would be covered. Since Feres prohibits all service-related tort claims against the Government, a contractor defense that rests upon it should prohibit all service-related tort claims against the manufacturer - making inexplicable the three limiting criteria for contractor immunity (which we will discuss presently) that the Court of Appeals adopted. On the other hand, reliance on Feres produces (or logically should produce) results that are in another respect too narrow. Since that doctrine covers only service-related injuries, and not injuries caused by the military to civilians, it could not be invoked to prevent, for example, a civilian's suit against the manufacturer of fighter planes, based on a state [487 U.S. 500, 511] tort theory, claiming harm from what is alleged to be needlessly high levels of noise produced by the jet engines. Yet we think that the character of the jet engines the Government orders for its fighter planes cannot be regulated by state tort law, no more in suits by civilians than in suits by members of the Armed Services.

There is, however, a statutory provision that demonstrates the potential for, and suggests the outlines of, "significant conflict" between federal interests and state law in the context of Government procurement. In the FTCA, Congress authorized damages to be recovered against the United States for harm caused by the negligent or wrongful conduct of Government employees, to the extent that a private person would be liable under the law of the place where the conduct occurred. 28 U.S.C. 1346(b). It excepted from this consent to suit, however,

> "[a]ny claim . . . based upon the exercise or performance or the failure to exercise or perform a discretionary function or duty on the part of a federal agency or an employee of the Government, whether or not the discretion involved be abused." 28 U.S.C. 2680(a).

We think that the selection of the appropriate design for military equipment to be used by our Armed Forces is assuredly a discretionary function within the meaning of this provision. It often involves not merely engineering analysis but judgment as to the balancing of many technical, military, and even social considerations, including specifically the trade-off between greater safety and greater combat effectiveness. And we are further of the view that permitting "second-guessing" of these judgments, see United States v. Varig Airlines, 467 U.S. 797, 814 (1984), through state tort suits against contractors would produce the same effect sought to be avoided by the FTCA exemption. The financial burden of judgments against the contractors would ultimately be passed through, substantially if not totally, to the [487 U.S. 500, 512] United States itself, since defense contractors will predictably raise their prices to cover, or to insure against, contingent liability for the Government-ordered designs. To put the point differently: It makes little sense to insulate the Government against financial liability for the judgment that a particular feature of military equipment is necessary when the Government produces the equipment itself, but not when it contracts for the production. In sum, we are of the view that state law which holds Government contractors liable for design defects in military equipment does in some circumstances present a "significant conflict" with federal policy and must be displaced. 5

We agree with the scope of displacement adopted by the Fourth Circuit here, which is also that adopted by the Ninth Circuit, see McKay v. Rockwell Int'l Corp., supra, at 451. Liability for design defects in military equipment cannot be imposed, pursuant to state law, when (1) the United States approved reasonably precise specifications; (2) the equipment conformed to those specifications; and (3) the supplier warned the United States about the dangers in the use of the equipment that were known to the supplier but not to the United States. The first two of these conditions assure that the suit is within the area where the policy of the "discretionary function" would be frustrated - i. e., they assure that the design feature in question was considered by a Government officer, and not merely by the contractor itself. The third condition is necessary because, in its absence, the displacement of state tort law would create some incentive for the manufacturer to withhold knowledge of risks, since conveying that knowledge might disrupt the contract but withholding it would produce no liability. We adopt this provision lest our effort to protect [487 U.S. 500, 513] discretionary functions perversely impede them by cutting off information highly relevant to the discretionary decision.

We have considered the alternative formulation of the Government contractor defense, urged upon us by petitioner, which was adopted by the Eleventh Circuit in Shaw v. Grumman Aerospace Corp., 778 F.2d 736, 746 (1985), cert. pending, No. 85-1529. That would preclude suit only if (1) the contractor did not participate, or participated only minimally, in the design of the defective equipment; or (2) the contractor timely warned the Government of the risks of the design and notified it of alternative designs reasonably known by it, and the Government, although forewarned, clearly authorized the contractor to proceed with the dangerous design. While this formulation may represent a perfectly reasonable tort rule, it is not a rule designed to protect the federal interest embodied in the "discretionary function" exemption. The design ultimately selected may well reflect a significant policy judgment by Government officials whether or not the contractor rather than those officials developed the design. In addition, it does not seem to us sound policy to penalize, and thus deter, active contractor participation in the design process, placing the contractor at risk unless it identifies all design defects.

III

Petitioner raises two arguments regarding the Court of Appeals' application of the Government contractor defense to the facts of this case. First, he argues that since the formulation of the defense adopted by the Court of Appeals differed from the instructions given by the District Court to the jury, the Seventh Amendment guarantee of jury trial required a remand for trial on the new theory. We disagree. If the evidence presented in the first trial would not suffice, as a matter of law, to support a jury verdict under the properly formulated defense, judgment could properly be entered for the respondent at once, without a new trial. And that is so even though (as petitioner claims) respondent failed to [487 U.S. 500, 514] object to jury instructions that expressed the defense differently, and in a fashion that would support a verdict. See St. Louis v. Praprotnik, 485 U.S. 112, 118 -120 (1988) (plurality opinion of O'CONNOR, J., joined by REHNQUIST, C. J., WHITE, and SCALIA, JJ.); Ebker v. Tan Jay Int'l, Ltd., 739 F.2d 812, 825-826, n. 17 (CA2 1984) (Friendly, J.); 9 C. Wright & A. Miller, Federal Practice and Procedure 2537, pp. 599-600 (1971).

It is somewhat unclear from the Court of Appeals' opinion, however, whether it was in fact deciding that no reasonable jury could, under the properly formulated defense, have found for the petitioner on the facts presented, or rather was assessing on its own whether the defense had been established. The latter, which is what petitioner asserts occurred, would be error, since whether the facts establish the conditions for the defense is a question for the jury. The critical language in the Court of Appeals' opinion was that "[b]ecause Sikorsky has satisfied the requirements of the military contractor defense, it can incur no liability for . . . the allegedly defective design of the escape hatch." 792 F.2d, at 415. Although it seems to us doubtful that the Court of Appeals was conducting the factual evaluation that petitioner suggests, we cannot be certain from this language, and so we remand for clarification of this point. If the Court of Appeals was saying that no reasonable jury could find, under the principles it had announced and on the basis of the evidence presented, that the Government contractor defense was inapplicable, its judgment shall stand, since petitioner did not seek from us, nor did we grant, review of the sufficiency-of-the-evidence determination. If the Court of Appeals was not saying that, it should now undertake the proper sufficiency inquiry.

Accordingly, the judgment is vacated and the case is remanded.

So ordered.

Footnotes

[Footnote 1] JUSTICE BRENNAN'S dissent misreads our discussion here to "intimat[e] that the immunity [of federal officials] . . . might extend . . . [to] nongovernment employees" such as a Government contractor. Post, at 523. But we do not address this issue, as it is not before us. We cite these cases merely to demonstrate that the liability of independent contractors performing work for the Federal Government, like the liability of federal officials, is an area of uniquely federal interest.

[Footnote 2] As this language shows, JUSTICE BRENNAN'S dissent is simply incorrect to describe Miree and other cases as declining to apply federal law despite the assertion of interests "comparable" to those before us here. Post, at 521-522.

[Footnote 3] We refer here to the displacement of state law, although it is possible to analyze it as the displacement of federal-law reference to state law for the rule of decision. Some of our cases appear to regard the area in which a uniquely federal interest exists as being entirely governed by federal law, with federal law deigning to "borro[w]," United States v. Little Lake Misere Land Co., 412 U.S. 580, 594 (1973), or "incorporat[e]" or "adopt" United States v. Kimbell Foods, Inc., 440 U.S. 715, 728 , 729, 730 (1979), state law except where a significant conflict with federal policy exists. We see nothing to be gained by expanding the theoretical scope of the federal pre-emption beyond its practical effect, and so adopt the more modest terminology. If the distinction between displacement of state law and displacement of federal law's incorporation of state law ever makes a practical difference, it at least does not do so in the present case.

[Footnote 4] Even before our landmark decision in Clearfield Trust Co. v. United States, 318 U.S. 363 (1943), the distinctive federal interest in a particular field was used as a significant factor giving broad pre-emptive effect to federal legislation in that field:

> "It cannot be doubted that both the state and the federal [alien] registration laws belong `to that class of laws which concern the exterior relation of this whole nation with other nations and governments.' Consequently the regulation of aliens is . . . intimately blended and intertwined with responsibilities of the national government . . . . And where the federal government, in the exercise of its superior authority in this field, has enacted a complete scheme of regulation and has therein provided a standard for the registration of aliens, states cannot, inconsistently with the purpose of Congress, conflict or interfere with, curtail or complement, the federal law, or enforce additional or auxiliary regulations." Hines v. Davidowitz, 312 U.S. 52, 66 -67 (1941) (citation omitted).

[Footnote 5] JUSTICE BRENNAN's assumption that the outcome of this case would be different if it were brought under the Death on the High Seas Act, Act of Mar. 30, 1920, ch. 111, 1 et seq., (1982 ed., Supp. IV), 41 Stat. 537, codified at 46 U.S.C. App. 761 et seq., is not necessarily correct. That issue is not before us, and we think it inappropriate to decide it in order to refute (or, for that matter, to construct) an alleged inconsistency. [487 U.S. 500, 515]

JUSTICE BRENNAN, with whom JUSTICE MARSHALL and JUSTICE BLACKMUN join, dissenting.

Lieutenant David A. Boyle died when the CH-53D helicopter he was copiloting spun out of control and plunged into the ocean. We may assume, for purposes of this case, that Lt. Boyle was trapped under water and drowned because respondent United Technologies negligently designed the helicopter's escape hatch. We may further assume that any competent engineer would have discovered and cured the defects, but that they inexplicably escaped respondent's notice. Had respondent designed such a death trap for a commercial firm, Lt. Boyle's family could sue under Virginia tort law and be compensated for his tragic and unnecessary death. But respondent designed the helicopter for the Federal Government, and that, the Court tells us today, makes all the difference: Respondent is immune from liability so long as it obtained approval of "reasonably precise specifications" - perhaps no more than a rubber stamp from a federal procurement officer who might or might not have noticed or cared about the defects, or even had the expertise to discover them.

If respondent's immunity "bore the legitimacy of having been prescribed by the people's elected representatives," we would be duty bound to implement their will, whether or not we approved. United States v. Johnson, 481 U.S. 681, 703 (1987) (dissenting opinion of SCALIA, J.). Congress, however, has remained silent - and conspicuously so, having resisted a sustained campaign by Government contractors to legislate for them some defense. 1 The Court - unelected and unaccountable to the people - has unabashedly stepped into [487 U.S. 500, 516] the breach to legislate a rule denying Lt. Boyle's family the compensation that state law assures them. This time the injustice is of this Court's own making.

Worse yet, the injustice will extend far beyond the facts of this case, for the Court's newly discovered Government contractor defense is breathtakingly sweeping. It applies not only to military equipment like the CH-53D helicopter, but (so far as I can tell) to any made-to-order gadget that the Federal Government might purchase after previewing plans - from NASA's Challenger space shuttle to the Postal Service's old mail cars. The contractor may invoke the defense in suits brought not only by military personnel like Lt. Boyle, or Government employees, but by anyone injured by a Government contractor's negligent design, including, for example, the children who might have died had respondent's helicopter crashed on the beach. It applies even if the Government has not intentionally sacrificed safety for other interests like speed or efficiency, and, indeed, even if the equipment is not of a type that is typically considered dangerous; thus, the contractor who designs a Government building can invoke the defense when the elevator cable snaps or the walls collapse. And the defense is invocable regardless of how blatant or easily remedied the defect, so long as the contractor missed it and the specifications approved by the Government, however unreasonably dangerous, were "reasonably precise." Ante, at 512.

In my view, this Court lacks both authority and expertise to fashion such a rule, whether to protect the Treasury of the United States or the coffers of industry. Because I would leave that exercise of legislative power to Congress, where our Constitution places it, I would reverse the Court of Appeals and reinstate petitioner's jury award.

I

Before our decision in Erie R. Co. v. Tompkins, 304 U.S. 64 (1938), federal courts sitting in diversity were generally free, in the absence of a controlling state statute, to fashion [487 U.S. 500, 517] rules of "general" federal common law. See, e. g., Swift v. Tyson, 16 Pet. 1 (1842). Erie renounced the prevailing scheme: "Except in matters governed by the Federal Constitution or by Acts of Congress, the law to be applied in any case is the law of the State." 304 U.S., at 78 . The Court explained that the expansive power that federal courts had theretofore exercised was an unconstitutional "`invasion of the authority of the State and, to that extent, a denial of its independence.'" Id., at 79 (citation omitted). Thus, Erie was deeply rooted in notions of federalism, and is most seriously implicated when, as here, federal judges displace the state law that would ordinarily govern with their own rules of federal common law. See, e. g., United States v. Standard

Oil Co., 332 U.S. 301, 307 (1947). 2

In pronouncing that "[t]here is no federal general common law," 304 U.S., at 78 , Erie put to rest the notion that the grant of diversity jurisdiction to federal courts is itself authority to fashion rules of substantive law. See United States v. Little Lake Misere Land Co., 412 U.S. 580, 591 (1973). As the author of today's opinion for the Court pronounced for a unanimous Court just two months ago, "`"`we start with the assumption that the historic police powers of the States were not to be superseded . . . unless that was the clear and manifest purpose of Congress.'"'" Puerto Rico Dept. of Consumer Affairs v. Isla Petroleum Corp., 485 U.S. 495, 500 (1988) (citations omitted). Just as "[t]here is no federal pre-emption in vacuo, without a constitutional text or a federal statute to assert it," id., at 503, federal common law cannot supersede state law in vacuo out of no [487 U.S. 500, 518] more than an idiosyncratic determination by five Justices that a particular area is "uniquely federal."

Accordingly, we have emphasized that federal common law can displace state law in "few and restricted" instances. Wheeldin v. Wheeler, 373 U.S. 647, 651 (1963). "[A]bsent some congressional authorization to formulate substantive rules of decision, federal common law exists only in such narrow areas as those concerned with the rights and obligations of the United States, interstate and international disputes implicating conflicting rights of States or our relations with foreign nations, and admiralty cases." Texas Industries, Inc. v. Radcliff Materials, Inc., 451 U.S. 630, 641 (1981) (footnotes omitted). "The enactment of a federal rule in an area of national concern, and the decision whether to displace state law in doing so, is generally made not by the federal judiciary, purposefully insulated from democratic pressures, but by the people through their elected representatives in Congress." Milwaukee v. Illinois, 451 U.S. 304, 312 -313 (1981). See also Wallis v. Pan American Petroleum Corp., 384 U.S. 63, 68 (1966); Miree v. DeKalb County, 433 U.S. 25, 32 (1977). State laws "should be overridden by the federal courts only where clear and substantial interests of the National Government, which cannot be served consistently with respect for such state interests, will suffer major damage if the state law is applied." United States v. Yazell, 382 U.S. 341, 352 (1966).

II

Congress has not decided to supersede state law here (if anything, it has decided not to, see n. 1, supra) and the Court does not pretend that its newly manufactured "Government contractor defense" fits within any of the handful of "narrow areas," Texas Industries, supra, at 641, of "uniquely federal interests" in which we have heretofore done so, 451 U.S., at 640 . Rather, the Court creates a new category of "uniquely federal interests" out of a synthesis of two whose origins predate Erie itself: the interest in administering the "obligations to and rights of the United States under its contracts," ante, [487 U.S. 500, 519] at 504, and the interest in regulating the "civil liability of federal officials for actions taken in the course of their duty," ante, at 505. This case is, however, simply a suit between two private parties. We have steadfastly declined to impose federal contract law on relationships that are collateral to a federal contract, or to extend the federal employee's immunity beyond federal employees. And the Court's ability to list 2, or 10, inapplicable areas of "uniquely federal interest" does not support its conclusion that the liability of Government contractors is so "clear and substantial" an interest that this Court must step in lest state law does "major damage." Yazell, supra, at 352.

A

The proposition that federal common law continues to govern the "obligations to and rights of the United States under its contracts" is nearly as old as Erie itself. Federal law typically controls when the Federal Government is a party to a suit involving its rights or obligations under a contract, whether the contract entails procurement, see Priebe & Sons v. United States, 332 U.S. 407 (1947), a loan, see United States v. Kimbell Foods, Inc., 440 U.S. 715, 726 (1979), a conveyance of property, see Little Lake Misere, supra, at 591-594, or a commercial instrument issued by the Government, see Clearfield Trust Co. v. United States, 318 U.S. 363, 366 (1943), or assigned to it, see D'Oench, Duhme & Co. v. FDIC, 315 U.S. 447, 457 (1942). Any such transaction necessarily "radiate[s] interests in transactions between private parties." Bank of America Nat. Trust & Sav. Assn. v. Parnell, 352 U.S. 29, 33 (1956). But it is by now established that our power to create federal common law controlling the Federal Government's contractual rights and obligations does not translate into a power to prescribe rules that cover all transactions or contractual relationships collateral to Government contracts.

In Miree v. DeKalb County, supra, for example, the county was contractually obligated under a grant agreement with the Federal Aviation Administration (FAA) to "`restrict [487 U.S. 500, 520] the use of land adjacent to . . . the Airport to activities and purposes compatible with normal airport operations including landing and takeoff of aircraft.'" Id., at 27 (citation omitted). At issue was whether the county breached its contractual obligation by operating a garbage dump adjacent to the airport, which allegedly attracted the swarm of birds that caused a plane crash. Federal common law would undoubtedly have controlled in any suit by the Federal Government to enforce the provision against the county or to collect damages for its violation. The diversity suit, however, was brought not by the Government, but by assorted private parties injured in some way by the accident. We observed that "the operations of the United States in connection with FAA grants such as these are undoubtedly of considerable magnitude," id., at 30, and that "the United States has a substantial interest in regulating aircraft travel and promoting air travel safety," id., at 31. Nevertheless, we held that state law should govern the claim because "only the rights of private litigants are at issue here," id., at 30, and the claim against the county "will have no direct effect upon the United States or its Treasury," id., at 29 (emphasis added).

Miree relied heavily on Parnell, supra, and Wallis v. Pan American Petroleum Corp., supra, the former involving commercial paper issued by the United States and the latter involving property rights in federal land. In the former case, Parnell cashed certain bonds guaranteed by the Government that had been stolen from their owner, a bank. It is beyond dispute that federal law would have governed the United States' duty to pay the value bonds upon presentation; we held as much in Clearfield Trust, supra. Cf. Parnell, supra, at 34. But the central issue in Parnell, a diversity suit, was whether the victim of the theft could recover the money paid to Parnell. That issue, we held, was governed by state law, because the "litigation [was] purely between private parties and [did] not touch the rights and duties of the United States." 352 U.S., at 33 (emphasis added). [487 U.S. 500, 521]

The same was true in Wallis, which also involved a Government contract - a lease issued by the United States to a private party under the Mineral Leasing Act of 1920, 30 U.S.C. 181 et seq. (1982 ed. and Supp. IV) - governed entirely by federal law. See 384 U.S., at 69 . Again, the relationship at issue in this diversity case was collateral to the Government contract: It involved the validity of contractual arrangements between the lessee and other private parties, not between the lessee and the Federal Government. Even though a federal statute authorized certain assignments of lease rights, see id., at 69, 70, and n. 8, and imposed certain conditions on their validity, see id., at 70, we held that state law, not federal common law, governed their validity because application of state law would present "no significant threat to any identifiable federal policy or interest," id., at 68.

Here, as in Miree, Parnell, and Wallis, a Government contract governed by federal common law looms in the background. But here, too, the United States is not a party to the suit and the suit neither "touch[es] the rights and duties of the United States," Parnell, supra, at 33, nor has a "direct effect upon the United States or its Treasury," Miree, 433 U.S., at 29 . The relationship at issue is at best collateral to the Government contract. 3 We have no greater power to displace state law governing the collateral relationship in the Government procurement realm than we had to dictate federal rules governing equally collateral relationships in the areas of aviation, Government-issued commercial paper, or federal lands.

That the Government might have to pay higher prices for what it orders if delivery in accordance with the contract exposes [487 U.S. 500, 522] the seller to potential liability, see ante, at 507, does not distinguish this case. Each of the cases just discussed declined to extend the reach of federal common law despite the assertion of comparable interests that would have affected the terms of the Government contract - whether its price or its substance - just as "directly" (or indirectly). Ibid. Third-party beneficiaries can sue under a county's contract with the FAA, for example, even though - as the Court's focus on the absence of "direct effect on the United States or its Treasury," 433 U.S., at 29 (emphasis added), suggests - counties will likely pass on the costs to the Government in future contract negotiations. Similarly, we held that state law may govern the circumstances under which stolen federal bonds can be recovered, notwithstanding Parnell's argument that "the value of bonds to the first purchaser and hence their salability by the Government would be materially affected." Brief for Respondent Parnell in Bank of America Nat'l Trust & Sav. Assn. v. Parnell, O. T. 1956, No. 21, pp. 10-11. As in each of the cases declining to extend the traditional reach of federal law of contracts beyond the rights and duties of the Federal Government, "any federal interest in the outcome of the question before us `is far too speculative, far too remote a possibility to justify the application of federal law to transactions essentially of local concern.'" Miree, supra, at 32-33, quoting Parnell, 352 U.S., at 33 -34.

B

Our "uniquely federal interest" in the tort liability of affiliates of the Federal Government is equally narrow. The immunity we have recognized has extended no further than a subset of "officials of the Federal Government" and has covered only "discretionary" functions within the scope of their legal authority. See, e. g., Westfall v. Erwin, 484 U.S. 292 (1988); Howard v. Lyons, 360 U.S. 593 (1959); Barr v. Matteo, 360 U.S. 564, 571 (1959) (plurality); Yaselli v. Goff, 12 F.2d 396 (CA2 1926), aff'd, 275 U.S. 503 (1927) (per curiam); Spalding v. Vilas, 161 U.S. 483 (1896). Never before [487 U.S. 500, 523] have we so much as intimated that the immunity (or the "uniquely federal interest" that justifies it) might extend beyond that narrow class to cover also nongovernment employees whose authority to act is independent of any source of federal law and that are as far removed from the "functioning of the Federal Government" as is a Government contractor, Howard, supra, at 597.

The historical narrowness of the federal interest and the immunity is hardly accidental. A federal officer exercises statutory authority, which not only provides the necessary basis for the immunity in positive law, but also permits us confidently to presume that interference with the exercise of discretion undermines congressional will. In contrast, a Government contractor acts independently of any congressional enactment.

Thus, immunity for a contractor lacks both the positive law basis and the presumption that it furthers congressional will.

Moreover, even within the category of congressionally authorized tasks, we have deliberately restricted the scope of immunity to circumstances in which "the contributions of immunity to effective government in particular contexts outweigh the perhaps recurring harm to individual citizens," Doe v. McMillan, 412 U.S. 306, 320 (1973); see Barr, supra, at 572-573, because immunity "contravenes the basic tenet that individuals be held accountable for their wrongful conduct," Westfall, supra, at 295. The extension of immunity to Government contractors skews the balance we have historically struck. On the one hand, whatever marginal effect contractor immunity might have on the "effective administration of policies of government," its "harm to individual citizens" is more severe than in the Government-employee context. Our observation that "there are . . . other sanctions than civil tort suits available to deter the executive official who may be prone to exercise his functions in an unworthy and irresponsible manner," Barr, 360 U.S., at 576 ; see also id., at 571, offers little deterrence to the Government contractor. On the other hand, a grant of immunity to Government [487 U.S. 500, 524] contractors could not advance "the fearless, vigorous, and effective administration of policies of government" nearly as much as does the current immunity for Government employees. Ibid. In the first place, the threat of a tort suit is less likely to influence the conduct of an industrial giant than that of a lone civil servant, particularly since the work of a civil servant is significantly less profitable, and significantly more likely to be the subject of a vindictive lawsuit. In fact, were we to take seriously the Court's assertion that contractors pass their costs - including presumably litigation costs - through, "substantially if not totally, to the United States," ante, at 511, the threat of a tort suit should have only marginal impact on the conduct of Government contractors. More importantly, inhibition of the Government official who actually sets Government policy presents a greater threat to the "administration of policies of government," than does inhibition of a private contractor, whose role is devoted largely to assessing the technological feasibility and cost of satisfying the Government's predetermined needs. Similarly, unlike tort suits against Government officials, tort suits against Government contractors would rarely "consume time and energies" that "would otherwise be devoted to governmental service." 360 U.S., at 571 .

In short, because the essential justifications for official immunity do not support an extension to the Government contractor, it is no surprise that we have never extended it that far.

C

Yearsley v. W. A. Ross Construction Co., 309 U.S. 18 (1940), the sole case cited by the Court immunizing a Government contractor, is a slender reed on which to base so drastic a departure from precedent. In Yearsley we barred the suit of landowners against a private Government contractor alleging that its construction of a dam eroded their land without just compensation in violation of the Takings Clause of the Fifth Amendment. We relied in part on the observation that the plaintiffs failed to state a Fifth Amendment claim [487 U.S. 500, 525] (since just compensation had never been requested, much less denied) and at any rate the cause of action lay against the Government, not the contractor. See id., at 21 ("[T]he Government has impliedly promised to pay [the plaintiffs] compensation and has afforded a remedy for its recovery by a suit in the Court of Claims") (citations omitted). It is therefore unlikely that the Court intended Yearsley to extend anywhere beyond the takings context, and we have never applied it elsewhere.

Even if Yearsley were applicable beyond the unique context in which it arose, it would have little relevance here. The contractor's work "was done pursuant to a contract with the United States Government, and under the direction of the Secretary of War and the supervision of the Chief of Engineers of the United States, . . . as authorized by an Act of Congress." Id., at 19. See also W. A. Ross Construction Co. v. Yearsley, 103 F.2d 589, 591 (CA8 1939) (undisputed allegation that contractor implemented "stabilized bank lines as set and defined by the Government Engineers in charge of this work for the Government"). In other words, unlike respondent here, the contractor in Yearsley was following, not formulating, the Government's specifications, and (so far as is relevant here) followed them correctly. Had respondent merely manufactured the CH-53D helicopter, following minutely the Government's own in-house specifications, it would be analogous to the contractor in Yearsley, although still not analytically identical since Yearsley depended upon an actual agency relationship with the Government, see 309 U.S., at 22 ("The action of the agent is `the act of the government'") (citation omitted), which plainly was never established here. See, e. g., Bynum v. FMC Corp., 770 F.2d 556, 564 (CA5 1985). Cf. United States v. New Mexico, 455 U.S. 720, 735 (1982). But respondent's participation in the helicopter's design distinguishes this case from Yearsley, which has never been read to immunize the discretionary acts of those who perform service contracts for the Government. [487 U.S. 500, 526]

III

In a valiant attempt to bridge the analytical canyon between what Yearsley said and what the Court wishes it had said, the Court invokes the discretionary function exception of the Federal Tort Claims Act (FTCA), 28 U.S.C. 2680(a). The Court does not suggest that the exception has any direct bearing here, for petitioner has sued a private manufacturer (not the Federal Government) under Virginia law (not the FTCA). Perhaps that is why respondent has three times disavowed any reliance on the discretionary function exception, even after coaching by the Court, 4 as has the Government. 5 [487 U.S. 500, 527]

Notwithstanding these disclaimers, the Court invokes the exception, reasoning that federal common law must immunize Government contractors from state tort law to prevent erosion of the discretionary function exception's policy of foreclosing judicial "`second-guessing'" of discretionary governmental decisions. Ante, at 511, quoting United States v. Varig Airlines, 467 U.S. 797, 814 (1984). The erosion the Court fears apparently is rooted not in a concern that suits against Government contractors will prevent them from designing, or the Government from commissioning the design of, precisely the product the Government wants, but in the concern that such suits might preclude the Government from purchasing the desired product at the price it wants: "The financial burden of judgments against the contractors," the Court fears, "would ultimately be passed through, substantially if not totally, to the United States itself." Ante, at 511.

Even granting the Court's factual premise, which is by no means self-evident, the Court cites no authority for the proposition that burdens imposed on Government contractors, but passed on to the Government, burden the Government in a way that justifies extension of its immunity. However substantial such indirect burdens may be, we have held in other contexts that they are legally irrelevant. See, e. g., South Carolina v. Baker, 485 U.S. 505, 521 (1988) (our cases have "completely foreclosed any claim that the nondiscriminatory imposition of costs on private entities that pass them on to . . . the Federal Government unconstitutionally burdens . . . federal functions").

Moreover, the statutory basis on which the Court's rule of federal common law totters is more unstable than any we have ever adopted. In the first place, we rejected an analytically similar attempt to construct federal common law out of the FTCA when we held that the Government's waiver [487 U.S. 500, 528] of sovereign immunity for the torts of its employees does not give the Government an implied right of indemnity from them, even though the "[t]he financial burden placed on the United States by the Tort Claims Act [could conceivably be] so great that government employees should be required to carry part of the burden." United States v. Gilman, 347 U.S. 507, 510 (1954). So too here, the FTCA's retention of sovereign immunity for the Government's discretionary acts does not imply a defense for the benefit of contractors who participate in those acts, even though they might pass on the financial burden to the United States. In either case, the most that can be said is that the position "asserted, though the product of a law Congress passed, is a matter on which Congress has not taken a position." Id., at 511 (footnote omitted).

Here, even that much is an overstatement, for the Government's immunity for discretionary functions is not even "a product of" the FTCA. Before Congress enacted the FTCA (when sovereign immunity barred any tort suit against the Federal Government) we perceived no need for a rule of federal common law to reinforce the Government's immunity by shielding also parties who might contractually pass costs on to it. Nor did we (or any other court of which I am aware) identify a special category of "discretionary" functions for which sovereign immunity was so crucial that a Government contractor who exercised discretion should share the Government's immunity from state tort law. 6

Now, as before the FTCA's enactment, the Federal Government is immune from "[a]ny claim . . . based upon the exercise or performance [of] a discretionary function," including presumably any claim that petitioner might have brought against the Federal Government based upon respondent's negligent design of the helicopter in which Lt. Boyle died. [487 U.S. 500, 529] There is no more reason for federal common law to shield contractors now that the Government is liable for some torts than there was when the Government was liable for none. The discretionary function exception does not support an immunity for the discretionary acts of Government contractors any more than the exception for "[a]ny claim [against the Government] arising out of assault," 2680(h), supports a personal immunity for Government employees who commit assaults. Cf. Sheridan v. United States, ante, at 400. In short, while the Court purports to divine whether Congress would object to this suit, it inexplicably begins and ends its sortilege with an exception to a statute that is itself inapplicable and whose repeal would leave unchanged every relationship remotely relevant to the accident underlying this suit.

Far more indicative of Congress' views on the subject is the wrongful-death cause of action that Congress itself has provided under the Death on the High Seas Act (DOHSA), Act of Mar. 30, 1920, ch. 111, 1 et seq., 41 Stat. 537, codified at 46 U.S.C. App. 761 et seq. (1982 ed., Supp. IV) - a cause of action that could have been asserted against United Technologies had Lt. Boyle's helicopter crashed a mere three miles further off the coast of Virginia Beach. It is beyond me how a state-law tort suit against the designer of a military helicopter could be said to present any conflict, much less a "`significant conflict,'" with "federal interests . . . in the context of Government procurement," ante, at 511, when federal law itself would provide a tort suit, but no (at least no explicit) Government-contractor defense, 7 against the same [487 U.S. 500, 530] designer for an accident involving the same equipment. See Pet. for Cert. in Sikorsky Aircraft Division, United Technologies Corp. v. Kloss, O. T. 1987, No. 87-1633, pp. 3-6 (trial court holds that family of marine can bring a wrongful-death cause of action under the DOHSA against United Technologies for the negligent design of a United States Marine Corps CH-53D helicopter in which he was killed when it crashed 21 miles offshore), cert. denied, 486 U.S. 1008 (1988).

IV

At bottom, the Court's analysis is premised on the proposition that any tort liability indirectly absorbed by the Government so burdens governmental functions as to compel us to act when Congress has not. That proposition is by no means uncontroversial. The tort system is premised on the assumption that the imposition of liability encourages actors to prevent any injury whose expected cost exceeds the cost of prevention. If the system is working as it should, Government contractors will design equipment to avoid certain injuries (like the deaths of soldiers or Government employees), which would be certain to burden the Government. The Court therefore has no basis for its assumption that tort liability will result in a net burden on the Government (let alone a clearly excessive net burden) rather than a net gain.

Perhaps tort liability is an inefficient means of ensuring the quality of design efforts, but "[w]hatever the merits of the policy" the Court wishes to implement, "its conversion into law is a proper subject for congressional action, not for any creative power of ours." Standard Oil, 332 U.S., at 314 -315. It is, after all, "Congress, not this Court or the other federal courts, [that] is the custodian of the national purse. By the same token [Congress] is the primary and most often the exclusive arbiter of federal fiscal affairs. And these comprehend, as we have said, securing the treasury or the Government against financial losses however inflicted . . . ." Ibid. (emphasis added). See also Gilman, supra, [487 U.S. 500, 531] at 510-512. If Congress shared the Court's assumptions and conclusion it could readily enact "A BILL [t]o place limitations on the civil liability of government contractors to ensure that such liability does not impede the ability of the United States to procure necessary goods and services," H. R. 4765, 99th Cong., 2d Sess. (1986); see also S. 2441, 99th Cong., 2d Sess. (1986). It has not.

Were I a legislator, I would probably vote against any law absolving multibillion dollar private enterprises from answering for their tragic mistakes, at least if that law were justified by no more than the unsupported speculation that their liability might ultimately burden the United States Treasury. Some of my colleagues here would evidently vote otherwise (as they have here), but that should not matter here. We are judges not legislators, and the vote is not ours to cast.

I respectfully dissent.

[Footnote 1] See, e. g., H. R. 4765, 99th Cong., 2d Sess. (1986) (limitations on civil liability of Government contractors); S. 2441, 99th Cong., 2d Sess. (1986) (same). See also H. R. 2378, 100th Cong., 1st Sess. (1987) (indemnification of civil liability for Government contractors); H. R. 5883, 98th Cong., 2d Sess. (1984) (same); H. R. 1504, 97th Cong., 1st Sess. (1981) (same); H. R. 5351, 96th Cong., 1st Sess. (1979) (same).

[Footnote 2] Not all exercises of our power to fashion federal common law displace state law in the same way. For example, our recognition of federal causes of action based upon either the Constitution, see e. g., Bivens v. Six Unknown Fed. Narcotics Agents, 403 U.S. 388 (1971), or a federal statute, see Cort v. Ash, 422 U.S. 66 (1975), supplements whatever rights state law might provide, and therefore does not implicate federalism concerns in the same way as does pre-emption of a state-law rule of decision or cause of action. Throughout this opinion I use the word "displace" in the latter sense.

[Footnote 3] True, in this case the collateral relationship is the relationship between victim and tortfeasor, rather than between contractors, but that distinction makes no difference. We long ago established that the principles governing application of federal common law in "contractual relations of the Government . . . are equally applicable . . . where the relations affected are noncontractual or tortious in character." United States v. Standard Oil Co., 332 U.S. 301, 305 (1947).

[Footnote 4] "QUESTION: [Would it be] a proper judicial function to craft the contours of the military contractor defense . . . even if there were no discretionary function exemption in the Federal Tort Claims Act?

"MR. LACOVARA: I think, yes. . . . [I]t ought not to make a difference to the contractor, or to the courts, I would submit, whether or not the Government has a discretionary function exception under the Federal Tort Claims Act. . . .

"QUESTION: I think your position would be the same if Congress had never waived its sovereign immunity in the Federal Tort Claims Act. . . .

"MR. LACOVARA: That's correct. . . .

"QUESTION: Now wait. I really don't understand that. It seems to me you can make the argument that there should be preemption if Congress wanted it, but how are we to perceive that's what Congress wanted if in the Tort Claims Act, Congress had said the Government itself should be liable for an ill designed helicopter? Why would we have any reason to think that Congress wanted to preempt liability of a private contractor for an ill designed helicopter?

. . . . .

"QUESTION: . . . [Y]our preemption argument, I want to be sure I understand it - does not depend at all on the Federal Tort Claims Act, as I understand it. . . .

"MR. LACOVARA: That's correct." Tr. of Oral Arg. 33-35 (reargument Apr. 27, 1988).

[Footnote 5] "QUESTION: Does the Government's position depend at all on the discretionary function exemption in the Federal Tort Claims Act?

"MR. AYER: Well, that's a hard question to answer. . . . I think my answer to you is, no, ultimately it should not." Id., at 40-41.

[Footnote 6] Some States, of course, would not have permitted a stranger to the contract to bring such a tort suit at all, but no one suggested that this rule of state tort law was compelled by federal law.

[Footnote 7] But cf. Tozer v. LTV Corp., 792 F.2d 403 (CA4 1986) (applying defense in DOHSA case), cert. pending, No. 86-674; Shaw v. Grumman Aerospace Corp., 778 F.2d 736 (CA11 1985) (same), cert. pending, No. 85-1529; Koutsoubos v. Boeing Vertol, Division of Boeing Co., 755 F.2d 352 (CA3) (same), cert. denied, 474 U.S. 821 (1985); McKay v. Rockwell Int'l Corp., 704 F.2d 444 (CA9 1983) (same), cert. denied, 464 U.S. 1043 (1984).

JUSTICE STEVENS, dissenting.

When judges are asked to embark on a lawmaking venture, I believe they should carefully consider whether they, or a legislative body, are better equipped to perform the task at hand. There are instances of so-called interstitial lawmaking that inevitably become part of the judicial process. 1 But when we are asked to create an entirely new doctrine - to answer "questions of policy on which Congress has not spoken," United States v. Gilman, 347 U.S. 507, 511 (1954) - we have a special duty to identify the proper decisionmaker before trying to make the proper decision. [487 U.S. 500, 532]

When the novel question of policy involves a balancing of the conflicting interests in the efficient operation of a massive governmental program and the protection of the rights of the individual - whether in the social welfare context, the civil service context, or the military procurement context - I feel very deeply that we should defer to the expertise of the Congress. That is the central message of the unanimous decision in Bush v. Lucas, 462 U.S. 367 (1983); 2 that is why I joined the majority in Schweiker v. Chilicky, ante, p. 412, 3 a case decided only three days ago; and that is why I am so distressed by the majority's decision today. For in this case, as in United States v. Gilman, supra: "The selection of that policy which is most advantageous to the whole involves a host of considerations that must be weighed and appraised. That function is more appropriately for those who write the laws, rather than for those who interpret them." Id., at 511-513.

I respectfully dissent.

[Footnote 1] "I recognize without hesitation that judges do and must legislate, but they can do so only interstitially; they are confined from molar to molecular motions. A common-law judge could not say I think the doctrine of consideration a bit of historical nonsense and shall not enforce it in my court. No more could a judge exercising the limited jurisdiction of admiralty say I think well of the common-law rules of master and servant and propose to introduce them here en bloc." Southern Pacific Co. v. Jensen, 244 U.S. 205, 221 (1971) (Holmes, J., dissenting).

[Footnote 2] "[W]e decline to create a new substantive legal liability without legislative aid and as at the common law, because we are convinced that Congress is in a better position to decide whether or not the public interest would be served by creating it." 462 U.S., at 390 (internal quotation omitted).

[Footnote 3] "Congressional competence at `balancing governmental efficiency and the rights of [individuals],' Bush, 462 U.S., at 389 , is no more questionable in the social welfare context than it is in the civil service context. Cf. Forrester v. White, 484 U.S. 219, 223 -224 (1988)." Ante, at 425. [487 U.S. 500, 533]

Basic concepts of real-time operating systems

by David Kalinsky (Nov. 18, 2003)

The fundamentals

To most people, embedded systems are not recognizable as computers. Instead, they are hidden inside everyday objects that surround us and help us in our lives. Embedded systems typically do not interface with the outside world through familiar personal computer interface devices such as a mouse, keyboard and graphic user interface. Instead, they interface with the outside world through unusual interfaces such as sensors, actuators and specialized communication links.

Real-time and embedded systems operate in constrained environments in which computer memory and processing power are limited. They often need to provide their services within strict time deadlines to their users and to the surrounding world. It is these memory, speed and timing constraints that dictate the use of real-time operating systems in embedded software.

Basic kernel services

In the discussion below, we will focus on the "kernel" ? the part of an operating system that provides the most basic services to application software running on a processor.

The "kernel" of a real-time operating system ("RTOS") provides an "abstraction layer" that hides from application software the hardware details of the processor (or set of processors) upon which the application software will run. This is shown in Figure1.

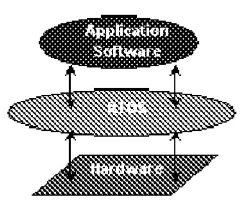

Figure 1: An RTOS Kernel provides an Abstraction Layer between Application Software and Embedded Hardware

In providing this "abstraction layer" the RTOS kernel supplies five main categories of basic services to application software, as seen in Figure 2.

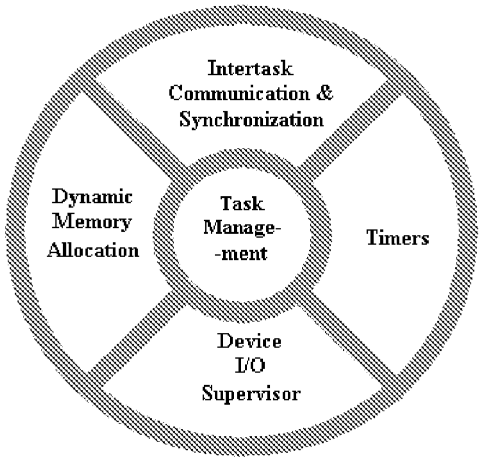

Figure 2: Basic Services Provided by a Real-Time Operating System Kernel

The most basic category of kernel services, at the very center of Figure 2, is Task Management. This set of services allows application software developers to design their software as a number of separate "chunks" of software -- each handling a distinct topic, a distinct goal, and perhaps its own real-time deadline. Each separate "chunk" of software is called a "task." Services in this category include the ability to launch tasks and assign priorities to them. The main RTOS service in this category is the scheduling of tasks as the embedded system is in operation. The Task Scheduler controls the execution of application software tasks, and can make them run in a very timely and responsive fashion. [Later, we will see the details of how this is done.]

The second category of kernel services, shown at the top of Figure 2, is Intertask Communication and Synchronization. These services make it possible for tasks to pass information from one to another, without danger of that information ever being damaged. They also make it possible for tasks to coordinate, so that they can productively cooperate with one another. Without the help of these RTOS services, tasks might well communicate corrupted information or otherwise interfere with each other.

Since many embedded systems have stringent timing requirements, most RTOS kernels also provide some basic Timer services, such as task delays and time-outs. These are shown on the right side of Figure 2.

Many (but not all) RTOS kernels provide Dynamic Memory Allocation services. This category of services allows tasks to "borrow" chunks of RAM memory for temporary use in application software. Often these chunks of memory are then passed from task to task, as a means of quickly communicating large amounts of data between tasks. Some very small RTOS kernels that are intended for tightly memory-limited environments, do not offer Dynamic Memory Allocation services.

Many (but not all) RTOS kernels also provide a "Device I/O Supervisor" category of services. These services, if available, provide a uniform framework for organizing and accessing the many hardware device drivers that are typical of an embedded system. [For more information on this, please visit: the device drivers page at the Kalinsky Associates Website]

In addition to kernel services, many RTOSs offer a number of optional add-on operating system components for such high-level services as file system organization, network communication, network management, database management, user-interface graphics, etc. Although many of these add-on components are much larger and much more complex than the RTOS kernel, they rely on the presence of the RTOS kernel and take advantage of its basic services. Each of these add-on components is included in an embedded system only if its services are needed for implementing the embedded application, in order to keep program memory consumption to a minimum.

In this paper, we will focus on the basic RTOS kernel services for task management, intertask communication and synchronization, and dynamic memory allocation.

RTOSs vs. general-purpose operating systems

Many non-real-time operating systems also provide similar kernel services. The key difference between general-computing operating systems and real-time operating systems is the need for " **deterministic** " timing behavior in the real-time operating systems. Formally, "deterministic" timing means that operating system services consume only known and expected amounts of time. In theory, these service times could be expressed as mathematical formulas. These formulas must be strictly algebraic and not include any random timing components. Random elements in service times could cause random delays in application software and could then make the application randomly miss real-time deadlines ? a scenario clearly unacceptable for a real-time embedded system.

General-computing non-real-time operating systems are often quite non-deterministic. Their services can inject random delays into application software and thus cause slow responsiveness of an application at unexpected times. If you ask the developer of a non-real-time operating system for the algebraic formula describing the timing behavior of one of its services (such as sending a message from task to task), you will invariably not get an algebraic formula. Instead the developer of the non-real-time operating system (such as Windows, Unix or Linux) will just give you a puzzled look. Deterministic timing behavior was simply not a design goal for these general-computing operating systems.

On the other hand, real-time operating systems often go a step beyond basic determinism. For most kernel services, these operating systems offer constant **load-independent** timing: In other words, the algebraic formula is as simple as: ***T(message_send) = constant*** , irrespective of the length of the message to be sent, or other factors such as the numbers of tasks and queues and messages being managed by the RTOS.

Task scheduling

Most RTOSs do their scheduling of tasks using a scheme called "priority-based preemptive scheduling." Each task in a software application must be assigned a priority, with higher priority values representing the need for quicker responsiveness. Very quick responsiveness is made possible by the "preemptive" nature of the task scheduling. "Preemptive" means that the scheduler is allowed to stop any task at any point in its execution, if it determines that another task needs to run immediately.

The basic rule that governs priority-based preemptive scheduling is that at every moment in time, "The Highest Priority Task that is Ready to Run, will be the Task that Must be Running." In other words, if both a low-priority task and a higher-priority task are ready to run, the scheduler will allow the higher-priority task to run first. The low-priority task will only get to run after the higher-priority task has finished with its current work.

What if a low-priority task has already begun to run, and then a higher-priority task becomes ready? This might occur because of an external world trigger such as a switch closing. A priority-based preemptive scheduler will behave as follows: It will allow the low-priority task to complete the current assembly-language instruction that it is executing. [But it won?t allow it to complete an entire line of high-level language code; nor will it allow it to continue running until the next clock tick.] It will then immediately stop the execution of the low-priority task, and allow the higher-priority task to run. After the higher-priority task has finished its current work, the low-priority task will be allowed to continue running. This is shown in Figure 3, where the higher-priority task is called "Mid-Priority Task."

Of course, while the mid-priority task is running, an even higher-priority task might become ready. This is represented in Figure 3 by "Trigger_2" causing the "High-Priority Task" to become ready. In that case, the running task ("Mid-Priority Task") would be preempted to allow the high-priority task to run. When the high-priority task has finished its current work, the mid-priority task would be allowed to continue. And after both the high-priority task and the mid-priority task complete their work, the low-priority task would be allowed to continue running. This situation might be called "nested preemption."

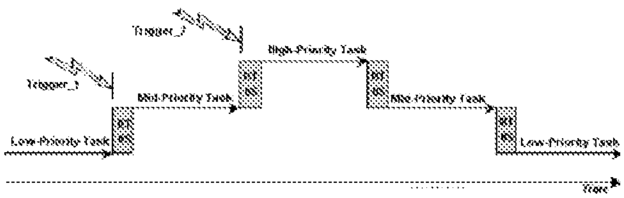

Figure 3: Timeline for Priority-based Preemptive Scheduling Examples

Each time the priority-based preemptive scheduler is alerted by an external world trigger (such as a switch closing) or a software trigger (such as a message arrival), it must go through the following 5 steps:

- Determine whether the currently running task should continue to run. If not ?
- Determine which task should run next.
- Save the environment of the task that was stopped (so it can continue later).
- Set up the running environment of the task that will run next.
- Allow this task to run.

These 5 steps together are called "task switching."

Fixed-time task switching

The time it takes to do task switching is of interest when evaluating an operating system. A simple general-computing (non-preemptive) operating system might do task switching only at timer tick times, which might for example be ten milliseconds apart. Then if the need for a task switch arises anywhere within a 10-millisecond timeframe, the actual task switch would occur only at the end of the current 10-millisecond period. Such a delay would be unacceptable in most real-time embedded systems.

In more sophisticated preemptive task schedulers, the scheduler may need to search through arrays of tasks to determine which task should be made to run next. If there are more tasks to search through, the search will take longer. Such searches are often done by general-computing operating systems, thus making them non-deterministic. Real-time operating systems, on the other hand, avoid such searches by using incrementally updated tables that allow the task scheduler to identify the task that should run next in a rapid fixed-time fashion.

These two types of timing behavior for task switching can be seen in Figure 4.

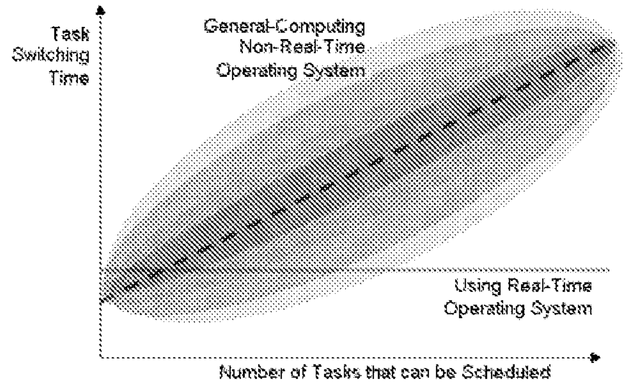

Figure 4: Task Switching Timing

In this figure, we see that for a general-computing (non-real-time) operating system, the task switching time generally rises as a software system includes more tasks that can be scheduled. However, the actual time for a task switch is not the time shown by the dashed red line. Instead, in any given task switch instance, it might be well above or well below the time shown by the dashed red line. The shaded regions surrounding the dashed red line simply show the likelihood of the actual task switch time being that far above or below the dashed red line.

On the other hand, the horizontal solid green line shows the task switching time characteristic of a real-time operating system. It is constant, independent of any load factor such as the number of tasks in a software system.

Please note that in some instances, such as the leftmost area of the graph, the task switching time might in special cases be quicker for a general-computing non-real-time operating system, than for a real-time operating system. This does not detract from the appropriateness of a real-time operating system for real-time embedded applications. For, in fact, the term "real-time" does not mean "as fast as possible" but rather "real-time" demands consistent, repeatable, known timing performance. Although a non-real-time operating system might do some faster task switching for small numbers of tasks, it might equally well introduce a long time delay the next time it does the same task switch. The strength of a real-time operating system is in its known, repeatable timing performance, which is also typically faster than that of a non-deterministic task scheduler in situations of large numbers of tasks in a software system. Most often, the real-time operating system will exhibit task-switching times much faster than its non-real-time competitor when the number of tasks grows above 5 or 10.

Intertask communication and synchronization

Most operating systems, including RTOSs, offer a variety of mechanisms for communication and synchronization between tasks. These mechanisms are necessary in a preemptive environment of many tasks, because without them the tasks might well communicate corrupted information or otherwise interfere with each other.

For instance, a task might be preempted when it is in the middle of updating a table of data. If a second task that preempts it reads from that table, it will read a combination of some areas of newly-updated data plus some areas of data that have not yet been updated. [New Yorkers would call this a "mish-mash."] These updated and old data areas together may be incorrect in combination, or may not even make sense. An example is a data table containing temperature measurements that begins with the contents "10 C." A task begins updating this table with the new value "99 F", writing into the table character-by-character. If that task is preempted in the middle of the update, a second task that preempts it could possibly read a value like "90 C" or "99 C." or "99 F", depending on precisely when the preemption took place. The partially updated values are clearly incorrect, and are caused by delicate timing coincidences that are very hard to debug or reproduce consistently.

An RTOS's mechanisms for communication and synchronization between tasks are provided to avoid these kinds of errors. Most RTOSs provide several mechanisms, with each mechanism optimized for reliably passing a different kind of information from task to task.

Probably the most popular kind of communication between tasks in embedded systems is the passing of data from one task to another. Most RTOSs offer a message passing mechanism for doing this, as seen in Figure 5. Each message can contain an array or buffer of data.

Figure 5: Intertask Message Communication

If messages can be sent more quickly than they can be handled, the RTOS will provide message queues for holding the messages until they can be processed. This is shown in Figure6.

Another kind of communication between tasks in embedded systems is the passing of what might be called "synchronization information" from one task to another. "Synchronization information" is like a command, where some commands could be positive, and some negative. For example, a negative command to a task would be something like "Please don?t print right now, because my task is using the printer." Or more generally, "I want to lock the . . . for my own use only." A positive command would be something like "I?ve detected a cardiac emergency, and I want you to help me handle it." Or more generally, "Please join me in handling . . ."

Most RTOSs offer a semaphore or mutex mechanism for handling negative synchronization (sometimes called "mutual exclusion"). These mechanisms allow tasks to lock certain embedded system resources for their use only, and subsequently to unlock the resource when they?re done.

For positive synchronization, different RTOSs offer different mechanisms. Some RTOSs offer event-flags, while others offer signals. And yet others rely on message passing for positive synchronization as well as data passing duties.

Determinism and high-speed message passing

Intertask message communication is another area where different operating systems show different timing characteristics. Most operating systems actually copy messages twice as they transfer them from task to task via a message queue. See Figure 6. The first copying is from the message-sender task to an operating system-owned "secret" area of RAM memory (implementing the "message queue"); and the second copying is from the operating system?s "secret" RAM area to the message-receiver task. Clearly this is non-deterministic in its timing, as these copying activities take longer as message length increases.

Figure 6: Message Transfer via Message Queue

An approach that avoids this non-determinism and also accelerates performance, is to have the operating system copy a pointer to the message and deliver that pointer to the message-receiver task without moving the message contents at all. In order to avoid access collisions, the operating system then needs to go back to the message-sender task and obliterate its copy of the pointer to the message. For large messages, this eliminates the need for lengthy copying and eliminates non-determinism.

Dynamic memory allocation

Determinism of service times is also an issue in the area of dynamic allocation of RAM memory. Many general-computing non-real-time operating systems offer memory allocation services from what is termed a "Heap." The famous "malloc" and "free" services known to C-language programmers work from a heap. Tasks can temporarily borrow some memory from the operating system?s heap by calling "malloc", and specifying the size of memory buffer needed. When this task (or another task) is finished with this memory buffer it can return the buffer to the operating system by calling "free." The operating system will then return the buffer to the heap, where its memory might be used again, perhaps as part of a larger buffer. Or perhaps it may in the future be broken into several smaller buffers.

Heaps suffer from a phenomenon called "External Memory Fragmentation" that may cause the heap services to degrade. This fragmentation is caused by the fact that when a buffer is returned to the heap, it may in the future be broken into smaller buffers when "malloc" requests for smaller buffer sizes occur. After a heap undergoes many cycles of "malloc"s and "free"s, small slivers of memory may appear between memory buffers that are being used by tasks. These slivers are so small that they are useless to tasks. But they are trapped between buffers that are being used by tasks, so they can?t be coagulated ("glued") together into bigger, useful buffer sizes. Over time, a heap will have more and more of these slivers. This will eventually result in situations where tasks will ask for memory buffers ("malloc") of a certain size, and they will be refused by the operating system --- even though the operating system has enough available memory in its heap. The problem: That memory is scattered in small slivers distributed in various separate parts of the heap. In operating system terminology, the slivers are called "fragments", and this problem is called "external memory fragmentation."

This fragmentation problem can be solved by so-called "garbage collection" (defragmentation) software. Unfortunately, "garbage collection" algorithms are often wildly non-deterministic ? injecting randomly-appearing random-duration delays into heap services. These are often seen in the memory allocation services of general-computing non-real-time operating systems.

This puts the embedded system developer who wants to use a general-computing non-real-time operating system into a quandry: Should the embedded system be allowed to suffer occasional randomly-appearing random-duration delays if / when "garbage collection" kicks in?... Or, alternatively, should the embedded system be allowed to fragment its memory until application software "malloc" requests to the heap are refused even though a sufficient total amount of free memory is still available? Neither alternative is acceptable for embedded systems that need to provide service continually for long periods of time.

Real-time operating systems, on the other hand, solve this quandry by altogether avoiding both memory fragmentation and "garbage collection", and their consequences. RTOSs offer non-fragmenting memory allocation techniques instead of heaps. They do this by limiting the variety of memory chunk sizes they make available to application software. While this approach is less flexible than the approach taken by memory heaps, they do avoid external memory fragmentation and avoid the need for defragmentation. For example, the "Pools" memory allocation mechanism allows application software to allocate chunks of memory of perhaps 4 or 8 different buffer sizes per pool. Pools totally avoid external memory fragmentation, by not permitting a buffer that is returned to the pool to be broken into smaller buffers in the future. Instead, when a buffer is returned the pool, it is put onto a "free buffer list" of buffers of its own size that are available for future re-use at their original buffer size. This is shown in Figure 7.

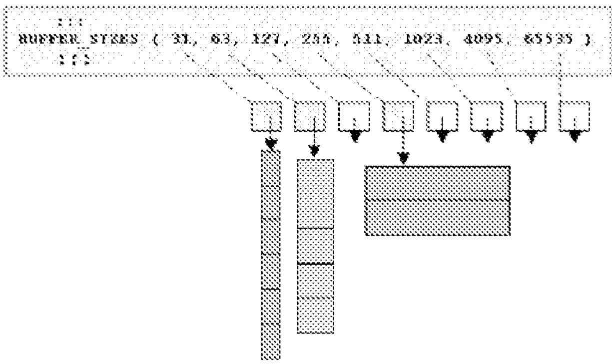

Figure 7: A Memory Pool's Free Buffer Lists

Memory is allocated and de-allocated from a pool with deterministic, often constant, timing.

Summary

Real-time and embedded systems are used in many applications such as airborne computers, medical instruments and communication systems. Embedded systems are characterized by limited processor memory, limited processing power, and unusual interfaces to the outside world. Real-time requirements impose stringent time deadlines for delivering the results of embedded processing.

RTOS kernels hide from application software the low-level details of system hardware, and at the same time provide several categories of services to application software. These include: task management with priority-based preemptive scheduling, reliable intertask communication and synchronization, non-fragmenting dynamic memory allocation, and basic timer services.

The issue of timing determinism is important in differentiating general-computing operating systems from real-time operating systems. This issue crops up in many parts of operating system kernels, such as task schedulers, dynamic memory allocation and intertask message communication. While general-computing operating systems often offer non-deterministic services in these areas, fully deterministic solutions are needed for real-time and embedded systems. A number of real-time operating systems implement these solutions in their compact high-performance kernels.

About the author: David Kalinsky is a popular lecturer and seminar leader on technologies for embedded software. He regularly presents classes at the Embedded Systems Conferences in the US and Europe, on topics such as "Architectural Design of Device I/O Drivers," and "Principles of High-Availability Embedded Systems Design." During the past 15 years, David has built high-tech training programs for a number of Silicon Valley companies on the development of real-time and embedded systems. Before that, he was involved in the design of embedded medical and aerospace systems. David holds a Ph.D. in nuclear physics from Yale. He can be reached at david@kalinskyassociates.com. An online sample lecture, course list, schedule, and price list are available on the Kalinsky Associates Website.

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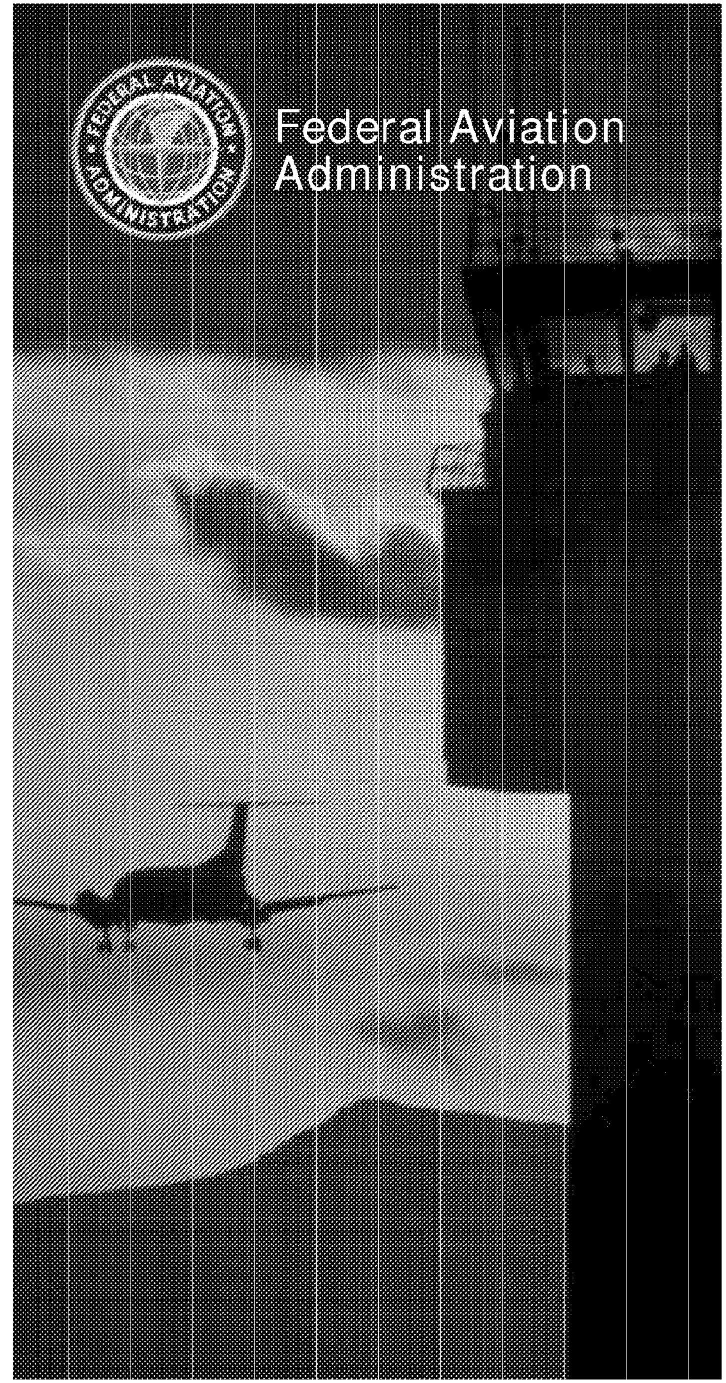
Unmanned Aircraft Systems

Integration into the National Airspace System (NAS)

Presented to: Access5

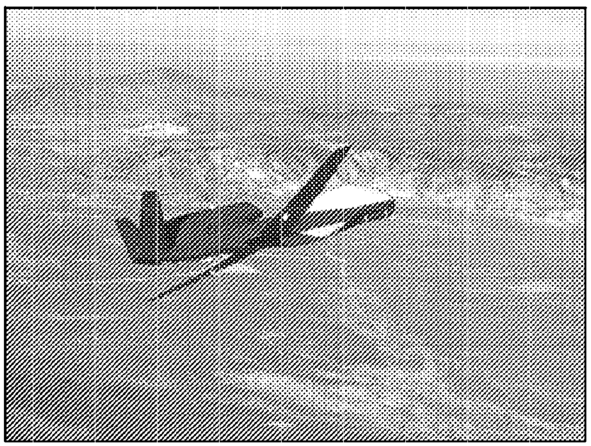
By: John Timmerman

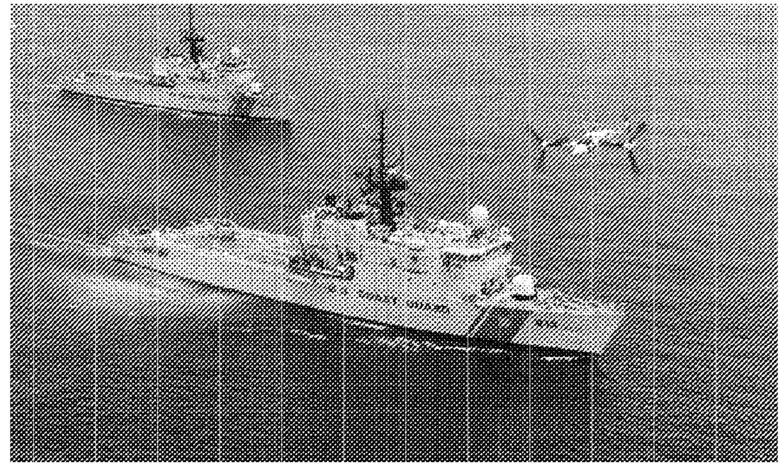
Date: July 12, 2005

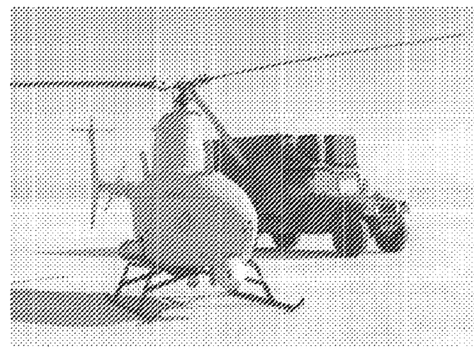


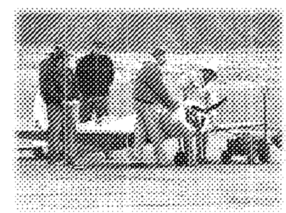
What is UAS?

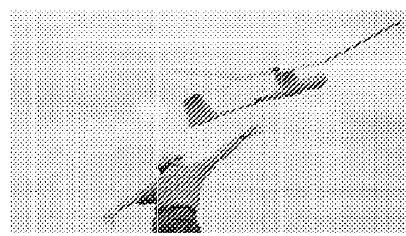
- Unmanned Aircraft Systems (UAS) historically called by various terms:
  - Drone/ROA/RPV/UAV/Model/R-C
- Includes:
  - Unmanned Aircraft (UA)
  - Aircraft Control Station
  - Command & Control Link/s
- Operated or flown by a “pilot”

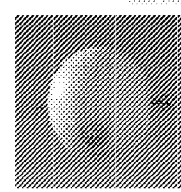


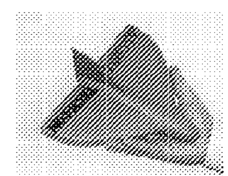












Current UAS Operations in the NAS

- Within “segregated” airspace
  - Includes Special Use Airspace (SUA) & Air Traffic Control Assigned Airspace (ATCAA)
  - Primarily by DOD

- In non-segregated airspace
  - “Public” UAS – through Certificate of Authorization (COA) process
    - Includes initial “trials” in support of DHS
  - “Civil” UAS – using experimental / type certification process
  - “Model” aircraft – with guidance from AC 91-57, dated June 1981
  - Variety of other operations believed to be occurring by both the public and private sector
    - Some based on interpretations of “model” aircraft guidance
    - Others with a lack of knowledge of aviation environment requirements

- While ensuring “no harm” to other NAS customers and public

Expected Changes - Next 5-10 years

- Many UAS's transitioning from R&D to operational status
  - Routine UAS flight - both VFR and IFR and in all airspace classes
- Wider scale development and uses for UAS
  - R&D activities in public and civil sectors continue to grow
  - New uses and applications – innovative customers and providers
- Increased demands on the NAS
  - Greater numbers and diversity of requests to operate in the NAS
  - UAS operations "mushrooming" in an increasingly busy NAS
  - Additional airspace and access requested for UAS flight
    - Including security and surveillance
      - Border and harbor patrol
      - Broad spectrum of law enforcement activities
  - Pressure for quicker access - "file and fly"
  - Conflicting interests among aviation stakeholders
- International efforts to "harmonize out of the box"

2015 and Beyond

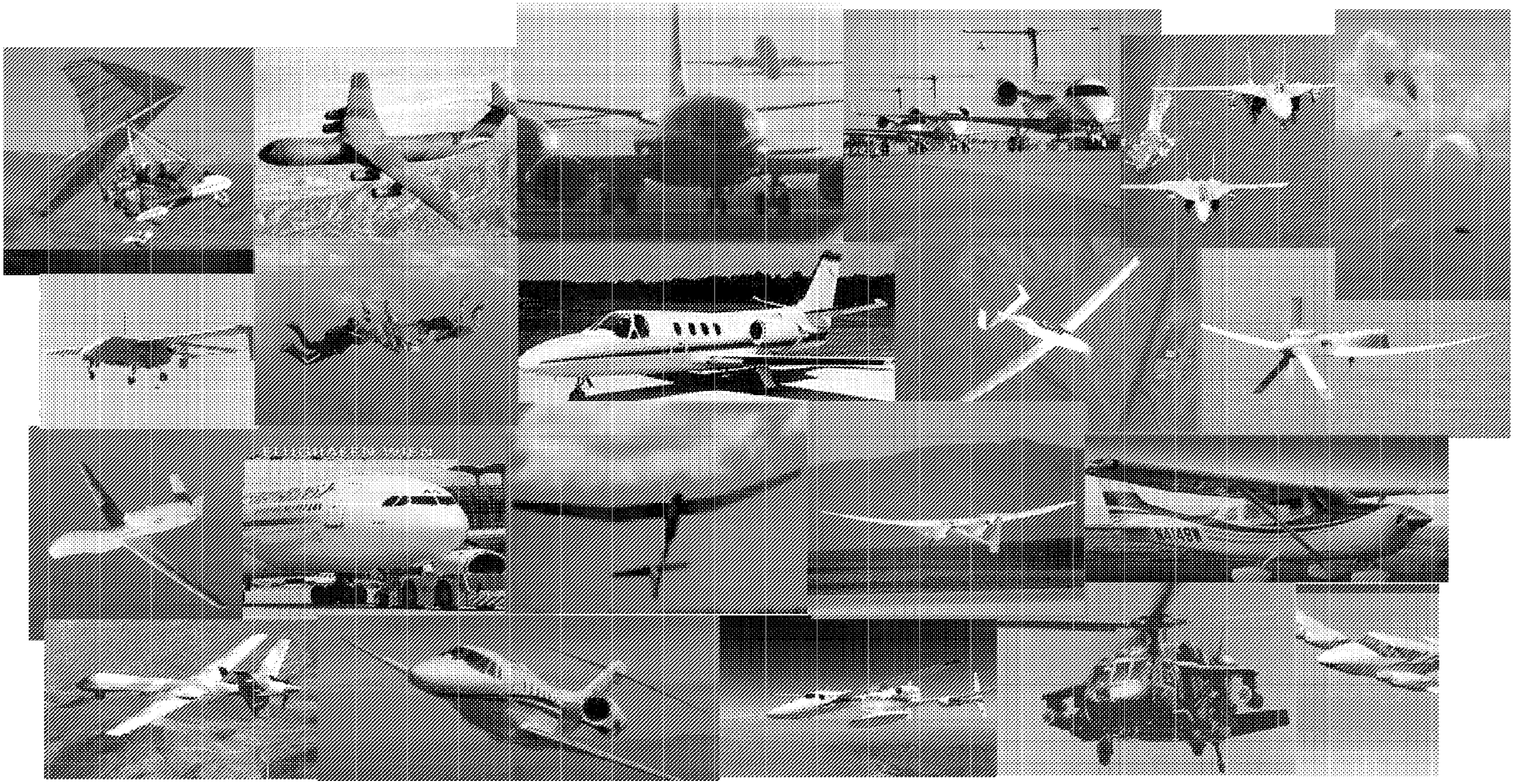
- UAS operations dominate some aviation sectors
  - Particularly those "dirty, dull or dangerous"
- Commercial UAS applications steadily grow
  - Driven by "business cases" for reduced costs
- Consumers becoming increasingly receptive to reduced human presence in aircraft cockpits
  - Passenger flights with a single "supervisory" pilot
  - Cargo operations without an on-board pilot
- Increased "cooperation" needed between aviation segments to efficiently manage finite airspace resources
- Increased expectations for higher levels of safety

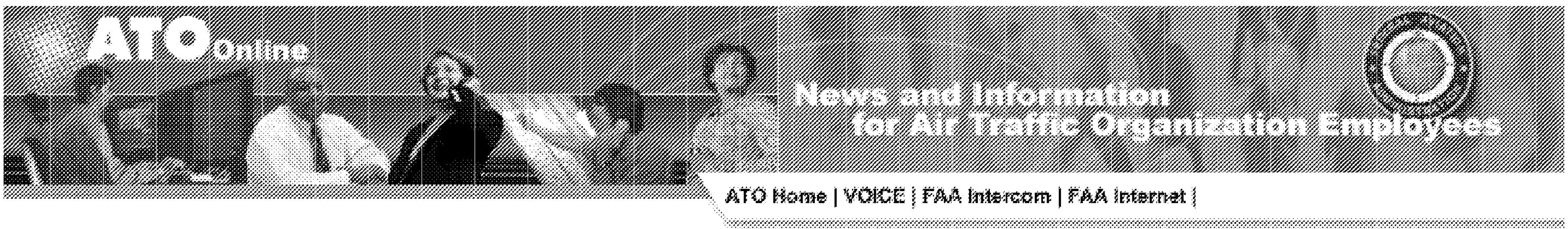
GOAL

&

RESPONSIBILITY!

A Safe NAS for All





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Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	System and Method For Safely Flying Unmanned Aerial Vehicles in Civilian Airspace
First Named Inventor/Applicant Name:	Jed Margolin
Filer:	Jed Margolin
Attorney Docket Number:	

Filed as Small Entity

Utility Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Utility filing Fee (Electronic filing)	4011	1	75	75
Utility Search Fee	2111	1	250	250
Utility Examination Fee	2311	1	100	100
Pages:				
Claims:				
Independent claims in excess of 3	2201	1	100	100
Miscellaneous-Filing:				
Petition:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**525**

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Application Number:	11736356
International Application Number:	
Confirmation Number:	3649
Title of Invention:	System and Method For Safely Flying Unmanned Aerial Vehicles in Civilian Airspace
First Named Inventor/Applicant Name:	Jed Margolin
Customer Number:	23497
Filer:	Jed Margolin
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Document Number	Document Description	File Name	File Size(Bytes)	Multi Part /.zip	Pages (if appl.)

1	Transmittal of New Application	jm_rpv2_xmit.pdf	120403	no	1
Warnings:					
Information:					
2	Oath or Declaration filed	jm_rpv2_decl.pdf	212345	no	2
Warnings:					
Information:					
3	Abstract	jm_rpv2_abstract.pdf	9346	no	1
Warnings:					
Information:					
4	Specification	jm_rpv2_spec.pdf	107647	no	16
Warnings:					
Information:					
5	Claims	jm_rpv2_claims.pdf	20788	no	4
Warnings:					
Information:					
6	Drawings	jm_rpv2_dwgs.pdf	16492	no	4
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7	Information Disclosure Statement (IDS) Filed	jm_rpv2_ids.pdf	240456	no	3
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8	NPL Documents	jm_rpv2_npl_01.pdf	176784	no	3
Warnings:					
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9	NPL Documents	jm_rpv2_npl_02.pdf	2520004	no	19
Warnings:					

Information:					
10	NPL Documents	jm_rpv2_npl_04.pdf	476572	no	2
Warnings:					
Information:					
11	NPL Documents	jm_rpv2_npl_05.pdf	74142	no	2
Warnings:					
Information:					
12	NPL Documents	jm_rpv2_npl_06.pdf	588716	no	3
Warnings:					
Information:					
13	NPL Documents	jm_rpv2_npl_07.pdf	34338	no	5
Warnings:					
Information:					
14	NPL Documents	jm_rpv2_npl_08.pdf	13255	no	1
Warnings:					
Information:					
15	NPL Documents	jm_rpv2_npl_09.pdf	136223	no	3
Warnings:					
Information:					
16	NPL Documents	jm_rpv2_npl_10.pdf	10678	no	1
Warnings:					
Information:					
17	NPL Documents	jm_rpv2_npl_11.pdf	60845	no	3
Warnings:					
Information:					
18	NPL Documents	jm_rpv2_npl_12.pdf	46142	no	5
Warnings:					

Information:					
19	NPL Documents	jm_rpv2_npl_13.pdf	34534	no	3
Warnings:					
Information:					
20	NPL Documents	jm_rpv2_npl_14.pdf	167348	no	10
Warnings:					
Information:					
21	NPL Documents	jm_rpv2_npl_15.pdf	102786	no	19
Warnings:					
Information:					
22	NPL Documents	jm_rpv2_npl_16.pdf	347502	no	9
Warnings:					
Information:					
23	NPL Documents	jm_rpv2_npl_03.pdf	1652727	no	8
Warnings:					
Information:					
24	Fee Worksheet (PTO-06)	fee-info.pdf	8486	no	2
Warnings:					
Information:					
			Total Files Size (in bytes):	7178559	

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If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

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PTO/SB/06 (12-04)

04/17/07

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PATENT APPLICATION FEE DETERMINATION RECORD
Substitute for Form PTO-875

Application or Docket Number: 11/736,356

APPLICATION AS FILED – PART I

FOR	NUMBER FILED (Column 1)	NUMBER EXTRA (Column 2)	SMALL ENTITY RATE ($)	SMALL ENTITY FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY FEE ($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	75		N/A	
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	250		N/A	
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	100		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	14 minus 20 =	*	X$ 25=		OR	X$50=	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	4 minus 3 =	* 1	X$100=	100		X$200=	
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $250 ($125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR						
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))			N/A			N/A	
			TOTAL	525		TOTAL	

* If the difference in column 1 is less than zero, enter "0" in column 2.

APPLICATION AS AMENDED – PART II

AMENDMENT A	CLAIMS REMAINING AFTER AMENDMENT (Column 1)		HIGHEST NUMBER PREVIOUSLY PAID FOR (Column 2)	PRESENT EXTRA (Column 3)	SMALL ENTITY RATE ($)	SMALL ENTITY ADDI-TIONAL FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY ADDI-TIONAL FEE ($)
Total (37 CFR 1.16(i))	*	Minus	**	=	X =		OR	X =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	X =		OR	X =	
Application Size Fee (37 CFR 1.16(s))									
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))					N/A		OR	N/A	
					TOTAL ADD'T FEE		OR	TOTAL ADD'T FEE	

AMENDMENT B	CLAIMS REMAINING AFTER AMENDMENT (Column 1)		HIGHEST NUMBER PREVIOUSLY PAID FOR (Column 2)	PRESENT EXTRA (Column 3)	RATE ($)	ADDI-TIONAL FEE ($)	OR	RATE ($)	ADDI-TIONAL FEE ($)
Total (37 CFR 1.16(i))	*	Minus	**	=	X =		OR	X =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	X =		OR	X =	
Application Size Fee (37 CFR 1.16(s))									
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))					N/A		OR	N/A	
					TOTAL ADD'T FEE		OR	TOTAL ADD'T FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.