National Aeronautics and Space Administration

Appeal under the Freedom of Information Act
to NASA Response Dated May 14, 2009 and
received via email May 18, 2009

FOIA 08-270 Filed: June 28, 2008

Jed Margolin

Appendix NA

Jed Margolin
1981 Empire Rd.
Reno, NV 89521-7430
775-847-7845
jm@jmargolin.com

Appendix NA - Table of Contents

Jed Margolin

From: "HQ-FOIA" <hq-foia@nasa.gov>
To: <jm@jmargolin.com>
Sent: Monday, May 18, 2009 12:30 PM
Attach: 2008-270.pdf; 08-270.DOC
Subject: FOIA 2008-270

FOIA 08-270 May 14, 2009

Mr. Jed Margolin
1981 Empire Road
Reno, NV 89521-7430
jm@jmargolin.com

Dear Mr. Margolin:

This is in response to your request received on June 30, 2008, pursuant to the Freedom of Information Act (FOIA) for *documents related to the Administrative Claim of Jed Margolin for infringement of U.S. Patent Nos. 5,566, 073 and 5,904,724; NASA Case No. I-222.*

The NASA Headquarters Office of the General Counsel conducted a search and from that search provided the enclosed documents responsive to your request.

It has been determined that portions of the records found responsive to your request contain information which is exempt from disclosure under the deliberative process privilege of Exemption 5. This privilege covers advisory opinions, recommendations, and deliberations, which are part of the government decision-making process, 5. U.S.C.§552(b)(5).

You may appeal this initial determination to the NASA Administrator. Your appeal must (1) be addressed to the Administrator, National Aeronautics and Space Administration, Washington, DC 20546, (2) be clearly identified on the envelope and in the letter as an "Appeal under the Freedom of Information Act", (3) include a copy of the request for the agency record and a copy of this initial adverse determination, (4) to the extent possible, state the reasons why you believe this initial determination should be reversed, and (5) be sent to the Administrator within thirty (30) calendar days of the receipt of this initial determination.

I apologize for the delay in processing your request. I appreciate your patience.

Sincerely,

Original Signed

Kellie N. Robinson
FOIA Public Liaison Officer
Headquarters
NASA
300 E Street, SW
Washington, DC 20546

Enclosures

From: McConnell, Stephen (HQ-NB000) [mailto:stephen.mcconnell-1@nasa.gov]
Sent: Tuesday, July 01, 2008 8:45 AM
To: foia@hq.nasa.gov
Cc: Robinson, Kellie N. (HQ-NB000)
Subject: FW: FOIA Request

From: Jed Margolin [mailto:jm@jmargolin.com]
Sent: Saturday, June 28, 2008 10:06 PM
To: nasafoia@nasa.gov
Subject: FOIA Request

This request is made pursuant to the Freedom of Information Act.

I would like all documents related to the **Administrative Claim of Jed Margolin for Infringement of U.S. Patent Nos. 5,566,073 and 5,904,724; NASA Case No. I-222**.
I am attaching a letter dated June 11, 2003 from Alan Kennedy, Director, Infringement Division, Office of the Associate General Counsel as file ***jm_nasa.pdf***. I provided the information requested, it was received by Mr. Kennedy, and thereafter Mr. Kennedy refused to respond to my attempts to find out the results of the investigation.

I believe NASA has had enough time to have completed its investigation by now.

Jed Margolin
1981 Empire Rd.
Reno, NV 89521-7430
775-847-7845
www.jmargolin.com

FOIA 08-270 May 14, 2009

Mr. Jed Margolin
1981 Empire Road
Reno, NV 89521-7430
jm@jmargolin.com

Dear Mr. Margolin:

This is in response to your request received on June 30, 2008, pursuant to the Freedom of Information Act (FOIA) for *documents related to the Administrative Claim of Jed Margolin for infringement of U.S. Patent Nos. 5,566, 073 and 5,904,724; NASA Case No. I-222.*

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I apologize for the delay in processing your request. I appreciate your patience.

Sincerely,

Original Signed

Kellie N. Robinson
FOIA Public Liaison Officer
Headquarters
NASA
300 E Street, SW
Washington, DC 20546

Enclosures

National Aeronautics and Space Administration
Headquarters
Washington, DC 20546-0001

August 20, 2008

Reply to Attn of:

Office of the General Counsel

Dr. Robert Adams, CEO
Optima Technology Group
1981 Empire Road
Reno, NV 89521-7430

RE: Administrative Claim for Infringement of U.S. Patent No. 5,904,724; NASA Case No. I-222

Dear Dr Adams:

This is to advise that I have been assigned the responsibility of evaluating the allegation that NASA has infringed U.S. Patent No. 5,904,724, as reflected in the above-identified administrative claim. You have provided me with a copy of an assignment from the inventor, Mr. Jed Margolin. Although this copy, dated 7/20/2004 is not notarized, it is recorded by the Patent and Trademark Office (PTO) with a recordation date of 12/21/2007. There are also four other assignments recorded with the PTO for this same patent, although one seems to be a correction. The recordation dates for three of these assignments precede the assignment recordation date of your claimed assignment; however, the dates of assignment are subsequent to your date of assignment. I have also received independent verification of your claim of ownership verbally (by telephone) from Mr. Margolin. Based on the above, although the verification of ownership appears far from certain based solely on the documentation, NASA will proceed on the assumption your claim of ownership of the patent is correct. In the event that NASA should determine that you are entitled to compensation based on this administrative claim, NASA will require certification (in a form acceptable to it) that you are the sole and proper party entitled to such compensation, as well as releases from all other parties that have previously asserted claims against NASA or who have otherwise maintained an ownership interest in this patent (regardless of whether or not such allegations of ownership have been brought to NASA's attention).

Because you are a new claimant, there is information that we will need in order to complete our analysis of the claim. These are:

1) the identification of all procurements known to the claimant which involve the alleged infringing item or process, including the identity of the vendor or contractor and the Government procuring activity.

2) a detailed identification of the accused articles or processes, particularly where the article or process relates to a component or subcomponent of the item procured, and an element by element comparison of the representative claims with the accused article or process. This identification should include documentation and drawings to illustrate the accused article or process in suitable detail to enable verification of the infringement comparison;

3) the names and addresses of all past and present licenses under the patent and copies of all license agreements and releases involving the patent;

4) a detailed description of all litigation in which the patent has been or is now involved and the present status thereof (regardless of whether you are the plaintiff or defendant);

5) a list of persons to whom notices of infringement have been sent, including all departments and agencies of the Government, and a statement of the ultimate disposition of each;

6) a declaration detailing whether your patent has been the subject of any certificate of correction request, reexamination or reissue proceedings at the U.S. Patent Office, lapsed for failure to pay any maintenance fee, as well as any ancillary matters that have a bearing on validity and/or infringement; and

7) if you have made claims against any other parties alleging infringement of this patent, we require that you furnish specific details of those claims and their disposition (whether pending or final), including any defenses or counterclaims that were made. This includes, but is not limited to, positions taken by such parties regarding invalidity and/or non-infringement of your patent.

You should pay particular attention to item (2) which essentially calls for you to prepare what is commonly referred to as a "claim chart" that specifies in some detail each and every element of the affected claims and the correspondence on an element-by-element basis with the device that you are alleging that NASA has infringed.

Please be aware that the review of this matter has just begun. Accordingly, even though only the seven elements listed above have been specifically identified, there may be additional elements that we may ask that you address or clarify further as this process moves along.

McNutt, Jan (HQ-MC000)

From: Robert Adams-OTG [radams@optimatechnologygroup.com]
Sent: Tuesday, September 30, 2008 1:04 PM
To: McNutt, Jan (HQ-MC000)
Subject: FW: Jan S. McNutt, Please see the attached letter; it is your response to your most recent letter.
Attachments: OTG_NASA_25AUG08.pdf; OTG_NASA_Refs.pdf; nasa_usps.pdf

Sir,

As you know, we offered to settle this infringement matter by NASA for $75,000.00 and are still waiting for a response.

Dr. Adams

From: Robert Adams-OTG [mailto:radams@optimatechnologygroup.com]
Sent: Monday, August 25, 2008 3:48 PM
To: 'McNutt, Jan (HQ-MC000)'; 'jan.mcnutt@nasaq.gov'
Subject: Jan S. McNutt, Please see the attached letter; it is your response to your most recent letter.

Sent via U.S. Mail with tracking number

Jan S. McNutt,

Please see the attached letter; it is your response to your most recent letter.

Thank you,

Dr. Robert Adams – CEO
Optima Technology Group
949-419-6970 Phone
949-226-7378 Fax

Finally, it is the practice of the Office of the General Counsel to conduct official business in writing so that a written record is created and maintained. In most instances, therefore, communications between us should be in written form (letters, E-mails, or faxes), rather than by telephone.

Sincerely,

Jan S. McNutt
Attorney-Advisor

McNutt, Jan (HQ-MC000)

From: Jed Margolin [jm@jmargolin.com]
Sent: Friday, August 08, 2008 2:19 PM
To: McNutt, Jan (HQ-MC000)
Subject: Re: NASA FOIA HQ 08-270

Attachments: jm_nasa_foia_x.pdf

jm_nasa_foia_x.pdf
(41 KB)

Dear Mr. McNutt.

I will agree to the 90 day extension you have requested for NASA to respond to my FOIA Request (HQ 08-270) if NASA acknowledges that my FOIA request is entirely separate from Optima Technology Group's Claim Case No. I-222.

Please see attached letter.

Sincerely yours,

Jed Margolin
1981 Empire Rd.
Reno, NV 89521-7430

775-847-7845
=====================
----- Original Message -----
From: "McNutt, Jan (HQ-MC000)" <jan.mcnutt@nasa.gov>
To: "Jed Margolin" <jm@jmargolin.com>
Sent: Wednesday, August 06, 2008 6:44 AM
Subject: RE: NASA Case I-222

Dear Mr. Margolin,

Please see the attached. Hard copy to follow.

Jan S. McNutt
Attorney-Advisor (Commercial)
Office of the General Counsel
NASA Headquarters
Suite 9T11
300 E Street, SW
Washington, DC 20546-0001
(202) 358-0632
Jan.McNutt@nasa.gov

Jed Margolin
Phone: 775-847-7845
1981 Empire Rd.
jm@jmargolin.com
Reno, NV 89521-7430
August 8, 2008

Mr. Jan S. McNutt
Office of the General Counsel
NASA Headquarters
Washington, DC 20546-0001

Re: FOIA Request (FOIA HQ 08-270) regarding NASA Case No. I-222

Dear Mr. McNutt,

As we discussed in our recent telephone conversations, my FOIA Request is entirely separate from NASA Claim Case I-222. The patents involved in the claim are now owned by Optima Technology Group, Inc. I trust that Optima Technology Group has now provided you with the documentation you requested in order to establish their ownership of the Patents.

I will agree to the 90 day extension you have requested for NASA to respond to my FOIA Request (HQ 08-270) if NASA acknowledges that my FOIA request is entirely separate from Optima Technology Group's Claim Case No. I-222.

Sincerely yours,

Jed Margolin

Jed Margolin

McNutt, Jan (HQ-MC000)

From: Robert Adams-OTG [radams@optimatechnologygroup.com]
Sent: Wednesday, August 06, 2008 11:17 AM
To: McNutt, Jan (HQ-MC000)
Subject: RE: Jan, please forward me a copy of the letter that you stated was sent out last Friday...OFFER TO COMPROMISE, SUBJECT TO RULE 408 FED. R. EVID.
Attachments: jm_assign.pdf

OFFER TO COMPROMISE, SUBJECT TO RULE 408 FED. R. EVID

Jan,

Based on the conversation with you and Jed, I was told by Jed that he walked you through the Patent & Trade Mark office's website and you had access to see the assignment.

If that was not acceptable, then please see the attachment concerning the fully executed assignment.

As time is short due to the delays in reviewing the matter on your end. We are acceptable to not clogging up the court system as we currently have one active case before the Federal court on 073" and would prefer licensing NASA and/or settling with you.

I look forward to hearing from you shortly.

Thank you,

Dr. Adams

From: McNutt, Jan (HQ-MC000) [mailto:jan.mcnutt@nasa.gov]
Sent: Wednesday, August 06, 2008 6:23 AM
To: Robert Adams-OTG
Subject: RE: Jan, please forward me a copy of the letter that you stated was sent out last Friday...OFFER TO COMPROMISE, SUBJECT TO RULE 408 FED. R. EVID.

Dr. Adams,

Please see attached.

Jan S. McNutt
Attorney-Advisor (Commercial)
Office of the General Counsel
NASA Headquarters
Suite 9T11
300 E Street, SW
Washington, DC 20546-0001
(202) 358-0632
Jan.McNutt@nasa.gov

This document, including any attachments, contains information may be confidential, protected by the attorney-client

PATENT ASSIGNMENT

Whereas I, the undersigned, Jed Margolin having an address in Virginia City Highlands, Nevada have made certain inventions or discoveries (or both) set forth in the following-identified Letters Patent of the United States of America, and

Whereas Optima Technology Group Inc, a Delaware corporation having a place of business at 1981 EMPIRE Road, Reno, NV 89521-7430, which, together with its successors and assigns, is hereinafter called "Assignee," is desirous of acquiring the title, rights, benefits and privileges hereinafter recited;

Now, therefore, for valuable consideration furnished by Assignee to me, receipt and sufficiency of which is hereby acknowledged, I do hereby, without reservation:

1. Assign, transfer and convey to Assignee the entire right, title and interest in and to the following Letters Patent and to all inventions disclosed and/or claimed in U.S. Patent No. 5,566,073 issued October 15, 1996 for a Pilot Aid Using A Synthetic Environment and U.S. Patent No. 5,904,724 issued May 18, 1999 for Method and Apparatus For Remotely Piloting An Aircraft, and to any and all other applications for Letters Patent on said inventions and discoveries in whatsoever countries worldwide, including all divisional, renewal, substitute, continuation, continuing, Convention and non-Convention applications based in whole or in part upon said inventions or discoveries, or upon said Letters Patent, and any and all reissues, reexaminations, and extensions of said Letters Patent or upon said applications, reissues, reexaminations, and extensions and every priority right that is or may be predicated upon or arise from said inventions, said discoveries and/or said Letters Patent.

2. Authorize and request the Commissioner of Patents and Trademarks of the United States of America and the empowered officials of all other governments to issue, transfer and record all said Letters Patent to and in the name of Assignee, as assignee of the entire right, title and interest therein or otherwise as Assignee may direct.

3. Bind my heirs, legal representatives and assigns, as well as myself, to do, upon Assignee's request and at Assignee's expense, but without additional consideration to me or them, all acts reasonably serving to assure that the said inventions and discoveries, the said Letters Patent and patent applications shall be held and enjoyed by Assignee as fully and entirely as the same could have been held and enjoyed by my heirs, legal representatives and assigns if this assignment had not been made.

In testimony of which I have executed this Assignment of Patent Application on the date indicated next to my name.

Jed Margolin ____________________ Date: 7-20-2004

Jed Margolin

National Aeronautics and Space Administration
Headquarters
Washington, DC 20546-0001

August 5, 2008

Reply to Attn of: Office of the General Counsel

Mr. Jed Margolin
1981 Empire Road
Reno, NV 89521-7430

Re: Administrative Claim of Jed Margolin for Infringement of U.S. Patent Nos. 5,566,073 and 5,904,724; NASA Case No. I-222.

Dear Mr. Margolin,

We are in receipt of the Freedom of Information Act Request (FOIA) conveyed to us by email dated June 30, 2008 in which you request copies of all documentation relating to your administrative claim of infringement of U.S. Patent Nos. 5,566,073 and 5,904,724.

We regret the delay in processing your claim and assure you that we are now undertaking measures to provide a resolution of your claim as soon as possible. Unfortunately. Mr. Alan Kennedy retired from NASA earlier this year and the action on your claim was not conveyed to management in a timely manner. In addition the local attorney responsible for review of your claim also departed from NASA. We are now cognizant of the importance of proceeding with a review of the claim and will contact you when we have reached a decision.

As to your FOIA request, as the investigation of your claim is ongoing, we kindly request that you allow us a 90 day extension to answer this request. Within that time period we should be able to obtain a better picture of our position vis-à-vis your claim and the request for documents may no longer be required.

We should inform you that we have received a separate communication from a company Optima Technology Group, claiming to have been assigned both of the patents in question. You informed me telephonically that this is the case; however, we have no record of any assignment of your patents to this firm and will need confirmation through appropriate attested documents delivered to the agency in order to recognize any claim of ownership by a party other than the inventor.

Thank you for your patience in this matter. Please contact the undersigned at (202) 358-0632 or email Jan.McNutt@nasa.gov if you have any additional questions or comments.

Sincerely,

Jan S. McNutt
Attorney-Advisor

National Aeronautics and Space Administration
Headquarters
Washington, DC 20546-0001

August 1, 2008

Reply to Attn of: Office of the General Counsel

Dr. Robert Adams, CEO
Optima Technology Group
1981 Empire Road
Reno, NV 89521-7430

Re: U.S. Patents Nos. 5,904,724 and 5,566,073

Dear Dr. Adams:

We are in receipt of your letter dated July 14, 2008 informing our office of an assignment of two patents by the inventor Mr. Jed Margolin. While Mr. Margolin's infringement claims are currently under investigation, we do not have any information from Mr. Margolin confirming the alleged assignment of his patents to your firm. Although your letter included copies of two licensing agreements, there is likewise no evidence of an assignment of the said inventions in the communication you sent to us. Until we receive appropriate evidence of such an assignment, we are not able to respond to your request for a license from our Agency.

Please refer any future correspondence in this matter to the undersigned, Mr. Jan S. McNutt, (202) 358-0632.

Sincerely,

Jan S. McNutt
Attorney-Advisor

OPTIMA
TECHNOLOGY GROUP

Main Office
Finance & Operation
[illegible] Empire Rd.
Reno, NV [illegible]
Tel [illegible]
Fax 949 226 [illegible]

Monday, July 14, 2008

Mr. Alan J. Kennedy
Director, Infringement Division
Office of the Associate General Counsel
Office of the Aeronautics and Space Administration
Washington, D.C 20546-0001
Attn.. GP 02-37016

RE: Case number I-222

Sir,

I have read all of the correspondence dating back to May 14, 2003 between NASA and Jed Margolin the inventor of U.S Patent 5,904,724 **Method and apparatus for remotely piloting an aircraft that NASA**. As you are well aware, this invention was infringed (literal infringement) by NASA and others at their direction.

My company has been assigned this patent as well as U.S. Patent 5,566,073 **Pilot Aid Using A Synthetic Environment** and we have since licensed L3 and Honeywell (please see attached copy of Honeywell and L3/Genève Aerospace agreement(s).

Your office has had these past 5 years and 7 months to offer up any prior art and has failed to do so in order to invalidate '724 and/or prove non-infringement. Clearly your office has failed, with that said you need now to pay for a license like the others for the use of our technology that you used and may still be using at NASA.

We would welcome the opportunity to further discuss the matter directly as to your proper license if need be and/or through our Intellectually Property attorney Larry Oliverio who can be reached at [illegible] 617-697-8000.

Respectfully,

Dr Robert Adams – U.S. Navy Retired
CEO, Optima Technology Group

OPTIMA
TECHNOLOGY GROUP

Main Office
Finance & Operation
[illegible] Empire Rd.
Reno, NV 89521-[illegible]
Tel. [illegible]
Fax. 949 226 7378

Monday, July 14, 2008

Mr. Alan J. Kennedy
Director, Infringement Division
Office of the Associate General Counsel
Office of the Aeronautics and Space Administration
Washington, D.C 20546-0001
Attn.. GP 02-37016

RE: Case number I-222

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We would welcome the opportunity to further discuss the matter directly as to your proper license if need be and/or through our Intellectually Property attorney Larry Oliverio who can be reached at [illegible] 617-697-8000.

Respectfully,

Dr. Robert Adams - U.S. Navy Retired
CEO, Optima Technology Group

Rissman Jobse
Hendricks & Oliverio Intellectual Property Law

- Home
- E-mail
- Legal

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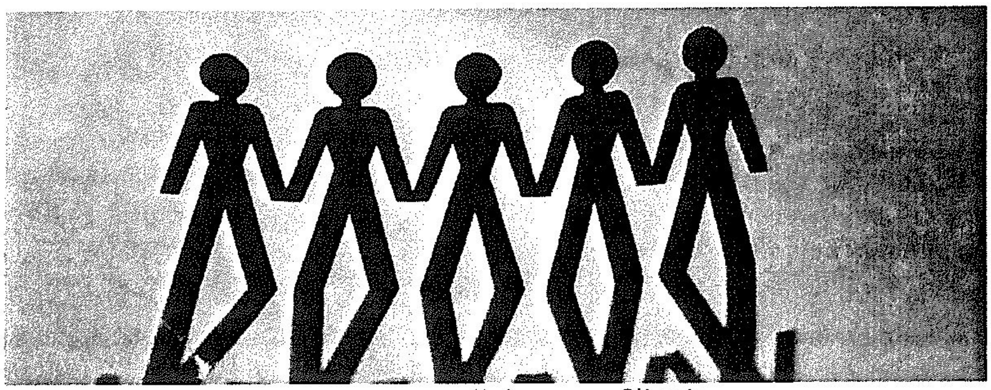

M. Lawrence Oliverio
loliverio@RJHOlaw.com

LARRY OLIVERIO has been in private practice for 27 years, also acting as corporate counsel for select clients (Secretary, RSA Security 1984-1997). Larry prepares and manages the filing, prosecution and maintenance of large and small IP portfolios in various areas of art such as bio/polymer chemistry (large and small molecule), electronic and mechanical devices, e.g. software, robots, injection molding equipment, physical exercise machines.

Larry and the firm's litigation team represent clients as both lead and supporting counsel at the trial and appeal levels, successfully bringing and defending dozens of infringement suits in Courts around the country for over 20 years in widely diverse areas of technology.

- John A. Rissman
- Bruce D. Jobse
- Therese A. Hendricks
- M. Lawrence Oliverio
- Inna Landsman
- Maria T. Bautista
- Jay A. Stelacone
- William G. Gosz
- Wolfgang Stutius (Patent Agent)
- Richard E. Galardy, Ph. D. (Professional)

Larry has an M. S. in Organic/Polymer Chemistry from Yale University, Yale fellow (1975), a B.S. in Chemistry from the University of Massachusetts at Amherst , Phi Beta Kappa, Olin Charitable Trust Fellow (1974), and a Juris Doctor from Boston College Law School (1980). He is admitted to the Massachusetts and New York bars, the U.S. Patent and Trademark Office, the U.S. Supreme Court, the appeal courts of the U.S. Federal, First and Second Circuits and the Federal trial Courts.

Representative cases include: Rosen v Eiger Vision, Icon Enterprises, Dongyang, Alpine Electronics (C.D.Cal. 2003-present), patent infringement; Signatures Networks, Inc. v. Does (D.Mass 1996-present), trademark infringement; Synventive Molding Solutions v. Hi-Tech, PETS (2003-present), pat infringement; Back Bay Prop. v. Back Bay Res. Prop. (D.Mass. 2003-present), trademark infringement; Cabletron Systems, Inc. v. Soderblom, Nx Networks, Inc. (D.Mass. 1997-2002), patent infringement; Datapoint v. Cabletron Systems, Inc. (E.D.N.Y. 1999-2002), patent infringement; Cybex International v. Ground Zero Design, (2001-present), unfair competition/pat infringement; Security Dynamics v. ActivCard (N.D. Cal. 1996-97), patent infringement; Buehler v. Ocrim SpA (N.D. Tex. 1993; Fed. Cir. 1994), patent infringement; Pfund v. U.S. (U.S. Ct.Cl. 1997-99), pat infringement; National Center For Jewish Film v.

Goldman (D.Mass. 1996-98) copyright infringement; Polaroid v. Eastman Kodak (D.Mass. 1982-84, Fed. Cir. 1986), patent infringement.

100 cambridge street
suite 2101 | boston, ma 02114
tel 617.367.4600 | fax 617.367.4656

CONFIDENTIAL

Non-Exclusive Patent License Agreement

THIS AGREEMENT is entered into by Optima Technology Group, Inc., a corporation of Delaware, having its Administration and Licensing place of business at 1981 EMPIRE RD Reno, NV 89521-7430 (herein called LICENSOR), and by Honeywell International Inc., a corporation of the State of Delaware, U.S.A., having an office at 101 Columbia Road, Morristown, NJ 07962 and its affiliates (herein called "LICENSEE").

1. Background of Agreement

1.1. LICENSOR is the owner of U.S. Patent No. 5,556,073, entitled "Pilot Aid Using a Synthetic Environment" ("the '073 Patent").

1.2. LICENSOR has accused LICENSEE of infringing the '073 Patent and LICENSEE has denied such infringement.

1.3. LICENSEE wishes to acquire rights under the '073 Patent.

1.4. LICENSEE also wishes to at a later date in time have first right to purchase the '073 Patent and to have the ability to later purchase or obtain rights to both United States Patent 5,904,724 Method and Apparatus for Remotely Piloting an Aircraft and United States Patent Application No. 60/745,111 System and Method for Safely Flying Unmanned Aerial Vehicles in Civilian Airspace.

2. Definitions

As used herein, the following terms shall have the meanings set forth below:

2.1. LICENSED PATENT shall mean the following U.S. Patent and all current and future patents (including divisionals, continuations, continuations-in-part, reissues, and therefore-examined patents) that that claim priority directly or indirectly from any application in the chain of applications from which such patent issued, and all foreign counterparts to any such patents and applications:

Letters Patent:

Patent No. **5,566,073** Date Filed **October 15, 1996**

Pilot Aid Using a Synthetic Environment

2.2. OPTION PATENTS shall mean the following U.S. Patent and Patent Application and all current and future patents (including divisionals, continuations, continuations-in-part, reissues, and therefore-examined patents) that that claim priority directly or indirectly from any application in the chain of applications from such patent application or from which such patent issued, and all foreign counterparts to any such patents and applications:

Letters Patent:

Patent No. **5,904,724** Date Filed January 19, 1996

Method and Apparatus for Remotely Piloting an Aircraft

Patent Application:

Patent Application No. 11/736,356 Date Filed **April 17, 2007**

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

2.3. LICENSED PRODUCTS shall mean any products made or had made by LICENSEE for sale exclusively to Licensee that in the absence of this license agreement would allegedly infringe at least one claim of the LICENSED PATENT.

2.4. EFFECTIVE DATE means October 11, 2007.

3. Patent License

3.1. LICENSOR hereby grants to LICENSEE a nonexclusive, world-wide, fully paid-up license under the LICENSED PATENT to make, have made for sale exclusively to Licensee, use, sell, offer for sale, lease, import, dispose of, or otherwise transfer LICENSED PRODUCTS to a third-party.

3.2. LICENSOR, on behalf of itself and its predecessors, successors and assigns, agrees to release, acquit, and forever discharge LICENSEE and its affiliates, shareholders, officers, and directors, respective successors and assigns, as well as any end-users, distributors, and customers of LICENSEE from any and all actions, causes of action, claims or demands whatsoever in law or equity, for infringement of the LICENSED PATENT to the extent resulting from any Licensed Products made or Had Made by LICENSEE on or before the Effective Date of this Agreement.

3.3. LICENSEE agrees to never challenge the validity of any claim of any of the Licensed Patent(s) in any judicial, administrative, arbitration or other proceeding or to assist any third party in challenging the validity or scope thereof; LICENSEE shall be released from its obligations under Section 3.3 upon LICENSOR's termination of this Agreement.

CONFIDENTIAL

4. Compensation

4.1 LICENSEE shall pay as a license execution fee via Wire transfer at said time of the signing of this agreement, the sum of $475,000.00 USD, which shall be nonrefundable

5. Royalties

5.1. LICENSEE shall have no obligation to pay any royalties, minimums or running, to LICENSOR on future sales of LICENSED PRODUCTS, except to the extent that LICENSEE is not otherwise liable for infringement as a result of termination of this Agreement or any relevant part thereof pursuant to the terms hereof.

6. Sublicensing

6.1. LICENSEE shall not have the right to sublicense.

7. Right of First Refusal

7.1. If LICENSOR shall receive an offer for the purchase of or for exclusive rights under the LICENSED PATENTS or the OPTION PATENTS, then LICENSOR shall promptly notify LICENSEE of the offer and terms thereto in writing and LICENSEE shall have the option in its sole discretion, exercisable by written election to LICENSOR within five (5) days of such notification to it, to enter into an agreement for the purchase of or for exclusive rights under the LICENSED PATENTS or OPTION PATENTS under the terms provided in such written notification.

8. Payments

8.1. **Under 5 U.S.C 552(b)(4) NASA was required to redact sensitive financial information.
They didn't, so I did. -JM**

9. Representations and Disclaimer of Warranties

9.1. NOTHING IN THIS AGREEMENT SHALL BE DEEMED TO BE A REPRESENTATION OR WARRANTY OF THE VALIDITY OF ANY PATENT LICENSED HEREUNDER OR THAT ANY PRODUCT MADE BY LICENSEE IN ACCORDANCE WITH THE LICENSED PATENT(S) WILL NOT INFRINGE THE RIGHTS OF OTHERS. LICENSOR SHALL HAVE NO LIABILITY WHATSOEVER TO LICENSEE OR ANY OTHER PERSON FOR OR ON ACCOUNT OF ANY INJURY, LOSS, OR DAMAGE, OF ANY KIND OR NATURE, SUSTAINED BY, OR ANY DAMAGE ASSESSED OR ASSERTED

AGAINST, OR ANY OTHER LIABILITY INCURRED BY OR IMPOSED ON LICENSEE OR ANY OTHER PERSON, ARISING OUT OF OR IN CONNECTION WITH OR RESULTING FROM THE PRODUCTION, USE, OR SALE OF ANY APPARATUS OR PRODUCT, OR THE PRACTICE OF THE PATENTS; OR ANY ADVERTISING OR OTHER PROMOTIONAL ACTIVITIES WITH RESPECT TO ANY OF THE FOREGOING. LICENSEE AGREES TO INDEMNIFY AND HOLD LICENSOR HARMLESS AGAINST ANY AND ALL CLAIMS, CAUSES OF ACTION, JUDGMENTS, DAMAGES AND THE LIKE ARISING OUT OF ANY AND ALL ACTS OR OMISSIONS COMMITTED BY OR FOR LICENSEE INCLUDING, WITHOUT LIMITATION, THE DESIGN, MANUFACTURE, SALE, USE, IMPORTATION, OR RE-SALE OF ANY PRODUCT BY OR FOR LICENSEE.

9.2. LICENSOR represents and warrants to LICENSEE that, as of the Effective Date, it is the sole and exclusive assignee of the entire right, title and interest in the LICENSED PATENTS, that it has the right to grant to LICENSEE the rights and licenses granted herein and to enter this Agreement.

10. Termination

10.1. This Agreement shall end upon the expiration of the LICENSED PATENT.

10.2. LICENSEE may terminate this Agreement in part or in whole at any time upon sixty (60) days' written notice in advance to LICENSOR.

10.3. If either party shall be in default of any obligation hereunder, the other party may terminate this Agreement by giving sixty (60) days' notice by Registered Mail to the other party, specifying the basis for termination. If within sixty (60) days after the receipt of such notice, the party who received notice shall remedy the condition forming the basis for termination, such notice shall cease to be operative, and this Agreement shall continue in full force.

11. Litigation

11.1. LICENSEE shall notify LICENSOR of any suspected infringement of the LICENSED PATENT. The sole right to institute a suit for infringement rests with LICENSOR. LICENSEE agrees to cooperate in all respects, at LICENSOR'S expense, with reasonable requests from LICENSOR to have any of LICENSEE's employees testify when requested by LICENSOR, and to make available any records, papers, information, specimens, and the like. Any recovery received pursuant to such suit shall be retained by LICENSOR.

11.2. During the term of this Agreement, LICENSEE shall bring to LICENSOR's attention any prior art or other information known to LICENSEE that is relevant to the patentability or validity of any of the LICENSED PATENTS or OPTION PATENTS and that might cause a court to deem any of the LICENSED

PATENTS or OPTION PATENTS wholly or partly inoperative or invalid. LICENSEE may particularly specify such prior art or other information to LICENSOR at the time it learns thereof and not less than ninety (90) days prior to bringing any action against LICENSOR asserting the invalidity of any of the LICENSED PATENTS or OPTION PATENTS.

11.3. LICENSEE's inadvertent breach of Sections 11.1 or 11.2 shall not constitute a breach of this Agreement.

12. Patents

12.1. LICENSOR shall have the sole right to file, prosecute, and maintain all of the LICENSED PATENT and the OPTION PATENTS covering the inventions that are the property of LICENSOR and shall have the right to determine whether or not, and where, to file a patent application, to abandon the prosecution of any patent or patent application, or to discontinue the maintenance of any patent or patent application. LICENSOR shall notify LICENSEE of any intent to abandon, or otherwise allow the lapsing of rights to, the LICENSED PATENT or the OPTION PATENTS at least thirty (30) days prior to the date upon which the patent or application will abandon or lapse.

12.2. Improvement inventions made by LICENSEE shall be the exclusive property of LICENSEE.

13. Non-assignability

13.1. This Agreement imposes personal obligations on LICENSEE. LICENSEE shall not assign any rights under this Agreement not specifically transferable by its terms without the written consent of LICENSOR.

13.2. LICENSOR may assign its rights hereunder, provided that (1) LICENSOR promptly notifies LICENSEE of the recipient of any such assignment and (2) LICENSOR notifies the intended assignee of the existence of this License Agreement.

14. Severability

14.1. The parties agree that if any part, term, or provision of this Agreement shall be found illegal or in conflict with any valid controlling law, the validity of the remaining provisions shall not be affected thereby.

14.2. In the event the legality of any provision of this Agreement is brought into question because of a decision by a court of competent jurisdiction of any country in which this Agreement applies, LICENSOR, by written notice to LICENSEE, may revise the provision in question or may delete it entirely so as to comply with the decision of said court.

15. Publicity and Miscellaneous

15.1. In publicizing anything made, used, or sold under this Agreement, LICENSEE shall not use the name of LICENSOR or otherwise refer to any organization related to LICENSOR, except with the written approval of LICENSOR.

15.2. Neither party shall make any public statements regarding the details of this License Agreement without the express written consent of the other party.

15.3. LICENSEE shall respond to any written request within ten (10) days for disclosure under 35 U.S.C. 287(b)(4)(B), and by also notifying LICENSOR within ten days of the request for disclosure.

16. Waiver, Integration, Alteration

16.1. The waiver of a breach hereunder may be effected only by a writing signed by the waiving party and shall not constitute a waiver of any other breach.

16.2. This Agreement represents the entire understanding between the parties, and supersedes all other agreements, express or implied, between the parties concerning the LICENSED PATENT.

A provision of this Agreement may be altered only by a writing signed by both parties, except as provided in Section 14.01, above.

16. Cooperation

Each party shall execute any instruments reasonably believed by the other party to be necessary to implement the provisions of this Agreement.

17. Construction

17.1 This Agreement shall be construed in accordance with the substantive laws of the State of Delaware of the United States of America.

18. Notices Under the Agreement

18.1 For the purpose of all written communications and notices between the parties, their addresses shall be:

LICENSOR: Rissman Jobse Hendricks & Oliverio, Attention: M Lawrence Oliverio, One State Street, Boston, MA 02109 C/O of Optima Technology Group

and

LICENSEE: Honeywell Intellectual Properties Inc., Suite 101, 960 West Elliot

Rd., Tempe, AZ 85284

or any other addresses of which either party shall notify the other party in writing.

IN WITNESS WHEREOF the parties have caused this Agreement to be executed by Their duly authorized officers on the respective dates hereinafter set forth.

LICENSOR

Optima Technology Group

By:______________________________

Name: Dr. Robert Adams

Title: Chief Executive Offices

Date: October 12, 2007

LICENSEE

Honeywell International Inc.

By:______________________________

Name: Neal F. Speranzo

Title: VP, Integrated Supply Chain

Date: October 12, 2007

Geneva Aerospace
At the core of UAV control

Geneva Aerospace, Inc
[illegible]

May 17th, 2006

CONFIDENTIAL

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

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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

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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 (30th) 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:

Under 5 U.S.C 552(b)(4) NASA was required to redact sensitive financial information. They didn't, so I did. -JM

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
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.

Jed Margolin ***3570 Pleasant Echo Dr.*** ***San Jose, CA 95148-1916***
Phone: (408) 238-4564 ***Email:* jm@jmargolin.com** ***June 17, 2003***

Mr. Alan J. Kennedy
Director, Infringement Division
Office of the Associate General Counsel
National Aeronautics and Space Administration
Headquarters
Washington, DC 20546-0001

Attn: GP(02-37016)

Dear Mr. Kennedy,

I have received your letter dated June 11, 2003.

In my contacts with NASA personnel I have repeatedly stressed my desire that this matter be resolved in a friendly manner. However, since NASA has rejected my request to consider a license proffer and in view of your letter of June 11, it is clear that NASA has decided to handle this in an adversarial manner.

Before I respond to your letter in detail, I want to make things easier for me by withdrawing my U.S. Patent **5,566,073** ***Pilot Aid Using a Synthetic Environment*** from this administrative claim in order to focus more directly on NASA's infringement of my U.S. Patent **5,904,724** ***Method and Apparatus For Remotely Piloting an Aircraft***. However, I reserve the right to file a claim concerning the '073 patent at a later time.

(1) The identification of all claims of the patent(s) alleged to be infringed.

As I stated in my email of May 13, 2003 to Mr. Hammerle of LARC and in my fax of June 7, 2003 to you, I have no way of determining exactly which claims the X-38 project may have infringed unless NASA makes a full and complete disclosure to me of that project. I also have no way of determining if NASA has (or has had) other projects that also infringe on my patent unless NASA makes a full and complete disclosure of those projects as well.

Therefore, in order to answer your question, I must request that NASA make a full and complete disclosure to me of the X-38 project as well as any other current or past projects that may infringe on my patent.

If this information requires a security clearance (I have none) I suggest you start the required security investigation immediately. If there is further information that you require in this regard feel free to contact me.

(2) ***The identification of all procurements known to the claimant or patent owner which involve the alleged infringing item or process, including the identity of the vendor or contractor and the Government procuring activity.***

As I stated in my fax to you of June 7, 2003, I became aware that NASA was using synthetic vision in the X-38 project in the January 2003 issue of NASA Tech Briefs, page 40, **"Virtual Cockpit Window" for a Windowless Aerospacecraft**. The article is available at: http://www.nasatech.com/Briefs/Jan03/MSC23096.html

This led me to Rapid Imaging Software, Inc. and their press release (http://www.landform.com/pages/PressReleases.htm) which states:

> *"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."*

The RIS press release provided a link to an article in *Aviation Week & Space Technology*: http://www.aviationnow.com/avnow/news/channel_space.jsp?view=story&id=news/sx381211.xml

As a result of more searching I discovered a link to a Johnson Space Center SBIR Phase II award to Rapid Imaging Systems at http://sbir.gsfc.nasa.gov/SBIR/successes/ss/9-058text.html .

It includes a particularly relevant paragraph:

> *The Advanced Flight Visualization Toolkit (VisualFlight™) project is developing a suite of virtual reality immersive telepresence software tools which combine the real-time flight simulation abilities with the data density of a Geographic Information System (GIS). This technology is used for virtual reality training of crews, analysis of flight test data, and as an on-board immersive situation display. It will also find application as a virtual cockpit, and in teleoperation of remotely piloted vehicles.*

The emphasis on *virtual reality immersive telepresence* and *teleoperation of remotely piloted vehicles* is mine.

A search of the SBIR archive shows the following entries.

For 2001 Phase I:
Rapid Imaging Software, Inc.
1318 Ridgecrest Place S.E.
Albuquerque, NM 87108-5136
Mike Abernathy (505) 265-7020
01 H6.02-8715 JSC
Integrated Video for Synthetic Vision Systems

For 2001 Phase II:
Rapid Imaging Software, Inc.
1318 Ridgecrest Place S.E.
Albuquerque , NM 87108-5136
Carolyn Galceran (505) 265 - 7020
01-2-H6.02-8715 JSC

Since my sources of information are limited to those available to the public (magazines such as *Aviation Week & Space Technology* as well as whatever I can find on the Internet) I have no way of knowing if there are other procurements, vendors, contractors, and Government procuring activity related to Claim I-222.

I believe that NASA is in a better position to know what it is (or has been) working on than I am.

(3) A detailed identification of the accused articles or processes, particularly where the article or process relates to a component or subcomponent of the item procured, an element by element comparison of the representative claims with the accused article or process. If available, this identification should include documentation and drawings to illustrate the accused article or process in suitable detail to enable verification of the infringement comparison.

I believe I have answered this in section (2) as much as I am able to without NASA's cooperation.

(4) The names and addresses of all past and present licenses under the patent(s), and copies of all license agreements and releases involving the patent.

There are no past licenses for this patent, and as of this date there are no present licenses for this patent. Naturally, I reserve the right to license this patent in the future as I see fit.

(5) A brief description of all litigation in which the patent(s) has been or is now involved, and the present status thereof.

There has been no past litigation involving this patent, and as of this date there is no present litigation regarding this patent.

(6) A list of all persons to whom notices of infringement have been sent, including all departments and agencies of the Government, and a statement of the ultimate disposition of each.

As of this date NASA is the only agency or department of the Government against which I have filed a claim.

5/11/03 – sent email to comments@hq.nasa.gov

I believe that NASA may have infringed on one or more of my U.S. Patents.
How do I file a claim and whom do I contact?

5/11/03 – Received reply:

Date: Sun, 11 May 2003 17:48:46 -0400 (EDT)
From: "PAO Comments" <comments@bolg.public.hq.nasa.gov>
Message-ID: <200305112148.h4BLmkhJ011314@bolg.public.hq.nasa.gov>
To: <jm@jmargolin.com>
Subject: Thank you for your email.

Thank you for your message to the NASA Home Page. The Internet Service Group will attempt to answer all e-mail regarding the site, but cannot guarantee a response by a particular time. The group will not be able to answer general inquiries regarding NASA, which should instead be sent to public-inquiries@hq.nasa.gov

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5/11/03 – Sent email to <public-inquiries@hq.nasa.gov>

I believe that NASA may have infringed on one or more of my U.S. Patents.
How do I file a claim and whom do I contact?

Jed Margolin

As far as I can tell I did not receive a response.

5/12/03 – Sent email to j.c.midgett@larc.nasa.gov (found on Web site)

I believe that NASA may have infringed on one or more of my U.S. Patents
How do I file a claim and whom do I contact?
(Or is my only recourse to sue in Federal Court?)

Jed Margolin

5/12/03 – Received reply:

Mr. Margolin,

Thank you for contacting NASA with your concerns. I have referred this matter to the Patent Counsel Office, and they will be contacting you to work with you on this issue.

Best wishes,
Jesse Midgett

5/12/03 – Given my experience with trying to contact Government officials via email (or mail, or fax) I hadn't waited for the reply from J. Midgett. I had found the web site for the LARC (NASA Langley) Patent Counsel Office, and called up. I was connected to Kurt Hammerle and we had a nice talk. I sent him an email the next day (May 13, 2003).

I received a phone call from Barry Gibbens (757-864-7141) who, apparently, was calling because of my email to to J.C.Midgett and hadn't seen the email I sent to K. Hammerle. (I explained to him what I had done.) We had a nice talk. He said he had already sent me a letter.

I received his letter and sent a reply on May 18, 2003 (USPS), adding to the email I had sent K. Hammerle.

Thursday, June 5, 2003 – Received message from B. Gibbens, asking me to call him because I should contact Alan Kennedy at NASA Headquarters (202-358-2065).

Friday, June 6, 2003 - I called B. Gibbens. Then I called A. Kennedy but he was out.

Saturday, June 7, 2003 – Sent a fax to A. Kennedy. The first number I tried (202-358-4341) only accepted 4 pages (out of 13). I tried a few times. Then I tried 202-358-2741. It turned out that 4341 was the correct number and that 2741 was another group. As a result, A. Kennedy initially only got 4 pages.

Monday, June 9, 2003 – Received message from A. Kennedy and called him back.

He had not gotten the fax so he went and found it. I learned the next day that he had only gotten 4 pages.

We had a "free and frank" discussion. I stressed that I wanted to resolve it in a friendly manner and that I preferred to have NASA buy the patent for the Government.

Tuesday, June 10, 2003 – Received a message from A. Kennedy and called him back.

He said that his Manager has turned down my request that NASA consider a license proffer and has decided to handle it as a Claim, and that the investigation would take 3-6 months.

However, NASA is not the only agency or department of the Government I have contacted.

7/5/1999 Email to: lbirckelbaw@darpa.mil
Dr. Birckelbaw, Project Manager for the UCAV contract awarded to Boeing.

Introduced myself and asked if DARPA was interested in my patent.
Response: none

7/26/1999 USPS Mail to:
Dr. Larry Birckelbaw
Program Manager, Aerospace Systems
DARPA Tactical Technology Office
3701 North Fairfax Drive
Arlington, VA 22203-1714

Introduced myself and asked if DARPA was interested in my patent. Enclosed copy of patent.
Response: none

Office of the Secretary of Defense (OSD)
Mr. E.C. "Pete" Aldridge
Under Secretary of Defense for Acquisition, Technology, and Logistics
U.S. Department of Defense
Contact Method: Email: webmaster@acq.osd.mil May 3, 2002 and June 6, 2002
Response: none

Army - AATD, Fort Eustice, VA.
Col. Wado Carmona, Commander
Applied Aviation and Training Directorate (AATD)
Army Aviation and Missile Command
Ft. Eustice, VA

Contact Method:
Email: Ms. Lauren L. Sebring lsebring@aatd.eustis.army.mil June 1, 2002
757-878-4828, fax: 757-878-0008

Phone Call Followup: She suggested I talk to Mr. Jack Tansey
Mr. Jack Tansey, Business Development 757-878-4105 June 18, 2002
Email Followup: jtansey@aatd.Eustis.army.mil June 18, 2002

Air Force Research Laboratory (AFRL)
Dr. Barbara Wilson
Contact Method: email (Barbara.Wilson@wpafb.af.mil) July 17, 2002
Response - none

Air Force Research Laboratory (AFRL)
Dr. R. Earl Good, Director,
Directed Energy Directorate
Air Force Research Laboratory
Kirtland Air Force Base, NM 87117-5776
Contact Method: Fax (505-846-0423) July 23, 2002
Response: none

Department of the Air Force
Dr. James G. Roche
Secretary of the Air Force
Washington, DC

Contact Method: Fax (703-695-8809) July 28, 2002

Response: Letter from August 13, 2002
Lt. General Charles F. Wald
Deputy Chief of Staff, Air & Space Operations, USAF

(7) A description of Government employment or military service, if any, by the inventor and/or patent owner.

I have never been employed by the U.S. Government (or any other government). Likewise, I have never been in military service (in the United States or elsewhere). In the interests of full disclosure, I worked for three summers (1967, 1968, 1969) at the RCA Astro-Electronics Division in Hightstown, NJ . (They had a summer job program for students.)

(8) A list of all Government contracts under which the inventor, patent owner, or anyone in privity with him performed work relating to the patented subject matter.

None. I did this entirely on my own dime.

(9) Evidence of title to the patent(s) alleged to be infringed or other right to make the claim.

This appears to be a two-part question. Does the patent belong to Jed Margolin, and am I that Jed Margolin?

Part 1 - If you look at the front page of the '724 patent you will see that it was, indeed, issued to Jed Margolin, 3570 Pleasant Echo Dr., San Jose, CA.

If you contact the U.S. Patent and Trademark Office, Document Services Department (703-308-9726), you can order an Abstract of Title to verify that I own the patent. According to 37 CFR 1.12, assignment records are also open to public inspection at the United States Patent and Trademark Office.

Part 2 - If you look up Jed Margolin, 3570 Pleasant Echo Dr., San Jose, CA, in a telephone directory you will find assigned to it the telephone number 408-238-4564.

When you called me on June 9 and June 10, that was the number you called.

Other than my affirming that I am, indeed, the Jed Margolin in question, I can only suggest that you contact my cousin Lenny (oops, I mean Dr. Len Margolin) who is employed by Los Alamos National Laboratory, and ask him if he has a cousin Jed who is an engineer and an inventor, and who possesses the Margolin gene for being very persistent. (Some say stubborn.) The last time I saw him was in Ann Arbor, Michigan, after he had just passed the orals for his doctorate. (He bought me a beer at a place on South University.)

(10) A copy of the Patent Office file of the patent, if available, to claimant.

I do not have a copy of the USPTO's patent file. What I have is my prosecution file which contains, among other things, privileged communications between my patent attorney and myself.

Besides, in our telephone conversation of June 10, you stated that one of the research centers (I believe it was LARC) had already ordered the file.

(11) Pertinent prior art known to claimant, not contained in the Patent Office file, particularly publications and foreign art.

I have found no relevant prior art.

However, there is an interesting article in the June 2, 2003 issue of *Aviation Week & Space Technology* on pages 48-51 entitled **GA Riding 'Highway-in-the-Sky'** which describes, among other things, the work of Dennis B. Berlinger, lead scientist for flight deck research at the FAA's Civil Aeromedical Institute (CAMI) regarding what is called **Performance-Controlled Systems**. In the Specification of my '724 patent I call it **First Order RPV Flight Control Mode.** In Claim 18:

> 18. The station of claim 13, wherein said set of remote flight controls are configured to allow inputting absolute pitch and roll angles instead of pitch and roll rates.

An Internet search turned up Mr. Beringer's report **Applying Performance-Controlled Systems, Fuzzy Logic, and Fly-By-Wire Controls to General Aviation** as DOT/FAA/AM-02/7.

I am pleased that Mr. Beringer's May 2002 study confirms the value of Performance-Controlled Systems in piloted aircraft and I believe that teaching it in my '724 patent (filed January 19, 1999) gave an additional novel and useful aspect to my invention.

(The article also describes the Synthetic Vision system used in the FAA's Capstone program.)

If you have any further questions, please contact me.

Sincerely yours,

Jed Margolin

Jed Margolin

Enclosed: Response from General Wald
AWST article
Beringer Report
U.S. Patent 5,904,724

National Aeronautics and
Space Administration

Headquarters
Washington, DC 20546-0001

June 11, 2003

Reply to Attn of: GP (02-37016)

Mr. Jed Margolin
3570 Pleasant Echo Dr.
San Jose, CA 95148-1916

Re: Administrative Claim of Jed Margolin for Infringement of U.S. Patent Nos. 5,566,073 and 5,904,724; NASA Case No. I-222

Dear Mr. Margolin:

Thank you for your letter dated June 7, 2003 regarding possible unauthorized uses by NASA of inventions protected by U.S. Patent Nos. 5,566,073 and 5,904,724. You have identified possible unauthorized uses in the X-38 project and other projects involving synthetic vision technology. NASA considers this matter to be an administrative claim for patent infringement, and has assigned the claim NASA Case No. I-222. An investigation will now be conducted to identify any unauthorized uses of the inventions claimed in the subject patents. In order to proceed further with this investigation, we need you to provide us with the following information:

(1) The identification of all claims of the patent(s) alleged to be infringed.

(2) The identification of all procurements known to the claimant or patent owner which involve the alleged infringing item or process, including the identity of the vendor or contractor and the Government procuring activity.

(3) A detailed identification of the accused articles or processes, particularly where the article or process relates to a component or subcomponent of the item procured, an element by element comparison of the representative claims with the accused article or process. If available, this identification should include documentation and drawings to illustrate the accused article or process in suitable detail to enable verification of the infringement comparison.

(4) The names and addresses of all past and present licenses under the patent(s), and copies of all license agreements and releases involving the patent.

(5) A brief description of all litigation in which the patent(s) has been or is now involved, and the present status thereof.

6) A list of all persons to whom notices of infringement have been sent, including all departments and agencies of the Government, and a statement of the ultimate disposition of each.

(7) A description of Government employment or military service, if any, by the inventor and/or patent owner.

(8) A list of all Government contracts under which the inventor, patent owner, or anyone in privity with him performed work relating to the patented subject matter.

(9) Evidence of title to the patent(s) alleged to be infringed or other right to make the claim.

(10) A copy of the Patent Office file of the patent, if available, to claimant.

(11) Pertinent prior art known to claimant, not contained in the Patent Office file, particularly publications and foreign art.

In addition to the foregoing, if claimant can provide a statement that the investigation may be limited to the specifically identified accused articles or processes, or to a specific procurement, it may materially expedite determination of the claim.

If you have any questions, please feel free to contact me on (202) 358-2065.

Cordially,

Alan J. Kennedy

Alan J. Kennedy
Director, Infringement Division
Office of the Associate General Counsel
(Intellectual Property)

13 Sheets

Jed Margolin *3570 Pleasant Echo Dr.* *San Jose, CA 95148-1916*
Phone: (408) 238-4564 *Email:* jm@jmargolin.com
June 7, 2003

Mr. Alan J. Kennedy
Office of the General Counsel
National Aeronautics and Space Administration
Mail Code GP, 300 E Street, S.W.
Washington DC USA 20546
Fax: 202-358-4341

Dear Mr. Kennedy,

Mr. Barry Gibbens of your Langley Research Center suggested I contact you. I missed you when I called on Friday so I am sending this fax to provide background.

I believe that NASA may have used one or more of my patents in connection with the X-38 project and may be using one or more of my patents in other projects using Synthetic Vision.

This fax contains a number of Internet links. If you would like an email version of this fax containing active links please send me an email (jm@jmargolin.com) with your email address.

Summary

In Synthetic Vision (NASA's term), the aircraft's position and orientation are used with a terrain database (such as the Digital Elevation Database) to produce a 3D projected view of the terrain over which the aircraft is flying. One of the advantages of this system is that the pilot is able to "see" the terrain regardless of weather conditions or whether it is day or night.

My U.S. Patent that pertains to this use of synthetic vision is: **U.S. Patent 5,566,073 Pilot Aid Using a Synthetic Environment** issued October 15, 1996 to Margolin. (I am the inventor and owner of the patent.) The patent application was filed August 9, 1995, and was a continuation of Application Ser. No. 08/274,394, filed July 11, 1994.

With synthetic vision it is not necessary for the pilot to be in the aircraft. I believe the X-38 project used this method.

My U.S. Patent that pertains to this use of synthetic vision is: **U.S. Patent 5,904,724 Method and Apparatus For Remotely Piloting an Aircraft** issued May 18, 1999 to Margolin. (I am the inventor and owner of the patent.) The patent application was filed January 19, 1996.

X-38 Project

I became aware that NASA was using synthetic vision in the X-38 project in the January 2003 issue of NASA Tech Briefs, page 40, **"Virtual Cockpit Window" for a Windowless Aerospacecraft**. The article is available at: http://www.nasatech.com/Briefs/Jan03/MSC23096.html

This led me to Rapid Imaging Software, Inc. and their press release (http://www.landform.com/pages/PressReleases.htm) which states:

> *"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."*

The RIS press release provided a link to an article in Aviation Week & Space Technology: http://www.aviationnow.com/avnow/news/channel_space.jsp?view=story&id=news/sx381211.xml

As a result of more searching I have discovered a link to a Johnson Space Center SBIR Phase II award to Rapid Imaging Systems at http://sbir.gsfc.nasa.gov/SBIR/successes/ss/9-058text.html .

It includes a particularly relevant paragraph:

> *The Advanced Flight Visualization Toolkit (VisualFlight™) project is developing a suite of virtual reality immersive telepresence software tools which combine the real-time flight simulation abilities with the data density of a Geographic Information System (GIS). This technology is used for virtual reality training of crews, analysis of flight test data, and as an on-board immersive situation display. It will also find application as a virtual cockpit, and in teleoperation of remotely piloted vehicles.*

{The emphasis on teleoperation of remotely piloted vehicles is mine.}

A search of the SBIR archive shows the following entries.

For 2001 Phase I:
Rapid Imaging Software, Inc.
1318 Ridgecrest Place S.E.
Albuquerque, NM 87108-5136
Mike Abernathy (505) 265-7020
01 H6.02-8715 JSC
Integrated Video for Synthetic Vision Systems

For 2001 Phase II:
Rapid Imaging Software, Inc.
1318 Ridgecrest Place S.E.
Albuquerque , NM 87108-5136

Carolyn Galceran (505) 265 - 7020
01-2-H6.02-8715 JSC
Integrated Video for Synthetic Vision Systems

My U.S. Patent that pertains to this use of synthetic vision is: **U.S. Patent 5,904,724 Method and Apparatus For Remotely Piloting an Aircraft** issued May 18, 1999 to Margolin. (I am the inventor and owner of the patent.) The patent application was filed January 19, 1996.

The patent can be downloaded from the UPTO Web site (www.uspto.gov) in html (no drawings) or in an odd tif format (with the drawings) that requires a special viewer.

An easier way to view and download the patent is through my Web site, on which I have posted the patent in PDF format. The link is http://www.jmargolin.com/patents2/rpv.htm .

While I have no way of knowing exactly what method(s) NASA used in controlling the X-38 (unless you are willing to make a full disclosure) my patent covers techniques as exemplified by claim 1.

1. A system comprising:

a remotely piloted aircraft including,

a position determining system to locate said remotely piloted aircraft's position in three dimensions; and

an orientation determining system for determining said remotely piloted aircraft's orientation in three dimensional space;

a communications system for communicating flight data between a computer and said remotely piloted aircraft, said flight data including said remotely piloted aircraft's position and orientation, said flight data also including flight control information for controlling said remotely piloted aircraft;

a digital database comprising terrain data;

said computer to access said terrain data according to said remotely piloted aircraft's position and to transform said terrain data to provide three dimensional projected image data according to said remotely piloted aircraft's orientation;

a display for displaying said three dimensional projected image data; and

a set of one or more remote flight controls coupled to said computer for inputting said flight control information, wherein said computer is also for determining a delay time for communicating said flight data between said computer and said remotely piloted aircraft, and wherein said computer adjusts the sensitivity of said set of one or more remote flight controls based on said delay time.

Although the X-38 project has been canceled, the methods developed to fly it are too good to waste and should be used in follow-up projects like CRV.

Synthetic Vision

I became aware of NASA's Synthetic Vision program perhaps two years ago from a program on NASA TV. I was unable to follow it up at that time due to health problems and the demands of my other patenting activity.

According to the NASA Aviation Safety Program Web site (http://avsp.larc.nasa.gov/program_svs.html)

Synthetic Vision Systems

TECHNOLOGY WOULD REDUCE AIRLINE FATALITIES
Synthetic Vision would give pilots clear skies all the time

A revolutionary cockpit display system being developed with seed money from NASA would help prevent the world's deadliest aviation accidents.

And I agree.

My U.S. Patent that pertains to this use of synthetic vision is: **U.S. Patent 5,566,073 Pilot Aid Using a Synthetic Environment** issued October 15, 1996 to Margolin. (I am the inventor and owner of the patent.) The patent application was filed August 9, 1995, and was a continuation of Application Ser. No. 08/274,394, filed July 11, 1994.

The patent can be downloaded from the USPTO Web site (www.uspto.gov) in html (no drawings) or in an odd tif format (with the drawings) that requires a special viewer.

The patent can also be downloaded from my Web site in PDF format at:
http://www.jmargolin.com/patents2/pilot.htm

As with the X-38 program I have no way of knowing exactly what method(s) NASA used in its Synthetic Vision program (unless you are willing to make a full disclosure). My patent covers techniques as exemplified by claim 1.

> *1. A pilot aid which uses an aircraft's position and attitude to transform data from a digital data base to present a pilot with a synthesized three dimensional projected view of the world comprising:*
>
> *a position determining system for locating said aircraft's position in three dimensions;*
>
> *a digital data base comprising terrain data, said terrain data representing real terrestrial terrain as at least one polygon, said terrain data generated from elevation data of said real terrestrial terrain;*
>
> *an attitude determining system for determining said aircraft's orientation in three dimensional space;*
>
> *a computer to access said terrain data according to said aircraft's position and to transform said terrain data to provide three dimensional projected image data according to said aircraft's orientation; and*
>
> *a display for displaying said three dimensional projected image data.*

NASA's Visits to My Web Site

There is good reason to believe that NASA was aware of my work in these areas through visits to my Web site. NASA has been visiting my Web site (www.jmargolin.com) regularly since I started it in December 2000. (I have no objection to NASA's visits; I am flattered that NASA considers my Web site worth visiting.)

A listing of NASA access statistics follows the end of this fax.

I also have regular visits from http://cap.nipr.mil, which I understand is a secure gateway to other military networks. I don't know if NASA uses nipr so I have not included it in my listing.

The Web Statistics software provided by my Web Hosting Service tell me who is visiting my Web site and what people are looking at but not who is looking at what, (In January of this year I discovered there are raw Web log files containing this information but my Web Hosting Service does not keep backup log files older than the previous month.)

I am including an example of the detailed Web log data; it's understandable why my Web Hosting Service abstracts it into a less detailed form.

The article being referenced is **Unit Vector Math for 3D Graphics** (www.jmargolin.com/uvmath/uvmenu.htm)

Now that I can see what people are looking at I have noticed a great deal of interest in this article as well as **The Relationship between Unit Vector Rotations and Euler Angle Functions** . (www.jmargolin.com/uvmath/euler.doc)

These articles also seem to interest military contractors like Lockheed Martin (lmco.com), Boeing (boeing.com), Northrop Grumman (northgrum.com), and SAIC (saic.hq.nasa.gov) as well as a large number of educational institutions.

Some accesses are obviously just for fun, to articles such as to **Gas Music From Jupiter** (www.jmargolin.com/gmfj/gmfj.htm)

There are also visits from most of our national labs. I expect they are interested in **U.S. Patent 6,377,436 Microwave Transmission Using a Laser-Generated Plasma Beam Waveguide** issued April 23, 2002 to Jed Margolin.

Abstract

A directed energy beam system uses an ultra-fast laser system, such as one using a titanium-sapphire infrared laser, to produce a thin ionizing beam through the atmosphere. The beam is moved in either a circular or rectangular fashion to produce a conductive shell to act as a waveguide for microwave energy. Because the waveguide is produced by a plasma it is called a plasma beam waveguide. The directed energy beam system can be used as a weapon, to provide power to an unmanned aerial vehicle (UAV) such as for providing communications in a cellular telephone system, or as an ultra-precise radar system.

There is a possibility that this device could be used to make a linear Tokamak. (www.jmargolin.com/debs/debs.htm)

Conclusion

I realize this is a great deal of material to wade through, but I would appreciate confirmation that you have received it and, if possible, an estimate as to when I can expect to hear NASA's decision on this claim.

Hopefully, then we can discuss compensation. The '724 patent is available for sale if NASA wishes to purchase it to avoid setting the precedent of the U.S. Government paying compensation for each flight of an aircraft using my patent. (I don't think this would be popular with DOD.) I expect that the first UAV to crash due to Pilot Induced Oscillation (or just Flight Computer Induced Oscillation, as occurred in the first flight of the Predator) would cost more than the cost of buying my patent. I believe this patent also has commercial applications like using UAVs for traffic reporting and in Law Enforcement so your Commercialization Department may be able to generate income with it.

Sincerely yours,

Jed Margolin

Jed Margolin
3570 Pleasant Echo Rd.
San Jose, CA 95148-1916
Phone: 408-238-4564
Email: jm@jmargolin.com

Here are NASA's visits to my Web site:

June 2001
nasa.gov

Total hits		Files	Pageview	Bytes sent		Hostname
2	0.02%	1	2	73232	0.02%	dhcp161-117.hst.nasa.gov

July 2001
nasa.gov

Total hits		Files	Pageview	Bytes sent		Hostname
24	0.27%	24	1	216909	0.08%	aavigil1.wff.nasa.gov
1	0.01%	1	1	96274	0.04%	antonius-dekorte-pc.jpl.nasa.gov
25	0.28%	25	2	313183	0.11%	

August 2001
nasa.gov

Total hits Files Pageview Bytes sent | Hostname

40	0.38%	40	1	184514	0.06%	time2burn.larc.nasa.gov
24	0.23%	24	1	216909	0.07%	gerhard.gsfc.nasa.gov
64	0.61%	64	2	401423	0.12%	

October 2001
nasa.gov

Total hits		Files	Pageview	Bytes sent		Hostname
1	0.01%	1	1	549657	0.11%	halljm.nsstc.nasa.gov

November 2001
nasa.gov

Total hits		Files	Pageview	Bytes sent		Hostname
48	0.39%	24	2	216909	0.06%	aavigil1.wff.nasa.gov
42	0.34%	42	1	532111	0.14%	mac01291100705.jpl.nasa.gov
1	0.01%	1	1	21505	0.01%	dhcp-78-14-233.jpl.nasa.gov
91	0.73%	67	4	770525	0.21%	

December 2001
nasa.gov

Total hits		Files	Pageview	Bytes sent		Hostname
1	0.01%	1	1	90494	0.01%	pgrant.arc.nasa.gov

February 2002
nasa.gov

Total hits		Files	Pageview	Bytes sent		Hostname
1	0.01%	1	0	120832	0.03%	csmad-nt-23.jpl.nasa.gov
1	0.01%	1	1	504805	0.11%	cielo2k.jpl.nasa.gov
2	0.01%	2	1	625637	0.13%	

March 2002
nasa.gov

Total hits		Files	Pageview	Bytes sent		Hostname
58	0.35%	45	5	319389	0.05%	fantasy.arc.nasa.gov
6	0.04%	5	4	1299302	0.22%	fryepc.larc.nasa.gov
1	0.01%	1	0	120832	0.02%	shum.larc.nasa.gov

65	0.39%	51	9	1739523	0.29%	

April 2002
nasa.gov

Total hits		Files	Pageview	Bytes sent		Hostname
40	0.23%	40	1	184514	0.03%	cevennes.jpl.nasa.gov
7	0.04%	7	2	45302	0.01%	doppler.jpl.nasa.gov
1	0.01%	1	1	5735	0.00%	math.jpl.nasa.gov
1	0.01%	1	0	120832	0.02%	k-137-78-152-182.jpl.nasa.gov
49	0.29%	49	4	356383	0.06%	

May 2002
nasa.gov

Total hits		Files	Pageview	Bytes sent		Hostname
4	0.02%	0	0	0	0.00%	k1505776.ksc.nasa.gov
1	0.00%	1	0	120832	0.02%	manzanita-227-215.arc.nasa.gov
1	0.00%	1	1	96274	0.02%	seraph3.lerc.nasa.gov
6	0.03%	2	1	217106	0.03%	

June 2002
nasa.gov

Total hits		Files	Pageview	Bytes sent		Hostname
3	0.02%	1	1	96694	0.02%	micronovich.gsfc.nasa.gov

July 2002
nasa.gov

Total hits		Files	Pageview	Bytes sent		Hostname
43	0.19%	43	4	190275	0.03%	seraph3.lerc.nasa.gov
42	0.19%	42	3	189552	0.03%	varies01113104503.jpl.nasa.gov
2	0.01%	2	2	7802	0.00%	paulafinlayson-pc-pentium.jpl.nasa.gov
1	0.00%	1	1	350096	0.06%	brodbell1.gsfc.nasa.gov
1	0.00%	1	1	93686	0.02%	poes12.gsfc.nasa.gov
89	0.39%	89	11	831411	0.14%	

August 2002
nasa.gov

Total hits		Files	Pageview	Bytes sent		Hostname
24	0.11%	24	1	216909	0.03%	envision.arc.nasa.gov

1	0.00%	1	1	90494	0.01%	pc02141110149.jpl.nasa.gov
1	0.00%	1	1	142144	0.02%	tizzie.nsstc.nasa.gov
26	0.12%	26	3	449547	0.06%	

September 2002
nasa.gov

Total hits		Files	Pageview	Bytes sent		Hostname
5	0.02%	1	0	121528	0.02%	knepper.ivv.nasa.gov
1	0.00%	1	0	285696	0.04%	seraph2.lerc.nasa.gov
1	0.00%	1	0	120832	0.02%	webproxy2.dfrc.nasa.gov
7	0.03%	3	0	528056	0.08%	

October 2002
nasa.gov

Total hits		Files	Pageview	Bytes sent		Hostname
98	0.45%	98	14	827297	0.11%	dial37.jsc.nasa.gov
1	0.00%	1	1	49690	0.01%	isdn-dial-050.gsfc.nasa.gov
1	0.00%	1	0	120832	0.02%	latema.jpl.nasa.gov
1	0.00%	1	0	285696	0.04%	dkiewicz-pc.jpl.nasa.gov
101	0.47%	101	15	1283515	0.16%	

November 2002
nasa.gov

Total hits		Files	Pageview	Bytes sent		Hostname
27	0.12%	25	1	506284	0.06%	ntserve.gdscc.nasa.gov
7	0.03%	7	2	45342	0.01%	ecn1950165.gsfc.nasa.gov
2	0.01%	2	2	1155686	0.15%	zebra.arc.nasa.gov
1	0.00%	1	1	350096	0.04%	norton.gsfc.nasa.gov
37	0.17%	35	6	2057408	0.26%	

December 2002
nasa.gov

Total hits		Files	Pageview	Bytes sent		Hostname
7	0.03%	7	2	45269	0.01%	ws196.gsfc.nasa.gov

January 2003
nasa.gov

Total hits Files Pageview Bytes sent | Hostname

2	0.01%	2	2	29129	0.00%	csg- 686.cdscc.nasa.gov

February 2003
nasa.gov

Total hits		Files	Pageview	Bytes sent		Hostname
2	0.01%	2	2	29138	0.00%	odinssc609337.ssc.nasa.gov

April 2003
nasa.gov

Total hits		Files	Pageview	Bytes sent		Hostname
40	0.17%	40	1	184514	0.02%	khgmac.larc.nasa.gov
8	0.03%	5	4	40212	0.00%	kid-emillerw2k.saic.hq.nasa.gov
5	0.02%	1	0	121528	0.01%	psycho.larc.nasa.gov
4	0.02%	3	3	63471	0.01%	b03042144127.jpl.nasa.gov
3	0.01%	3	3	29881	0.00%	seraph2.grc.nasa.gov
60	0.25%	52	11	439606	0.05%	

Example of Detailed Web Log Data

This is an example of the detailed Web log data, so it's understandable why my Web Hosting Service abstracts it into a less detailed form.

The article being referenced is Unit Vector Math for 3D Graphics (www.jmargolin.com/uvmath/uvmenu.htm)

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khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:14 -0500] "GET /uvmath/fig1.gif HTTP/1.1" 200 2590 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:14 -0500] "GET /uvmath/m1.gif HTTP/1.1" 200 2237 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:14 -0500] "GET /uvmath/m2.gif HTTP/1.1" 200 1464 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:14 -0500] "GET /uvmath/m3.gif HTTP/1.1" 200 715 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:14 -0500] "GET /uvmath/m4.gif HTTP/1.1" 200 1720 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:14 -0500] "GET /uvmath/m5.gif HTTP/1.1" 200 1738 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:14 -0500] "GET /uvmath/m7.gif HTTP/1.1" 200 1549 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:14 -0500] "GET /uvmath/m8.gif HTTP/1.1" 200 1939 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:14 -0500] "GET /uvmath/m6.gif HTTP/1.1" 200 1762 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:14 -0500] "GET /uvmath/m9.gif HTTP/1.1" 200 4152 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:14 -0500] "GET /uvmath/m10.gif HTTP/1.1" 200 2732 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:14 -0500] "GET /uvmath/m11.gif HTTP/1.1" 200 2572 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:14 -0500] "GET /uvmath/m12.gif HTTP/1.1" 200 2580 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:14 -0500] "GET /uvmath/m13.gif HTTP/1.1" 200 3915 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:14 -0500] "GET /uvmath/m14.gif HTTP/1.1" 200 2591 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:14 -0500] "GET /uvmath/m15.gif HTTP/1.1" 200 2224 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:14 -0500] "GET /uvmath/m16.gif HTTP/1.1" 200 1858 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:14 -0500] "GET /uvmath/m17.gif HTTP/1.1" 200 1742 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:14 -0500] "GET /uvmath/m18.gif HTTP/1.1" 200 2642 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:14 -0500] "GET /uvmath/m19.gif HTTP/1.1" 200 1738 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:14 -0500] "GET /uvmath/m20.gif HTTP/1.1" 200 1762 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:14 -0500] "GET /uvmath/m21.gif HTTP/1.1" 200 1696 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:15 -0500] "GET /uvmath/m22.gif HTTP/1.1" 200 2224 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:15 -0500] "GET /uvmath/m23.gif HTTP/1.1" 200 1858 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:15 -0500] "GET /uvmath/m24.gif HTTP/1.1" 200 1711 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:15 -0500] "GET /uvmath/fig6.gif HTTP/1.1" 200 3304 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:15 -0500] "GET /uvmath/fig7.gif HTTP/1.1" 200 995 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:15 -0500] "GET /uvmath/fig8.gif HTTP/1.1" 200 4441 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:15 -0500] "GET /uvmath/fig11.gif HTTP/1.1" 200 3186 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:15 -0500] "GET /uvmath/fig12.gif HTTP/1.1" 200 3743 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:15 -0500] "GET /uvmath/fig14.gif HTTP/1.1" 200 1936 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)" khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:15 -0500] "GET /uvmath/fig16.jpg HTTP/1.1" 200 61706 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:15 -0500] "GET /uvmath/m25.gif HTTP/1.1" 200 1358 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:15 -0500] "GET /uvmath/m26.gif HTTP/1.1" 200 1413 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:15 -0500] "GET /uvmath/m27.gif HTTP/1.1" 200 1052 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:15 -0500] "GET /uvmath/m28.gif HTTP/1.1" 200 1017 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:15 -0500] "GET /uvmath/m29.gif HTTP/1.1" 200 1673 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:15 -0500] "GET /uvmath/m30.gif HTTP/1.1" 200 2224 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:24 -0500] "GET /uvmath/uvmath.htm HTTP/1.1" 200 40231 "http://www.google.com/search?q=+%22euler+angle%22+normal+openGL&hl=en&lr=&ie=UTF-8&oe=UTF-8&start=10&sa=N" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:24 -0500] "GET /uvmath/fig3.gif HTTP/1.1" 200 2524 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

---end

JOURNAL REPORT

TIME : 06/08/2003 00:00
NAME : NASA GEN COUNSEL
FAX# : 202-358-2741
TEL# : 202-358-2741
SER.# : BRO2J2502686

NO.	DATE	TIME	FAX NO./NAME	DURATION	PAGE(S)	RESULT	COMMENT
	06/07	17:03		12:25	13	OK	RX

BUSY: BUSY/NO RESPONSE
NG : POOR LINE CONDITION / OUT OF MEMORY
CV : COVER SHEET
POL : POLLING
RET : RETRIEVAL
PC : PC-FAX

Jed Margolin

From: "Jed Margolin" <jm@jmargolin.com>
To: <nasafoia@nasa.gov>
Sent: Saturday, June 28, 2008 7:05 PM
Attach: jm_nasa.pdf
Subject: FOIA Request

This request is made pursuant to the Freedom of Information Act.

I would like all documents related to the **Administrative Claim of Jed Margolin for Infringement of U.S. Patent Nos. 5,566,073 and 5,904,724; NASA Case No. I-222**.
I am attaching a letter dated June 11, 2003 from Alan Kennedy, Director, Infringement Division, Office of the Associate General Counsel as file ***jm_nasa.pdf***. I provided the information requested, it was received by Mr. Kennedy, and thereafter Mr. Kennedy refused to respond to my attempts to find out the results of the investigation.

I believe NASA has had enough time to have completed its investigation by now.

Jed Margolin
1981 Empire Rd.
Reno, NV 89521-7430
775-847-7845
www.jmargolin.com

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS UNITED STATES AIR FORCE
WASHINGTON, DC

13 Aug 02

HQ USAF/XO
1630 Air Force Pentagon
Washington, DC 20330-1630

Mr. Jed Margolin
3570 Pleasant Echo Dr.
San Jose, CA 95148-1916

Dear Mr. Margolin

On behalf of Secretary Roche, thank you for providing your ideas on ways to improve UAV control technology. As you know, we are now operating the Global Hawk and Predator systems in reconnaissance roles, and envision expanding unmanned aircraft applications into the weapons delivery mission area with the UCAV and the Predator/Predator B aircraft. Certainly we see a growing role for UAVs in the Air Force as technology advances and we gain experience in their operation. The improved control methods you have patented may well play a part in future UAV design. I suggest that you present these concepts to the various UAV manufacturers who are in the business of designing systems to meet our operational requirements. They can offer the best assessment on the overall feasibility of integrating your technology. I suggest a similar approach regarding your patented laser techniques.

Again, thank you for taking the time to offer these suggestions. I admire your ingenuity, and appreciate your desire to help us improve our national defense capabilities.

Sincerely

Charles F. Wald

CHARLES F. WALD, Lt Gen, USAF
Deputy Chief of Staff
Air & Space Operations

cc:
SAF/AQ
AF/XOR

United States Patent [19]

Margolin

[11] **Patent Number: 5,904,724**

[45] **Date of Patent: May 18, 1999**

[54] **METHOD AND APPARATUS FOR REMOTELY PILOTING AN AIRCRAFT**

[76] Inventor: **Jed Margolin**, 3570 Pleasant Echo, San Jose, Calif. 95148

[21] Appl. No.: **08/587,731**

[22] Filed: **Jan. 19, 1996**

[51] **Int. Cl.**[6] **G06F 165/00**; H04N 7/18

[52] **U.S. Cl.** **701/120**; 701/2; 701/24; 244/189; 244/190; 348/114

[58] **Field of Search** 364/423.099, 424.012, 364/424.013, 424.021, 424.022, 449.2, 449.7, 460, 439, 424.028; 340/825.69, 825.72, 967, 989, 991, 992, 993; 244/189, 190, 181, 17.13, 3.11, 3.15; 348/42, 51, 113, 114, 117, 123, 143; 382/154; 395/118, 119, 125

[56] **References Cited**

U.S. PATENT DOCUMENTS

3,742,495	6/1973	Diamantides	342/64
3,795,909	3/1974	Vehrs, Jr.	343/7
4,218,702	8/1980	Brocard et al.	348/144
4,405,943	9/1983	Kanaly	358/133
4,467,429	8/1984	Kendig	343/433
4,660,157	4/1987	Beckwith et al.	345/421
4,739,327	4/1988	Konig et al.	342/26
4,760,396	7/1988	Barney et al.	342/65
4,835,532	5/1989	Fant	382/284
4,855,822	8/1989	Naredra et al.	364/423.099
4,964,598	10/1990	Berejik et al.	244/190
5,015,187	5/1991	Lord	364/462
5,072,396	12/1991	Fitzpatrick et al.	364/450
5,086,396	2/1992	Waruszewski, Jr.	364/454
5,155,683	10/1992	Rahim	364/424.029
5,179,638	1/1993	Dawson et al.	395/125
5,240,207	8/1993	Eiband et al.	364/423.099
5,257,347	10/1993	Busbridge et al.	395/129
5,266,799	11/1993	Steinitz et al.	324/330
5,272,639	12/1993	McGuffin	364/449
5,335,181	8/1994	McGuffin	364/443
5,381,338	1/1995	Wysocki et al.	348/116
5,406,286	4/1995	Tran et al.	342/13
5,446,666	8/1995	Bauer	364/434
5,552,983	9/1996	Thornberg et al.	364/424.027
5,581,250	12/1996	Khvilivitzky	340/961

OTHER PUBLICATIONS

Lyons, J.W., "Some Navigational Concepts for Remotely Piloted Vehicles", AGARD Conference Proceed. n 176, Med. Accur. Low Cost Navig. at Avion. Panel Tec. Meeting, 5-1-5-15, Sep. 1975.

"US GeoData Digital Line Graphs", U.S. Dept. of the Interior, U.S. Geolg. Surv. Earth Sci. Info Ctr. (Factsheet) Jun. 1993.

"US GeoData Digital Elevation Models", U.S. Dept. of the Interior, U.S. Geolg. Surv. Earth Sci. Info Ctr. (Factsheet) Jun. 1993.

Shifrin, Carole A., "Gripen Likely to Fly Again Soon," *Aviation Week & Space Technology*, Aug. 23, 1993, pp. 72-73.

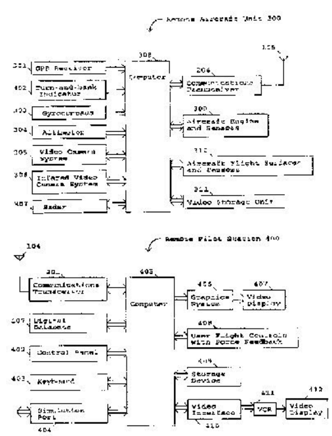
Primary Examiner—Tan Q. Nguyen

Attorney, Agent, or Firm—Blakely, Sokoloff, Taylor and Zafman LLP

[57] **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.

20 Claims, 7 Drawing Sheets



GA Riding 'Highway-in-the-Sky'

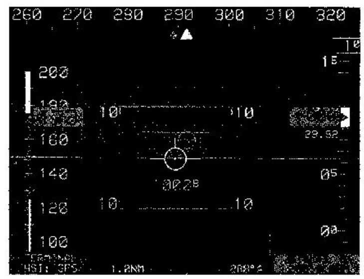
General aviation sector reaps the benefits of research originally conducted for military, commercial transport cockpits

BRUCE D. NORDWALL/WASHINGTON and OKLAHOMA CITY

General aviation aircraft are finally catching up with some of the advances found in the latest commercial transports and military cockpits, and in one particular sphere—display innovations—GA is actually taking the lead.

Researchers in industries and universities around the world have been pursuing a more intuitive guidance display for pilots for years. In general, this elusive presentation is referred to as highway-in-the-sky (HITS) (*AW&ST* Apr. 20, 1998, p. 58). In a twist that may foreshadow future advances, it was a general aviation aircraft that received the FAA's first certification of HITS technology for navigation guidance.

Instead of following course deviation indicators and altimeters, a pilot using this HITS presentation flies through a series of 3D boxes on a multifunction display. By maneuvering through the 400 X 320-ft. boxes spaced at 2,000-ft. intervals along the planned GPS route of flight, the pilot keeps the aircraft on course and altitude, which is particularly helpful for a descending, curved instrument approach.



Flying through "boxes in the sky" keeps pilots on course and altitude during a simulated curved instrument approach down the mountainous Gastineau Channel to Juneau, Alaska.

L.A.B. Flying Service's Piper Seneca made the first commercial revenue flight using HITS in Juneau, Alaska, on Mar. 31. It followed an optimized area navigation (RNAV) route through airspace that would be inaccessible with conventional avionics.

The system was built by Chelton Flight Systems as part of the second phase of the imaginative Capstone program, an FAA industry/academic partnership in Alaska. The cockpit employs a Chelton FlightLogic electronic flight information system-synthetic vision (EFIS-SV) using two glass displays, one for primary flight guidance and one for navigation.

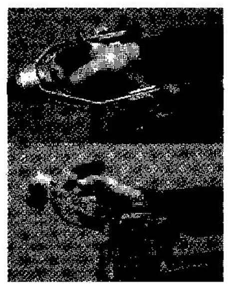
The big innovation is the use of synthetic vision symbology to present information to pilots. The initial EFIS systems digitally replicated the rudimentary attitude and flight-director symbols of electro-mechanical instruments from an earlier era. Now, in addition to the flight path, pilots see a real-time 3D view of the terrain and obstacles on the primary flight display. These are complemented by a moving map on the navigation display and by aural terrain warnings.

Among the other "firsts" claimed by Capstone Phase II on the Juneau flight were the use of forward-looking 3D terrain and HUD symbology on a certified primary flight display, and commercial use of the GPS wide-area augmentation system (WAAS).

Capstone has equipped three aircraft in Alaska with the Chelton Flight Systems' cockpit, and plans to outfit every commercial operator in SE Alaska within the next 18 months. The contract for 125 aircraft could expand to up to 200, according to Gordon Pratt, Chelton's president. The FAA is providing the equipment at no charge in Alaska to any commuter and on-demand (FAA Part 135) operator of fixed-wing aircraft or helicopters. A supplemental type certificate for helicopters was scheduled to be delivered on May 31. An additional 10 aircraft are being outfitted in the contiguous U.S., Pratt said, but at the expense of aircraft owners.

The first phase of the Capstone Program started as a demonstration that equipped a number of commuter and air taxi aircraft in the Yukon-Kuskokwim River delta area with a low-cost GPS, a terrain database, data link and Automatic Dependent Surveillance-Broadcast (ADS-B) equipment (*AW&ST* Sept. 18, 2000, p. 68). With GPS as the enabling technology, that phase indicated that a low-cost system could give bush pilots many of the safety benefits long-standard for commercial jet transports. The emphasis was on reducing controlled flight into terrain accidents for these pilots, who usually operate out of the range of navigation aids or radar help from ATC. Phase II with HITS and synthetic vision greatly expands those capabilities.

The navigation display shows GPS WAAS position and an approach not possible with conventional navigation aids due to a 20-30-deg. turn after the GASTN waypoint to align with the runway.



CAMI tested a four-axis side-arm controller in a simulator as a replacement for stick and throttle in a fly-by-wire performance control system.

The next major safety enhancement for GA aircraft could come from "performance control," according to Dennis B. Beringer, lead scientist for flight deck research at the FAA's Civil Aeromedical Institute (CAMI) in Oklahoma City. While known more for assisting FAA's Aircraft Certification Service and Flight Standards in defining requirements for both aircraft and pilots, CAMI is also an active partner in human factors research to improve cockpits.

With **performance control,**
non-pilots could learn to fly
a *simulator* in *15 min.*

The performance-control concept was introduced in the 1970s, before electronics were sufficiently advanced for implementation. Beringer said that now some of the fly-by-wire military and commercial aircraft use what could be legitimately called performance-control logic, which not only make aircraft easier to fly, but can also add flight envelope protection.

With conventional flight controls, a pilot has direct command of the aerodynamic surfaces. With performance control, his movements would be transmitted via a fuzzy-logic controller to a flight management system or an auto pilot that would guide the aircraft to carry out the desired performance goal. But unlike a simple autopilot, which directs a change in heading at a limited rate of turn, performance-control logic changes control laws so that a pilot commands the rate of turn and bank, and rate of climb or descent. It simplifies command of more complicated maneuvers, and is a compromise between automated maneuvering and manual flight control, Beringer said. Safety is further enhanced using a self-centering (spring-loaded) side stick which returns to the centered position when the pilot relaxes pressure, thus bringing the aircraft to straight and level flight.

The reduced number of control movements is one reason flying is easier. Going into a turn with conventional controls, the pilot has to initiate the roll, and then neutralize the ailerons when he achieves the desired bank angle. But with performance controls, one movement establishes the desired bank angle/turn rate. One downside to performance control with envelope protection is the inability to do aerobatics, such as an aileron roll or loop, Beringer said.

In the four-axis side-arm controller (above), rotating the wrist governs the rate of turn, flexing the wrist vertically directs the rate of climb or descent, and fore and aft movement varies the airspeed. Interest in performance controls was renewed with NASA's Agate (Advanced General Aviation Transport Experiments) program, which was concerned with simplifying the flight task and reducing ab initio training requirements. Agate has also been a strong supporter of HITS.

Researchers had previously found that with performance control, non-pilots could learn to fly a simulator in 15 min. Beringer tested the system in a simula-

-NA70-

tor configured as a Piper Malibu at CAMI. It used HITS displays and a four-axis side-arm controller. Twenty-four individuals with varying flight experience participated: six high-flight-time pilots; six low-flight-time pilots; six student pilots, and six non-pilots. Each flight involved a takeoff into instrument conditions, a continuous climb while turning downwind, a turn to intercept the instrument landing system glidepath, and a descent to landing. Flights were divided between use of a conventional yoke and the side-arm controller.

The findings were consistent. The aircraft was more stable and had less variations in course and altitude using performance control than with conventional controls. Although experienced pilots

The big innovation is use of synthetic vision symbology

always outperformed less-experienced individuals, with either system, all agreed the effort required was nearly halved.

Performance control is not apt to be seen in Piper Cubs, but perhaps in Beech Bonanzas and Piper Malibus. A lot of them already have two- or three-axis autopilots, so a significant capability could be achieved by rigging a side-stick control to the autopilot, Beringer said.

But two large problems must be overcome for performance controls to appear in the next generation of GA aircraft. The first is cost. Affordable and certifiable computer controls and servos would have to drop to a level competitive with more conventional systems.

Second, a fly-by-wire debate must be resolved. Could an affordable system be built with sufficient reliability using triple- or quad-redundancy, or would a costly manual-reversion be required? A mechanical backup would add cost for installation and for training pilots to operate the two systems.

Complicating that issue is the question of the level of reliability required. The FAA's current standard for a flight-critical system is a failure rate of 10^{-9}. While this is a standard for NASA, it might not be reasonable for general aviation aircraft. Beringer points out that the failure rate for humans is about 10^{-3}.

-NA71-

Jed Margolin ***3570 Pleasant Echo Dr.*** ***San Jose, CA 95148-1916***
Phone: (408) 238-4564 ***Email:* jm@jmargolin.com** ***January 8, 2004***

Mr. Alan J. Kennedy
Director, Infringement Division
Office of the Associate General Counsel
National Aeronautics and Space Administration
Headquarters
Washington, DC 20546-0001

Attn: GP(02-37016)

Dear Mr. Kennedy,

I am disappointed to hear that the investigation that you promised would take 3-6 months has not been completed.

As per our telephone conversation of 10 December 2003, please confirm that you believe the Statute of Limitations gives NASA the right to take up to six years to rule on my claim for compensation for the use of my patent.

Also, please confirm that you expect NASA to reject my claim for compensation on the grounds that the X-38 never flew.

Sincerely yours,

Jed Margolin

Jed Margolin

Jed Margolin 1981 Empire Rd. Reno, NV 89521-7430
Phone: 775-847-7845
April 27, 2009

Mr. Christopher J. Scolese,
Acting Administrator, NASA
300 E Street, SW
Washington, DC 20546
(202) 358-2810 (Fax)

Dear Sir,

I sent you a letter by certified mail on April 6, 2009. According to USPS it has not been delivered. USPS has several theories:

1. They lost it;
2. NASA refused to accept delivery;
3. Something happened to it when it was sent to New Jersey to be irradiated.

I am appending the letter to this fax.

The letter asks you to confirm that I have exhausted all of the administrative remedies that NASA has to offer in my attempt to get NASA to comply with the Freedom of Information Act. Since it took me an hour this morning just to get a fax number for you -I was misdirected all around NASA- the answer is obviously, "Yes."

When I file suit against NASA in the U.S. District Court For the District of Nevada I had planned to mail the Complaint to you. Since it does not seem possible to mail anything to NASA with any hope of success, will you allow me to email or fax the Complaint to you and will you waive Service?

If you refuse, I will have to pay a process server to serve you. Then I will amend my Complaint to ask the Court to assess costs and punitive damages against NASA.

Sincerely yours,

Jed Margolin

Jed Margolin

Cc: Senator Harry Reid

Jed Margolin
Phone: 775-847-7845
1981 Empire Rd.
Reno, NV 89521-7430
April 6, 2009

Mr. Christopher J. Scolese,
Acting Administrator,
NASA
300 E. Street, SW
Washington, DC 20546

Dear Sir,

NASA has been acting in bad faith toward me for the past almost-6 years.

I am the named inventor on U.S. Patent 5,904,724 **Method and apparatus for remotely piloting an aircraft** issued May 18, 1999. This patent teaches the use of (what is now called) synthetic vision for controlling a UAV.

I contacted NASA in May 2003 after I became aware that NASA had used synthetic vision in the X-38 project. Because the use of synthetic vision for controlling a UAV can be used to the detriment of this country by unfriendly entities I wanted a friendly conversation because I thought NASA should buy the patent in order to control the technology

In June 2003 I was turned over to Mr. Alan Kennedy in the Office of the General Counsel. This is what I recorded in my Contact Log:

> *Summary: He basically said that what most independent inventors have is junk and that since I am an independent inventor what I have is probably junk. If NASA evaluates it as a license proffer it will give it a pro forma rejection and I will file a claim anyway, so the same people who rejected it as a proffer will reject it as a claim, but in the process will have had to do more work, so to save them some work they will ignore the proffer and handle it as a claim.*

So, I filed a claim, completely answering all the questions on NASA's claim form. Then Mr. Kennedy informed me that NASA would conduct an investigation (expected to last 3-6 months) and that the purpose of the investigation would be to find prior art to invalidate the patent.

After six months I did not hear from NASA so I called Mr. Kennedy. He said:

1. The investigation had not been done.

2. NASA had a Research Exemption for using the patent. [Not true. See Madey v. Duke 307 F.3d 1351 (Fed. Cir. 2002)]

3. "The X-38 never flew." I informed him of the video on NASA's web site showing the X-38 flying.

4. The Statute of Limitations gives NASA 6 years to respond to my claim. (Wrong, it gives me 6 years to take NASA to Federal Claims Court.)

5. It would cost me more to sue NASA in Federal Claims Court than I could hope to recover from NASA.

After that, Mr. Kennedy refused to talk to me or respond to my letters. Then, various things came up and I was unable to pursue my claim against NASA.

Subsequently, I assigned the patent to Optima Technology Group, which has inherited the claim.

However, I still wanted to know what came up during the investigation so, on July 1, 2008 I filed a FOIA request. It was assigned FOIA HQ 08-270.

For some reason it was turned over to Mr. Jan McNut in the Office of the General Counsel.

His response is attached as *Reference 1.*

On August 5, 2008 Mr. McNut asked me to give NASA a 90-day extension to my FOIA request. I agreed.

In January, 2009 I received a letter from Mr. McNut who sent me back to the FOIA Office (*See Reference 2*), who wanted me to start over from scratch. Ms. Kelly Robinson then explained that she was currently working on FOIA requests filed two years before.

I told her that NASA did not get a do-over.

In the interests of brevity:

1. I talked to Ms. Robinson on March 18, 2009. She said she was sending me the results of the FOIA search, but there was some material she would not send me before it was internal Agency communications.

2. That was almost three weeks ago I have not received anything from NASA.

Therefore, Mr. Scolese, please confirm that I Have Exhausted All the Administrative Remedies that NASA Has to Offer. I need you to do this so I can bring suit against NASA in Federal Circuit Court.

If you fail to respond to this letter within ten days I will assume the answer is "Yes."

And I will note your failure to respond in my upcoming article, "How NASA Defrauds Independent Inventors." (That was not the title when this process started.) I will be sending the article to the various House and Senate oversight committees.

Sincerely yours,

Jed Margolin

Jed Margolin

Ref. 1

National Aeronautics and Space Administration

Headquarters
Washington, DC 20546-0001

August 5, 2008

Reply to Attn of: Office of the General Counsel

Mr. Jed Margolin
1981 Empire Road
Reno, NV 89521-7430

Re: Administrative Claim of Jed Margolin for Infringement of U.S. Patent Nos. 5,566,073 and 5,904,724; NASA Case No. I-222.

Dear Mr. Margolin,

We are in receipt of the Freedom of Information Act Request (FOIA) conveyed to us by email dated June 30, 2008 in which you request copies of all documentation relating to your administrative claim of infringement of U.S. Patent Nos. 5,566,073 and 5,904,724.

We regret the delay in processing your claim and assure you that we are now undertaking measures to provide a resolution of your claim as soon as possible. Unfortunately. Mr. Alan Kennedy retired from NASA earlier this year and the action on your claim was not conveyed to management in a timely manner. In addition the local attorney responsible for review of your claim also departed from NASA. We are now cognizant of the importance of proceeding with a review of the claim and will contact you when we have reached a decision.

As to your FOIA request, as the investigation of your claim is ongoing, we kindly request that you allow us a 90 day extension to answer this request. Within that time period we should be able to obtain a better picture of our position vis-à-vis your claim and the request for documents may no longer be required.

We should inform you that we have received a separate communication from a company Optima Technology Group, claiming to have been assigned both of the patents in question. You informed me telephonically that this is the case; however, we have no record of any assignment of your patents to this firm and will need confirmation through appropriate attested documents delivered to the agency in order to recognize any claim of ownership by a party other than the inventor.

Thank you for your patience in this matter. Please contact the undersigned at (202) 358-0632 or email Jan.McNutt@nasa.gov if you have any additional questions or comments.

Sincerely,

Jan S. McNutt

Jan S. McNutt
Attorney-Advisor

Ref. 2

National Aeronautics and Space Administration

Headquarters
Washington, DC 20546-0001

January 22, 2009

Reply to Attn of: Office of the General Counsel

Mr. Jed Margolin
1981 Empire Road
Reno, NV 89521-7430

Re: FOIA Request No. 10-F-2008-270

Dear Mr. Margolin,

Please contact our Freedom of Information Act (FOIA) Office below concerning the above FOIA request. That office should be providing you with a response to your FOIA request.

NASA Headquarters
300 E Street, SW
Room 5M15
Washington, DC 20546
(202) 358-2265

Sincerely,

Jan S. McNutt
Attorney-Advisor

Ref. 3

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Sent To: Christopher Scolese, NASA
Street, Apt. No.; or PO Box No.: 300 E. Street, SW
City, State, ZIP+4: Washington, DC 20546

PS Form 3800, June 2002 — See Reverse for Instructions

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2

National Aeronautics and Space Administration
Headquarters
Washington, DC 20546-0001

March 19, 2009

Reply to Attn of: Office of the General Counsel

CERTIFIED MAIL

Dr. Robert Adams, CEO
Optima Technology Group
1981 Empire Road
Reno, NV 89521

RE: Administrative Claim for Infringement of US Patent No. 5,904,724;
NASA Case No. I-222

Dear Dr. Adams:

This letter concerns the above-identified administrative claim for patent infringement.

NASA received the initial notification of this claim in an email dated May 12, 2003, from Mr. Jed Margolin addressed to attorneys at the NASA Langley Research Center claiming that "NASA may have used one or more of [Mr. Margolin's] patents in connection with the X-38 project and may be using one or more of my patents in other projects using Synthetic Vision". Mr. Margolin identified two patents that he believed NASA may be infringing; the subject patent and Patent No. 5,566,073. On June 7, 2003, Mr. Margolin submitted his claim by fax to the NASA HQ attorney, Mr. Alan Kennedy. Mr. Kennedy responded by letter dated June 11, 2003 acknowledging the administrative claim and requesting that Mr. Margolin give a more detailed breakdown of the exact articles or processes that constitute the claim. Mr. Margolin responded by letter dated June 17, 2003, withdrawing his claim with regard to U.S. Patent No. 5,566,073, leaving the remaining claim for the subject patent. NASA is aware of the long pendency of this matter and we regret the delay.

On July 14, 2008 Optima Technology Group sent a letter addressed to Mr. Kennedy stating that they were the owners of the Jed Margolin patents due to an assignment and requesting that NASA now license the technology of the subject patent. With an email dated August 6, 2008 from Optima, NASA received a copy of a Patent Assignment, dated July 20, 2004, executed by Jed Margolin, the sole inventor on the subject patent, by which the entire right, title and interest in the patent has been assigned to Optima Technology Group, Inc. We previously noted in a letter dated August 20, 2008 from Mr. Jan McNutt of our office addressed to you that NASA believes there are certain irregularities surrounding this and collateral assignment documents associated with the subject patent. However, NASA will at this time forestall a detailed consideration of that issue. Instead, we will assume your *bona fides* in asserting that you are the legitimate owner of the subject patent and communicate our findings directly with you. To the extent that Mr. Margolin has any interest in this matter, formally or informally, we will leave it up to you whether or not to communicate with him.

In light of the prior claim by Mr. Margolin, we consider your license proffer as an administrative claim of patent infringement. We turn now to the substance of your claim. In response to your initial letter dated July 14, 2008, Mr. McNutt's August 20, 2008 letter posed a number of questions, the purpose of which was to enable NASA to fully evaluate the details of your claim. Your organization failed to respond to these questions and, further, advanced the position that this matter does not involve a *new* claim (*Adams letter to McNutt, August 25, 2008*). We disagree that this is not a new claim. Nevertheless, NASA proceeds – in order to bring closure to this matter – on the basis that this claim centers around allegations that infringement arose from activities associated with NASA's X-38 Program, as advanced by Mr. Margolin. Accordingly, our investigation of this claim necessarily reflects the answers previously furnished by Mr. Margolin in response to NASA's June 11, 2003 letter to him containing substantially the same set of questions.

U.S. Patent No. 5,904,724 issued with twenty claims, claims 1 and 13 being the sole independent claims.

In order for an accused device to be found infringing, each and every limitation of the claim must be met by the accused device. To support a finding of literal infringement, each limitation of the claim must be met by the accused device exactly, any deviation from the claim precluding a finding of infringement. See *Lantech, Inc. v. Keip Mach. Co.*, 32 F.3d 542 (Fed. Cir. 1994). If an express claim limitation is absent from an accused product, there can be no literal infringement as a matter of law. See *Wolverine World Wide, Inc. v. Nike, Inc.*, 38 F.3d 1192, 1199 (Fed. Cir.1994).

In applying these legal precepts, reproduced below are the relevant portions of claims 1 and 13.

> Claim 1. A system comprising:
>
> * * *
>
> a computer
>
> * * *
>
> said computer is. . .for *determining a delay time* for communicating said flight data between said computer and said remotely piloted aircraft, and wherein said computer adjusts the sensitivity of said set of one or more remote flight controls based on said delay time. (emphasis added.)
>
> Claim 13. A station for flying a remotely piloted aircraft that is real or simulated comprising:
>
> * * *
>
> a computer
>
> * * *

> said computer. . . to *determine a delay time* for communicating. . .flight control information between said computer and [a] remotely piloted aircraft, and said computer to adjust the sensitivity of [a] set of remote flight controls based on said delay time. . . .(emphasis added.)

NASA has investigated activities surrounding the X-38 program at its Centers that conducted X-38 development efforts and has determined that no infringement has occurred. This result is compelled because none of NASA's X-38 implementations utilized a computer which is "for determining a delay time for communicating said flight data between said computer and said remotely piloted aircraft," as required by claim 1, nor a "computer ... to determine a delay time for communicating ... flight control information between said computer and [a] remotely piloted aircraft," as required by the limitations of claim 13.

Given that a computer which measures delay time is lacking from the NASA X-38 configuration, it follows that the NASA X-38 configuration had no "adjusting of the sensitivity of [a] set of one or more remote flight controls based on said delay time", as required in claim 1. Similarly, because the NASA X-38 configuration had no "computer to determine a delay time for communicating ... flight control information between said computer and [a] remotely piloted aircraft, the configuration also had no adjusting of "the sensitivity of [a] set of remote flight controls based on said delay time", as called for by claim 13.

For at least the above-explained exemplary reasons, claims 1 and 13 have not been infringed. It is axiomatic that none of the dependent claims may be found infringed unless the claims from which they depend have been found to be infringed. *Wahpeton Canvas Co. v. Frontier, Inc.*, 870 F.2d 1546 (Fed. Cir. 1989). One who does not infringe an independent claim cannot infringe a claim dependent on, and thus containing all the limitations of, that claim. *Id.* Thus, none of claims 2-12 and 14-20 have been infringed.

NASA's X-38 development efforts ended in 2002. There may also be other features in NASA's X-38 development efforts that, upon further analysis, would reveal yet more recited claim limitations that are lacking in the NASA configuration related to those efforts.

We also note as a point of particular significance that the limitations included in claims 1 and 13 discussed above were added by amendment during the prosecution of the patent application. It is clear from an analysis of the patent application file wrapper history that the individual prosecuting the application stressed the importance of "the measurement of a communication delay in order to adjust the sensitivity of flight controls based on that delay." Also noted is the distinguishing arguments that these claims require that there be a "computer ... located in the pilot station" and that "at least one real time measurement of the delay and some adjustment is contemplated." (See *Applicant's Amendment and Remark*, February 27, 1998 and *Response Under 37 C.F.R. § 1.116*, July 6, 1998). Clearly, the Patent Office Examiner allowed the application based on these prosecutorial arguments.

We have completed our investigation regarding the claim of patent infringement of U.S. Patent No. 5,904,724 and have determined that there is no patent infringement by, or unauthorized use on behalf of, NASA. The above detailed discussion explains the basis for NASA's analysis and decision regarding the subject administrative claim.

As an aside, during NASA's investigation, numerous pieces of evidence were uncovered which would constitute anticipatory prior knowledge and prior art that was never considered by the U.S. Patent and Trademark Office during the prosecution of the application which matured into Patent No. 5,904,724. In view of the clear finding of lack of infringement of this patent, above, NASA has chosen to refrain from a discussion that would demonstrate, in addition to non-infringement, *supra*, invalidity of the subject patent. However, NASA reserves the right to introduce such evidence of invalidity in an appropriate venue, should the same become necessary.

This is a FINAL agency action and constitutes a DENIAL of the subject administrative claim for patent infringement.

Pursuant to 35 U.S.C. § 286, the statute of limitations for the filing of an action of patent infringement in the United States Court of Federal Claims is no longer tolled. Thus, any further appeal of this decision must be made by filing a claim for patent infringement in the United States Court of Federal Claims, pursuant to 28 U.S.C. § 1498(a).

Sincerely,

Gary G. Borda
Agency Counsel for Intellectual Property

Fly-By-Wire

A Primer for Aviation Accident Investigators

Air Line Pilot, February 2000, page 18
By F/O Steve Stowe (Delta), Local Air Safety Chairman, Delta Council 16

Fly-by-wire (FBW) is the generally accepted term for flight control systems in which a computer processes the pilot's control movements and sends electric signals to the flight control surface actuators without any mechanical linkage. While enhancing aircraft performance and flying qualities, today's fly-by-wire systems present their own unique hazards and risks. Aviation safety officers and accident investigators need to become "fly-by-wire literate" to be effective today. Here, I briefly introduce fly-by-wire concepts, acquaint you with some of the FBW lingo, and look at safety applications.

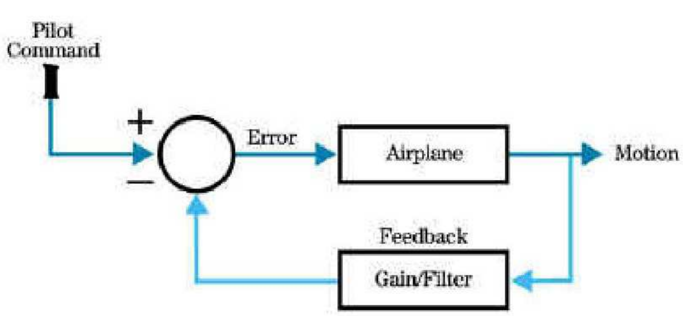
As aircraft design progressed to high-speed, swept-wing jets, capable of flying over a broad flight envelope, flight control designers faced new problems. Airplane handling qualities varied tremendously with speed, fuel burn, or external stores configuration. Improved stability and handling precision were needed, and fly-by-wire technology provided the solution. To understand how this technology makes modern airplanes fly, we'll look first at the concept of electronic feedback control.

Feedback control systems

Feedback compensation is essentially error control. It regulates a system by comparing output signals to input signals. Any error between the two becomes a command to the flight control surface until output equals input.

A computer measures an aircraft's motion parameter, conditions the signal, amplifies it, and sums it up with an input command, forming a closed "loop" (see Figure 1).

Figure 1:



In an FBW schematic diagram of this process, called a block diagram, the upper line is called the forward path while the lower loop is called the feedback loop or path. Gain is the amplification (or attenuation) that is applied to the signal to adjust the aircraft response as desired. A filter may be used to block feedback of signals or motion of an undesired frequency. The diagram's circle, or summer, indicates algebraic summation according to the arrows and signs.

An advantage of a feedback system is that the flight control system (FCS) can be used to reduce sensitivity to changes in basic aircraft stability characteristics or external disturbances. Autopilots, stability augmentation systems (SASs), and control augmentation systems (CASs) are feedback control systems.

In an SAS, the damper function is formed in the feedback loop and usually has low gain, or authority, over a control surface. CAS, implemented in the forward path, is high-authority "power steering," providing consistent response over widely varying flight conditions.

CAS and SAS were used extensively before fly-by-wire, as in the A-7 and the F-15, but fly-by-wire provides more precision and much greater flexibility. Uniform aircraft response is achieved over a broad flight envelope through CAS gains that are programmed as functions of airspeed, mach, center-of-gravity position, and configuration.

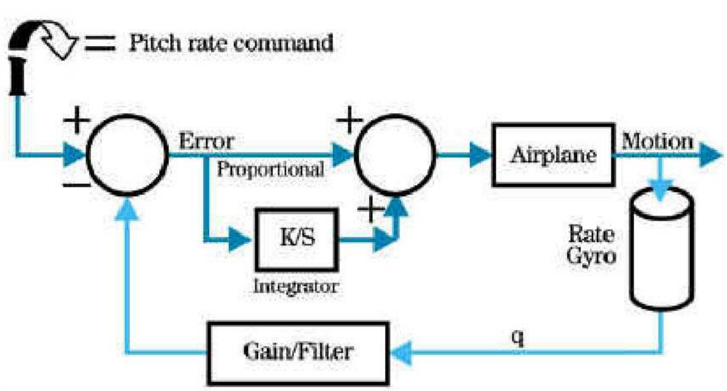
Control laws

Modern flight control computers are programmed with *control laws* that govern the feedback control system. Control laws are commonly named after the primary feedback parameter as "___feedback" or "___command." For the pitch channel, common feedbacks are vertical load factor (Nz or just "g"), pitch rate (q), pitch angle (θ or attitude), and angle of attack (α or alpha). Common lateral feedbacks are bank angle (ϕ) and roll rate (p). Typical directional feedbacks are yaw rate (r), sideslip angle (β or "beta feedback"), and rate of change of sideslip angle (β with a dot over it, or "beta dot feedback").

G command, desirable at high speeds, means for a particular amount of stick force, you get the same "g" regardless of airspeed (energy permitting). In a pitch-rate command system, you get the same amount of pitch rate for a given stick force regardless of speed. (Pitch-rate feedback and its effects are presented in detail in Figure 2--the concepts apply to any feedback control law.)

The pilot applies a certain control force, demanding pitch rate, and that becomes the flight control computer's command for a particular pitch rate. Because the pilot's control input "demands" a certain maneuver parameter, such an arrangement is often termed a "maneuver demand" system. The computer, not the pilot, then moves the control surfaces as required to meet the pilot's demand.

Figure 2:



To provide immediate response to pilot input, the computer provides a direct path to the elevator via the proportional line (called the "feed forward gain" in the B-777). For precision over time, an integrator produces a control surface command until the feedback signal is equal to the pilot's command signal.

Pure integral control, or too much integrator gain (K), causes excessive lag in the aircraft response, hence the use of the proportional circuit. This arrangement, called "proportional plus integral" control, is found in most fly-by-wire designs, including the B-777 and the A320.

In a block diagram, "1/s" or "K/s" denotes an integrator, the "K" indicating some gain value. FBW engineers must "tune" the integrator gain to prevent excessive lag.

Lag causes delay in changing directions--for example, nose-up to nose-down, which is a classic cause of pilot-involved oscillation, or PIO. Engineers can mathematically analyze control laws for such instabilities. Thorough flight testing is still required, however, to validate an FBW system.

So how does an airplane with a pitch-rate command or g command fly? Essentially, it gives you attitude hold with controls free, similar to an autopilot's control wheel steering feature. If you change pitch attitude and release control pressure at the desired attitude, the system holds that new attitude because the FCS reacts to bring pitch rate to zero. The airplane should fly nicely with pleasant control forces and precise attitude control.

A side benefit of either pitch-rate or g feedback is autotrim in that you can change speed without needing to retrim for level flight. And you don't have to retrim for thrust or configuration changes either. Autotrim gives you apparent neutral-speed stability. Even though positive speed stability was a generally accepted design requirement for more classical airplanes, the lack of it doesn't seem to bother Airbus pilots. However, Boeing opted to retain conventional trim "feel" in its B-777 design.

C Star

C* (pronounced "C Star") is the popular name for a control law in which Nz (g) and pitch-rate feedback are blended. (In the late 60s and early 70s, Nz feedback was called the C law. NASA space shuttle approach studies added pitch-rate feedback, which was called C*.) At low speed in a C* airplane, pitch rate is primary; at higher speeds, g is primary. The changeover is transparent and occurs at about 210 knots in the A320 ("Fly-By-Wire for Commercial Aircraft: The Airbus Experience," C. Favre, 1991).

C*U ("U" represents forward velocity in flight equations) is a modified C* control law used in the B-777 to provide apparent speed stability. The trim switches set a reference speed that is summed with the actual speed in the feedback loop in such a way that the pilot feels conventional control force cues as speed changes. You "trim a speed," not the stabilizer (weight off wheels). Because the max trim reference speed is 330 knots, you would have to push on the control wheel to further increase speed toward Vmo. This provides a tactile high-speed cue.

Fly-by-wire allows designers to optimize the effective dynamics for different flight tasks--for example, an approach mode or a flare mode. This is called task tailoring and produces a multi-mode FCS.

In both the A320 and the B-777, the control laws are not fully active during takeoff until after liftoff because the sensors used for feedback would sense a lot of vibration and "noise" during the ground roll. Landing requires other transitions. Accident investigators should thoroughly understand mode transition points and effects.

Landing with C*

Because C* doesn't "see" ground effect and would require a forward control movement to land, flare compensation may be introduced to the control law. In the B-777, the control law generates a nose-down pitch command at 30 feet radio altitude, requiring aft stick to flare, duplicating conventional ground effect.

The B-777 control laws also improve derotation characteristics over those of the B-757/767. This was achieved by fine-tuning the C*U integrator gain during flight tests and required absolutely no hardware or tooling changes!

Redundancy management

Want a mechanical backup system for all this fly-by-wire magic? This is a popular discussion issue, but the need for such a backup system is really a function of how much redundancy the computers and the sensors have. With today's technology, money is generally better spent on electrical and sensor system integrity and redundancy.

Some military aircraft, because they get shot at, have a quadraplex FCS; that is, they have four each of every essential component. airliners, such as the B-777 and A340, generally use triplex FCSs. Boeing and Airbus both provide limited mechanical backup to ensure a period of survivability at cruise to sort out any electrical problems. Duplex FBW systems should generally have a full mechanical backup.

With all components operative, an FCS is commonly said to be operating in normal law. Various failures usually cause autoreversion to some degraded, but still computed, FCS mode. The lowest level of FBW backup modes normally features analog electronic signals that bypass the primary computers and go directly to the actuators, hence the term direct mode. Direct modes have no feedback control and may have fixed gains to provide acceptable control forces proportional to control surface deflection. The gain selected may optimize control forces for the landing configuration only, or the design might provide different gains for cruise and landing, switched through the flap handle, for example.

Envelope protection

Feedback control of airspeed, mach, attitude, and angle of attack can be used to keep the FBW airplane within a design envelope. Two strategies have been pursued.

With "hard limits," control laws have absolute control (unless the pilot selects direct mode); this is the Airbus strategy.

With "soft limits," the pilot can override envelope protection and so has final authority for the operation of the airplane; this is the Boeing philosophy (and that of the former McDonnell Douglas).

Hazards

Now for the bad news. While FBW technology could make an aerodynamically unstable aircraft flyable, it can also destabilize an otherwise stable airframe.

FBW flight control laws may not be stable for all values of gain or phase angle (the difference between pilot input and airplane response in terms of frequency; exactly opposite would be a 180-degree phase angle) that can be applied. Now costarring with static margin as stability factors are "gain margin" and "phase margin"--measures of how much additional gain or phase-angle lag are available until the system becomes unstable. Computer simulation or flight testing can determine these two margins. But these data are often the manufacturer's proprietary information, so don't look for it on your weight-and-balance sheet.

Highly augmented aircraft, in which fly-by-wire transforms the basic aircraft aerodynamics, can exhibit cliff-like handling qualities.

One reason is that fly-by-wire systems are susceptible to time delay, from a number of causes, which can seriously degrade the pilot's ability to control the aircraft. Time delay may vary for different sizes or frequencies of inputs. U.S. military standards suggest that time delays should be less than one tenth of a second for good handling qualities and that loss of control may occur with delays more than one quarter of a second (MIL STD 1797).

Another factor seen in a number of FBW aircraft accidents involving loss of control is actuator rate limiting, which occurs when the control actuator is commanded to move faster than it is physically capable of moving. Large or rapid control inputs, causing the actuator to lag or not respond to commands, can induce rate limiting in FBW airplanes. Rate limiting can also occur when multiple functions are trying to control the same surface; for example, during rapid pilot pitch commands while the pitch damping function is working hard during turbulence.

Some FBW designs may have a software rate limit placed on the pilot's inputs in the command path. In this case, commands faster than the software limit cause a delay between control movement and resulting aircraft response (*Aircraft Control System Rate Limiting*, L. Knotts, M. Parrag, E. Ohmit, Calspan Corp., 1993).

While your basic Cessna also has rate limits, the control stops provide some cues that are totally lacking in an FBW airplane. With cable and/or pushrod controls, pilots don't and can't move the controls opposite the surfaces; in FBW, it could happen without the pilot's being aware. Furthermore, time delay and rate limiting can occur with all equipment components operating normally--you don't need a failure somewhere to get these effects.

These factors can lead to an inadvertent or unwanted flightpath motion, aircraft-pilot coupling (APC). Formerly called "pilot-induced oscillations," APC is preferred as it removes the pilot-blaming implicit in "PIO." A good safety program for an FBW airplane should have a reporting system to track APC events. Any unusual handling problems or aircraft motions should be reported. Without tracking APC events, control law deficiencies may go uncorrected.

Safety applications

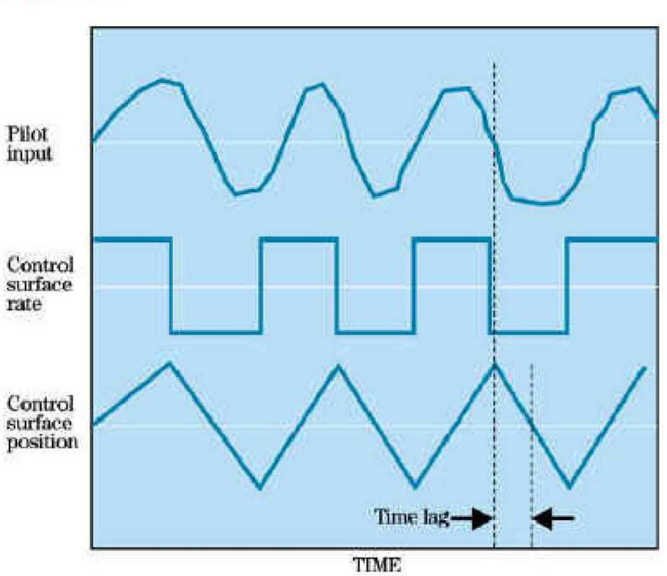
Fly-by-wire means adding a few new chapters to our accident investigation handbooks. I'll cover just one accident investigation application--detecting rate limiting. This has been the cause of some FBW loss-of-control accidents, including the August 1993 Gripen airshow crash at Stockholm. If loss of control or aircraft handling qualities are suspected in an FBW accident, first assume that the FCS--and not the pilot--induced it until proven otherwise (it might be "designer error").

Your investigation team should include an FBW flight controls expert capable of evaluating phase and gain margins of the system. Also, you may need a manufacturer's FCS engineer who has access to proprietary control law details and flight test data.

One "smoking gun" that investigators should look for is the unmistakable signature of rate limiting. Using the flight data recorder data, compare control surface position to pilot control force (or position). If these data are not available, suspect flight conditions might be repeated in a simulator and computer time histories analyzed, but simulators don't respond like the real airplane outside of a small envelope. (See Figure 3 for the characteristic shapes to look for--this is not an actual data trace.)

A "sawtooth" shape of the data trace of the control surface position, as in Figure 3, indicates that the actuator is moving "stop to stop"--the distinct indication of rate limiting. If actuator-rate or rate-signal data are available, you will see a "checker" shape over the control surface position; the flat spots are the actual rate-limit value. For a software rate limit upstream of the actuator, the sawtooth shape may not be detectable on the control surface time history, and other signals may need to be analyzed. In any case, look for a time delay between input and output.

Figure 3:



If you see the sawtooth, try to find a "trigger" that caused rapid or full deflection pilot inputs. For example, in the case of a YF-22 landing accident at Edwards AFB, the trigger was raising the gear for a go-around with afterburner engaged. This caused a step control law gain change to the stick forces and activated thrust vectoring. With the sudden change in aircraft response, the pilot became immediately involved in an oscillatory APC event with rate limiting.

In closing, this article has tried to acquaint the aviation accident investigator with safety aspects of fly-by-wire flight control systems. Now, you should be able to "talk fly-by-wire" with the best of them. The FBW glossary (page 20) defines, with additional explanation, the fbw terms used in the article.

FLY-BY-WIRE GLOSSARY

* **Aircraft–pilot coupling (APC)**--Inadvertent, unwanted flightpath and attitude motions, usually oscillatory, caused by abnormal interactions between the aircraft FCS and the pilot. Also known as "PIO" for "pilot-induced oscillation," with pilot-blaming implied. APC, or "pilot-*involved* oscillation," implies the FCS may be at fault.

* **Alpha feedback**--Feedback of angle-of-attack (denoted by the Greek letter α, alpha). Because accurate alpha measurement at high angles of attack is difficult with airflow vane-type systems due to airframe buffeting and structural flexing, alpha values for feedback are often derived from inertial sensor data.

* **Apparent neutral speed stability**--FBW feature such that the pilot doesn't have to trim to maintain level flight during speed changes; autotrim.

* **Augmentation**--Enhancing an aircraft's natural aerodynamic response though the internal design characteristics of the flight control system. SAS, CAS, and FBW (see below) all provide augmentation.

* **Augmented aircraft**--The combination of the aircraft's natural aerodynamic response plus the additional dynamics and characteristics provided by the flight control system; augmentation systems turned on. Conversely, the "unaugmented aircraft" would have the augmentation systems turned off.

* **Autotrim**--No pilot trim inputs required to maintain level flight when speed is changed. Autotrim can be a side-effect of a pitch rate command or g command FBW system, which is called "apparent neutral speed stability" (note: pitching moments due to the thrust changes that would effect the speed change are compensated for without the need for pilot trim inputs as well).

* **Beta**--Sideslip angle, β, as measured with respect to the relative wind (often called the wind-axes, aerodynamic-axes, or stability-axes coordinate system). Sideslip angle is different from the yaw angle (y), which is measured relative to the body axes coordinate system that is rigidly fixed in the airplane; the two are essentially numerically equivalent only at low angles of attack.

* **Beta dot**--Rate of change of sideslip angle, β with a dot over it (the dot means derivative or rate of change of the parameter). Beta dot and yaw rate are often used as feedback signals in the lateral–directional modes, depending on the application. For example, the B-777 yaw damper control law uses Beta dot feedback at low angles of attack and switches to yaw-rate feedback at high angles of attack.

* **Block diagram**--A schematic diagram illustrating a basic control law, the signal flow, and associated sensors and feedbacks. As with electrical schematics, a block diagram may be represented by equations and analyzed mathematically for system stability characteristics.

* **Body axes**--Set of three mutually perpendicular directions (x,y,z), rigidly fixed to the body of an aircraft. Commonly, the axes originate at the cg and are defined as the longitudinal (roll) or x axis, measured positive forward and negative to rear; the lateral (UK= "transverse") (pitch) or y axis, measured positive to the right and negative to the left; and the vertical (yaw) or z axis, measured positive downward and negative upward. The x axis may be parallel to the thrust line, the wing aerodynamic chord, or some other longitudinal reference line. The xz plane is the plane of symmetry for the aircraft.

* **C***--Pronounced "C Star," a pitch-axis control law in which pitch-rate and load-factor (g) feedback are blended. Pitch rate dominates at low speed, load factor at higher speed. Used in the Airbus A320/330/340.

* **C*U**--Modified C* pitch-axis control law with forward velocity feedback included to give apparent speed stability. Used in the Boeing 777.

* **CAS**--Control (or "command") augmentation system; provides "power steering" and consistent aircraft response over a broad flight envelope. CAS functions originate in the forward path of the FCS block diagram. It essentially boosts the pilot's initial control force and makes flying the airplane easier and more precise. Sensors in the CAS circuit provide feedback signals (typically load factor, pitch rate, or roll rate) to a computer, which compares the aircraft response to the pilot's command signal to make the airplane respond as desired.

* **Command path**--The portion of a control law, as shown on a block diagram, before summation with feedback. Here, the pilot's command input may be shaped, filtered, or limited.

* **Compensation**--FBW feature by which control laws automatically prevent unwanted flightpath excursions. Typically, compensation is provided to eliminate trim changes due to configuration changes (extending or retracting landing gear, flaps, and/or speed brake) or thrust changes, to automatically coordinate the rudder required during roll into a turn, to adjust pitch attitude to maintain level flight during a turn, and to provide gust alleviation. An example is the B-777 thrust asymmetry compensation system, which automatically adds rudder to minimize yaw due to engine failure.

* **Direct mode**, aka direct link--A backup FBW mode in which analog electrical signals bypass the computers and go straight to the control actuators, producing deflection proportional to stick input. The ratio of control surface deflection to stick deflection/force is often fixed, called fixed gains, as a function of configuration, with more deflection provided with flaps down, for instance. Alternatively, gains may be optimized only for landing.

* **Envelope protection**--FBW feature by which flight envelope limits are implemented through the flight control system's control laws. Protections provided might include g limiting (2.5 gs on A320), angle-of-attack limiting, overspeed protection, low-speed limiting, or bank-angle limiting.

* **Feedback**--Motion output parameter such as pitch rate, angle of attack, or g that is measured, amplified (or attenuated), and then summed with the original input command. Named for the given parameter; for example, "pitch-rate feedback."

* **Feedback control system**--Flight control system circuit in which performance in maintaining a desired output parameter is substantially improved by feeding back the output for comparison with the input. If the output differs from the desired value, corrective signals are automatically sent to the flight control surface actuators without any pilot action required. Feedback circuits may consist of one or more "loops."

* **Feedback loop**--The portion of a block diagram that shows the path of the feedback signals that forms a "loop," usually depicted as the lower part of a block diagram.

* **Filter**--Modifies a feedback signal according to the frequency content of the parameter of interest to eliminate unwanted feedback effects. A "noise filter" can block nuisance variations in the feedback parameter; for example, pitch rate due to atmospheric turbulence. A "notch filter" can block feedback of structural bending effects occurring at some specific frequency.

* **Fly-by-wire (FBW)**--Flight control system in which a computer processes the pilot's commands and sends them to the flight control surface actuators by electrical signals rather than mechanical linkage; backup modes may bypass the computer. FBW also includes "fly-by-light," in which the same effects are accomplished through fiber-optic cables. "power-by-wire," means the actuators themselves are electric.

* **Forward path**--In a block diagram, the path for pilot inputs and their modification upstream of the flight control actuator.

* **G command**--Pitch-axis control law by which the pilot gets the same "g" for a particular amount of stick force, regardless of speed (energy permitting).

* **Gain**--Ratio of output to input, or amplification (or attenuation), of a feedback control system element. *Pilot gain* is often used to describe the magnitude and rapidity (frequency) of pilot control inputs. An urgent or high-effort task, such as flaring and touching down in a gusty crosswind, is often called a *high-gain task*.

* **Gain margin**--Amount of additional gain that could be applied to a control law before the system becomes unstable, in the same manner as "static margin" affects static pitch stability. Note: FBW flight control laws are not stable for all values of gain that could be applied.

* **Hard limits**--FBW envelope protection scheme by which the pilot cannot override the control law limits (in normal mode). Airbus designs use hard limits.

* **Inertial Axes**--A set of axes used for analysis of inertial effects (that is, the effects of weight distribution) on an aircraft's flightpath during maneuvering flight. In sustained maneuvers, the aircraft would actually rotate about the inertial axes. The longitudinal inertial axis need not be the same as the body x axis or wind x axis; however, the y and z axes usually coincide for a symmetrically loaded aircraft.

* **Integrator**--Circuit in an FBW flight control system that reduces response errors over time. It "remembers" the pilot's command and continues to move the control surfaces until the desired response is achieved and no further "error signal" is present. Represented by a "1/s" term in a block diagram. Important: integrator circuits often know only the pilot's maneuver request and may have no clue as to what the aircraft's physical capability to respond might be. Additionally, integrators remember the pilot's request as of some time ago, which may differ significantly from the pilot's instantaneous request during rapid control inputs. This may cause system lag and instability.

* **Lag**--Delay between pilot inputs and the aircraft's response. The severity of the lag is described by a parameter called phase lag or phase angle specified in angular degrees. Exactly opposite input and output would be a 180-degree phase lag/angle. Phase margin describes the additional amount of phase lag, measured in degrees, the system can have before it becomes unstable.

* **Load factor** (also g, Nz, or vertical-load factor)--Ratio of lift generated to aircraft weight, which pilots call "gs." Accelerometers that measure g for FBW feedback functions are not usually located at the cg, since it moves fore and aft during flight, but rather are located near the pilot's station; g accelerometers located aft of the cg can induce feedback control system problems.

* **Maneuver demand**--Because the pilot's control input "demands" a certain maneuver response in a FBW flight control system, it is often referred to as a "maneuver demand" system.

* **Multimode FCS**--FBW flight control system in which the effective dynamics change for different flight phases or tasks. The aircraft response is optimized, or "tailored," for various events, such as in an approach mode or flare mode, for example. Each mode has a different control law; mode changes may be enabled through gear/flap/throttle position.

* **Normal mode**--Normal control laws are in effect, all SAS and CAS functions working normally. Loss of certain sensors or components may cause automatic reversion to some degraded mode and control laws.

* **Pitch attitude**--Pitch angle, represented in block diagrams by the Greek letter theta, θ. Note: "Nose up" is usually positive, but the sign convention for corresponding elevator deflection varies. For instance, in NASA sign convention, a negative elevator deflection is trailing-edge-up, which produces a positive pitch motion.

* **Pitch rate**--Rate of change of pitch attitude measured relative to the body "y" axis, represented in block diagrams by the letter "q."

* **Pitch-rate command**--Pitch-axis control law in which the pilot gets the same pitch rate for a particular amount of stick force (or deflection in some designs), regardless of speed.

* **Proportional plus integral (PPI)**--Popular FBW arrangement that includes a "proportional" path to produce immediate control surface response to stick input while an "integrator" continues control surface commands until the feedback signal equals the pilot's command signal, yielding precision over time. Used in the B-777 and A320 pitch-axis control laws.

* **Rate limiting**--A phenomenon in FBW FCSs that causes handling difficulties ranging from unintended flightpath changes to loss of control. A flight control surface can be moved at some maximum rate, depending on the actuator's capability to reposition the surface (hardware limit) or on some lower rate limit imposed by the FBW flight control system (software limit). When the FCS commands exceed this limit, surface movement can significantly lag the pilot's inputs and go "stop-to-stop" trying to catch up with pilot commands. A data recorder time history would show the control surfaces moving back and forth in very unpilot-like straight lines, in a "sawtooth" fashion.

* **Redundancy management**--Describes the level of backup capability. Quadraplex means four of all essential components and computers--common on military aircraft (because of battle damage potential). A "fail-operate" system can be produced with a triplex system (as on B-777 and A320/330/340). Duplex FBW provides a low level of redundancy and should probably require a full mechanical backup.

* **Roll rate**--Rate of change of bank angle measured about the body "x" axis, represented by the letter "p." Usually, right roll and right stick are positive. Note: roll rate about the velocity vector (stability axis) may also be used.

* **Sign convention**--Establishes the positive and negative directions for control surface deflections and pitch, roll, and yaw motions used in a control law. Conventions vary among manufacturers. Caution: You must know the manufacturer's sign convention to evaluate its block diagram algebraically. For example, elevator trailing edge up (nose up) may be either a positive or a negative deflection depending on the sign convention adopted. Understanding the sign convention is imperative for accident investigation.

* **Soft limits**--FBW envelope protection scheme in which the pilot can override the control law limits. The B-777 design philosophy used soft limits.

* **Stability augmentation system (SAS)**--Feedback control system that provides pitch, roll, or yaw damping; sometimes called a "damper." Older aircraft with an SAS use an electrical, single-loop feedback signal in parallel (stick moves) or series (stick doesn't move) with the mechanical flight control system.

* **Summer**--In a block diagram, indicates the algebraic summation of the input quantities according to the arrows and the signs; represented by a circle or by a circle and an x.

* **Time delay**--Delay from pilot input to FBW aircraft response. Caused by many factors including the effect of filters, computer processing time, task time-sharing by computers and signal processors, "higher order" effects of the feedback control system, digital sampling effects, and/or actuator rate limiting. Time delays of more than 0.25 second can cause enough lag to make the FBW aircraft unstable during certain tasks, especially in "high gain" situations.

* **Wind axes** (aka aerodynamic axes and stability axes)--Set of three mutually perpendicular axes (u,v,w), usually with origin at the cg. The wind axes differ from the body axes in that the longitudinal axis is parallel to the flight path (relative wind) and not a fuselage reference line; the angle between the two longitudinal axes would be the angle of attack.

* **Yaw damper**--SAS system that damps unwanted yawing motions. A "body axis yaw damper" might use feedback from a yaw rate gyro or accelerometer and can be effective in eliminating "Dutch roll" tendency. However, these might be detrimental when roll about the velocity vector is desired (requires a "conical" motion with body axis roll and yaw rates) because it would oppose body axis yaw rate. Hence, Beta dot feedback might be used to provide damping about the velocity vector.

* **Yaw rate**--Rate of change of yaw angle as measured about the airplane's "z" body axis, denoted by "y."

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INTRODUCTION

During the final free flight (FF-5) of the shuttle's approach and landing test (ALT) phase, the vehicle underwent pilot-induced oscillations (PIO's) near touchdown (refs. 1 to 3). The oscillations were present in both the pitch and roll axes and were initiated when the pilot made pitch controller inputs in an effort to control sink rate by changing pitch attitude. Because the control inputs were large and fairly rapid, the elevons rate limited in the pitch axis at the maximum priority rate limit set in the computers. The elevon rate limit also limits the vehicle's roll control capability, and this was partially responsible for the lateral control problem.

Several unpublished studies indicate that time delays as well as priority rate limiting were a significant factor in the PIO's. A simulator study of the effect of time delays on shuttle PIO's is reported in reference 4.

This report describes the combined effect of pilot input rate limiting and time delays. Frequency responses are predicted for various parameters under rate saturated conditions by using nonlinear analysis.

SYMBOLS AND ABBREVIATIONS

Physical quantities in this report are given in the International System of Units (SI) and parenthetically in U.S. Customary Units. The measurements were taken in U.S. Customary Units. Factors relating the two systems are presented in reference 5.

A/C	aircraft
ALT	approach and landing test
APU	auxiliary power unit
a_n	normal acceleration, g
C_D	drag coefficient, $\frac{Drag}{\bar{q}S}$
C_{D_α}	change in drag coefficient with angle of attack, $\frac{\partial C_D}{\partial \alpha}$, per rad
$C_{D_{\delta_e}}$	change in drag coefficient with elevator deflection, $\frac{\partial C_D}{\partial \delta_e}$, per rad
C_L	lift coefficient, $\frac{Lift}{\bar{q}S}$
C_{L_α}	lift-curve slope, $\frac{\partial C_L}{\partial \alpha}$, per rad
$C_{L_{\delta_e}}$	change in lift coefficient with elevator deflection, $\frac{\partial C_L}{\partial \delta_e}$, per rad
C_m	pitching moment coefficient, $\frac{Pitching\ moment}{\bar{q}S\bar{c}}$
C_{m_q}	pitch damping derivative, $\frac{\partial C_m}{\partial q \frac{\bar{c}}{2V}}$, per rad
C_{m_α}	static longitudinal stability derivative, $\frac{\partial C_m}{\partial \alpha}$, per rad
$C_{m_{\delta_e}}$	change in pitching moment coefficient with elevator deflection, $\frac{\partial C_m}{\partial \delta_e}$, per rad
$\bar{c}$	mean aerodynamic chord, m (ft)
c_{ref}	overall vehicle length, m (ft)
cg	center of gravity
FF	free flight
f( )	function of parameter inside the parentheses

h_p	altitude, m (ft)
I_y	moment of inertia about y-axis, N-m^2 (slug-ft^2)
$j\omega$	imaginary part of root, per sec
K	gain constant
K_s	gain factor out of the shaping function
M	Mach number
PIO	pilot-induced oscillation
q	pitch rate, rad/sec
$\bar{q}$	dynamic pressure, N/m^2 (lb/ft^2)
S	reference area, m^2 (ft^2)
s	Laplace transform variable, per sec
T	time delay, sec
Ts	transfer function
t	time, sec
u, V	velocity, m/sec (ft/sec)
w	weight, kg (lb)
α	angle of attack, deg
Δ	transfer function denominator
δ_e	elevon deflection, deg or rad
δ_{e_c}	commanded input, rad
δ_{e_p}	pilot input, deg or rad
δ_{e_s}	shaping function output, deg or rad
θ_0	trim attitude, deg or rad

* **Yaw damper**--SAS system that damps unwanted yawing motions. A "body axis yaw damper" might use feedback from a yaw rate gyro or accelerometer and can be effective in eliminating "Dutch roll" tendency. However, these might be detrimental when roll about the velocity vector is desired (requires a "conical" motion with body axis roll and yaw rates) because it would oppose body axis yaw rate. Hence, Beta dot feedback might be used to provide damping about the velocity vector.

* **Yaw rate**--Rate of change of yaw angle as measured about the airplane's "z" body axis, denoted by "y."

Figure 1 is a three-view drawing illustrating the relative size and location of the primary control surfaces of the shuttle. Pertinent physical characteristics are presented in table 1.

Primary Flight Control Systems

Aerodynamic surfaces.— Full span independently actuated elevons provide both pitch and roll control. A conventional rudder mounted on the trailing edge of a single vertical stabilizer provides directional control. Speed brakes are activated by mechanically splitting the rudder symmetrically. A flap on the lower aft fuselage provides active trim control.

Control systems.— A digital fly-by-wire control system is implemented on the space shuttle. All elements of the control system, including the hand controller electrical signals, sensors, computers, and electrical paths up to the servoactuators, are quadruply redundant. Three independent hydraulic systems (APU's) supply power to the surface actuators. The independent operation of the four control systems and three hydraulic systems provides fail-operational/fail-safe capability.

Rotational hand controller.— Both the commander's and the pilot's station are provided with identical rotational hand controllers. In pitch, the controller pivots about the palm of the hand; in roll, it pivots about a point slightly below the base. Therefore, the pilot effectively applies a torque gradient rather than a force gradient. The commander's and the pilot's station controllers are not mechanically linked, but if both are deflected the input signals are combined and the elevons are deflected accordingly. However, the controllers are spring centered and null at zero electrical output.

Pilot control and augmentation.— A pitch rate command system is used on the space shuttle for the approach and landing phases of flight. The system is implemented as a digital flight control system resident in the onboard flight control computers. The mathematical block diagram in figure 2 shows the major elements of the closed-loop pitch attitude control system. The rotational hand controller input, δ_{e_p}, commands an output given by the pitch stick shaping function. The shaping function output, δ_{e_s}, is prefiltered to form the pitch rate command, $\dot{\theta}_c$. In the forward path and downstream of the error signal, a lead-lag filter along with a gain term, $f(\bar{q})$, gives the desired pitch rate response. The gain is scheduled as a function of dynamic pressure ($200/\bar{q} = 1.64$ for touchdown). Pitch rate command is achieved by positive feedback around the power actuator and servo, yielding an equivalent system for the actuator loop with a "free" s in the denominator. As such, the error signal, which is made up of the commanded response and aircraft pitch rate, is continually driven to zero. Therefore, the integration rate is proportional to the scheduled gain. Internal to the actuator and servo loop, the priority rate at which the actuator can move is restricted to 20 degrees per second, and the travel limit, which has been changed, is restricted for the following calculations to 21.5°. The filters, gains, summations, restrictions, and pitch stick shaping function are implemented in the shuttle's digital flight control computers.

A more complete description of the total flight control system and its design is given in reference 6.

ANALYSIS AND DISCUSSION

Shuttle PIO Experience

The first four landings of the ALT shuttle configuration were made on the lakebed without incident, as reported in references 2 and 3. The handling qualities were judged to be good; longitudinal control was rated approximately 2 on the Cooper-Harper scale (ref. 3).

A precision landing on the runway was attempted during the last flight. During the landing, the pilot induced both a longitudinal and a lateral PIO. The PIO first occurred in the pitch axis and then propagated to the roll axis. The oscillation was initiated by pitch controller inputs that were made to control sink rate. The excessive controller inputs caused the elevons to rate saturate. A right roll disturbance was then introduced as the main gear touched the runway. A lateral PIO then followed because roll control was restricted by priority rate limiting and control authority, which favored the pitch axis. The combined time of the oscillations was more than 12 seconds, and both oscillations were near the same frequency. Because the oscillations originated in pitch, it was assumed that the PIO problem was primarily a longitudinal control problem, with the roll control problem system induced. The flight conditions near the time of the PIO's are listed in table 2.

Figure 3 presents a time history illustrating the longitudinal PIO. Pilot inputs to the hand controller, δ_{e_p}, were approximately 0.5 hertz and in excess of 20° peak to peak. The average travel of the elevons was about 15° peak to peak. In addition, the control surface time history indicates that the actuators had reached the priority rate limits. The resulting pitch rate during the longitudinal PIO reached a peak to peak value of 7 degrees per second and appeared to be neutrally stable.

Prior investigations had predicted the shuttle to be susceptible to PIO's. An analytical study based on the shuttle's aerodynamics concluded that the shuttle would be prone to a longitudinal PIO (ref. 1). Also, simulator studies conducted concurrently with the approach and landing tests, as reported in reference 2, showed a tendency towards PIO's.

After the PIO's were experienced during FF-5, the rotational hand controller signal shaping was modified to include a suppression filter like that reported in references 7 and 8, and an analytical study was undertaken to investigate and evaluate the following:

1. System lag caused by rating limiting in the actuator loop.

2. The effect of varying the rotational hand controller input on the total attenuation and phase lag.

3. The effect of time delay in the augmentation loop on the gain and phase lag.

The following section gives an analytical description of the longitudinal or pitch control mode implemented on the shuttle.

Pitch Control Modeling

Presented in figure 4 is a conceptual block diagram of the shuttle control system. The pilot attempts to minimize pitch attitude error; he also tries to maintain the desired sink rate by changing the vehicle's reference attitude. The amount of rotation or torque applied by the pilot to the controller per unit error signal is referred to as pilot gain.

Figure 5 shows the parabolic hand controller shaping function programmed on the shuttle. The primary purpose of the shaping function, as it is in most fly-by-wire systems, is to increase the gain as a nonlinear function of controller displacement. Figure 6 presents the gain variation as a function of controller input, δ_{e_p}. In the command path and downstream of the shaping function, a gain constant of 0.4 degrees per second per degree is scheduled for the final approach and landing phases of flight. The pitch rate commanded, therefore, is $\delta_{e_p} \frac{\Delta\delta_{e_s}}{\Delta\delta_{e_p}} 0.4$. To improve the handling qualities, a lead-lag filter, $1.5 \frac{(s + 1.8)}{(s + 2.7)}$, is cascaded in the forward path of the augmentation loop.

It was reasoned that dead time resulting from transport lag plus the delay due to the rather low rotational hand controller sample rate of 12.5 cycles per second had worsened the PIO problem. Consequently, in the analysis a time delay function e^{-Ts} was added into the forward path of the augmentation loop. To assess the effect of this type of nonlinearity on the closed- and open-loop behavior of the system, the time delay function, T, was assigned various values: 0, 0.1, 0.2, and 0.4 second. Pitch rate command was achieved by positive feedback around the power actuator and servomechanism, as shown in figure 7. The system for the actuator loop with no rate limiting is given by

$$\frac{\delta_e}{\delta_{e_c}} = \frac{(s/1.5 + 1)}{s(s/30 + 1)}$$

Therefore, the integration rate was proportional to the gain $f(\bar{q})$ (fig. 4), where $f(\bar{q}) = \frac{200}{\bar{q}} = 1.64$.

During FF-5, the longitudinal control system underwent an extensive amount of rate limiting prior to touchdown, as is evident in the elevator time history of figure 3. The boundary limits of both position and rate limit as a function of input amplitude and frequency are presented in figure 8. Three δ_{e_p} inputs are shown parametrically as a function of frequency. These variations were obtained from a linear calculation with the shaping gain equivalent to the peak controller input. At realistic trim conditions and from controller inputs, δ_{e_p}, up to 15°, the system would only experience priority rate limiting over the frequency range shown. For controller inputs typical of the PIO condition of FF-5 (δ_{e_p} = 10°), the system would rate limit at 2.5 to 3.0 radians per second. Because rate limiting would be expected to add phase lag into the overall system, the actuator loop was first investigated in a separate or isolated fashion.

Presented in figure 9 is a time history typical of the digital simulation of just the actuator loop. For this particular example, the input amplitude to the actuator was 10° at a frequency of 3 radians per second. The system rate limited at 20 degrees per second over 90 percent of the time, and the through gain based on peak values was less than unity. Several computations were made at various frequencies and amplitudes to obtain a broad comparison to a model of the actuator loop.

Figure 10 compares both the amplitude ratio and the phase angle of the digital simulation to the algorithm that describes the actuator model. For a value of δ_{e_c} of 10° (near the PIO condition), the rate limit causes attenuation from 3 radians per second on. Additional phase lag is also added into the system from there on. The algorithm describing the actuator model is developed and presented as a subroutine in appendix A.

Integrated Analysis of the PIO

Nonlinear method.— During the PIO, an extensive amount of rate saturation prevailed. In addition, it was estimated (as reported in ref. 2) that up to 0.38 second of equivalent time delay may have been present in the augmentation loop (fig. 4). Therefore, a realistic analysis requires consideration of these two nonlinearities as well as the gain variation through the shaping function. The following discussion utilizes a nonlinear computation of the system gain and phase as a function of pilot input and frequency.

The method, in general, is simply to assign a value to the error vector, which has amplitude and frequency but phase equal to zero. Then an input/output vector can be computed successively through each element, keeping track of amplitude and phase algebraically until an open-loop vector for the augmentation loop is obtained. The input to the augmentation loop is then determined by adding the feedback vector to the error vector. The reciprocal or inverse functions in the command path (reversing the direction of flow) are used to obtain the pilot input, δ_{e_p}. This then gives a closed-loop vector relationship of the desired elements as a function of δ_{e_p} and frequency.

Appendix B outlines the nonlinear computational procedure. The aircraft aerodynamics and transfer functions are presented in table 3.

Elevon attenuation and system response characteristics.— If the amplitude of the input is great enough, elevon travel will be attenuated due to rate limiting as frequency is increased. Figure 11 presents the elevon travel as a function of controller input, δ_{e_p}, and frequency. Also shown are the boundary curves for minimum perceptible and fully developed rate limiting. For inputs of 5°, no attenuation is expected because of rate limiting for frequencies up to 8 radians per second, as indicated by the circle symbols, which remain below the minimum rate limit boundary. At δ_{e_p} = 10° the elevons are fully limited in a sawtooth fashion at frequencies from 3.5 radians per second on. If the input increases to 15°, the rate limiting begins at approximately 2 radians per second and then follows the fully developed rate limit boundary identical to the 10° input.

The effect of time delay on elevon amplitude as a function of frequency is shown in figure 12. Time delay is varied parametrically from 0 to 0.4 second. A constant controller input amplitude of 10° is applied to the shaping function. Increasing the time delay increases the elevon amplitude as frequency increases. From 4 radians on, rate limit tends to limit the elevon amplitude, regardless of the amount of dead time.

The normal force response of the aircraft, particularly the crossover phase frequency, is believed to affect pilot ratings. An assessment of the PIO tendencies based on both pitch attitude and the aircraft's normal force response is reported in reference 1. Presented in figure 13 is the effect of time delay on the frequency response of a_n at the cockpit per controller input. A value of 5° was used for the controller input in order to stay below any rate limiting over the frequency range shown. It is clearly evident by the increase in gain and phase lag that an excessive amount of dead time (T = 0.4 sec) causes the aircraft to be more responsive per controller input. The peak increase occurs at frequencies from 2.5 to 3.0 radians per second. For a time delay of 0.4 second the crossover phase frequency (fig. 13(b)) is about 2 radians per second; with no time delay, the crossover phase frequency is above 10 radians per second. The same parameters are shown in figure 14 for three controller inputs at a constant value of dead time, T, of 0.1 second. For a controller input of 5°, the system behaves in a linear fashion. At 10°, the response is attenuated by rate limiting from approximately 2.5 radians per second on. As shown in figure 14(b), rate limiting also adds phase lag into the system.

The calculated frequency response of the shuttle's pitch rate command system is presented in figure 15. A constant value of δ_{e_p} of 5° is applied to the shaping function. The effect of dead time is shown parametrically and is varied from 0 to 0.4 second. Again, and consistent with normal force response characteristics, the system would be highly susceptible to oscillations at approximately 3 radians per second with 0.4 second of dead time in the augmentation. Figure 16 shows the frequency response of the pitch rate command system for a constant value of dead time of 0.1 second at three values of pilot input. For a value of δ_{e_p} of 5°, the system retains linear behavior throughout the frequency range shown. For values of δ_{e_p} of 10° and 15°, rate saturation limits the attenuation, as shown by the diagonal lines. The breakpoint for a value of δ_{e_p} of 10° is approximately 3.5 radians per second; it is approximately 2 radians per second for $\delta_{e_p} = 15°$. Rate saturation adds about 50° of lag into the system, as shown in figure 16(b).

Figure 17 presents the computed results of pitch attitude response per pilot input versus frequency. Three values of controller input are presented. As pointed out previously, the system behaves in a linear fashion for $\delta_{e_p} = 5°$. The amplitude rates normally decrease at 20 decibels per decade until the system starts to rate limit. The breakpoint occurs at 2.0 and 3.5 radians per second for values of δ_{e_p} of 15° and 10°, respectively. The crossover phase frequency is approximately 3.5 radians per second for both 5° and 10° of δ_{e_p} (fig. 17(b)). About 70° of additional phase lag is added into the attitude system at maximum pilot inputs.

In order to sustain an oscillation in a closed-loop system, the total gain must be unity at a phase shift of -180° (Nyquist criteria). Assuming that the pilot acts as pure gain and with no phase changes, the pilot gain required to cause a PIO would be the gain margin at a -180° phase shift. Because of system nonlinearities, the critical pilot gain is also a function of controller input, δ_{e_p}. Figure 18 presents PIO frequency and critical pilot gain variation as a function of pilot input for various values of dead time. Increasing the pilot input decreases the pilot gain required to PIO. This effect is due primarily to the increase in gain across the shaping function with an increase in δ_{e_p} (fig. 6). Increasing the amount of dead time in the augmentation loop reduces both the crossover frequency and pilot gain required to PIO. For reasonable values of dead time (T = 0.1 sec), the critical pilot gain would be reduced at least 50 percent.

CONCLUSIONS

A longitudinal PIO experienced on the shuttle was analyzed by a nonlinear technique. In general, the analysis indicates that:

1. For controller inputs of 5° or less with no dead time, the control system behaves in a linear fashion.

2. For 10° of controller inputs, regardless of the amount of dead time, the elevon loop rate saturates at frequencies above 4 radians per second.

3. The pitch attitude crossover phase frequency is about 3.5 radians per second for both the 5° and 10° controller input.

4. At the PIO condition, rate limiting in the forward path decreases the system gain and also adds phase lag into the system.

5. Increasing the amount of dead time reduces the phase crossover frequency and reduces the pilot gain required to PIO. An excessive amount of dead time (0.4 second, for example) significantly increases the PIO tendencies.

APPENDIX A— MATHEMATICAL DESCRIPTION OF THE ACTUATOR LOOP

A pitch rate command system was used on the shuttle for the approach and landing phases of flight. The system was designed such that the error signal in the augmentation loop was continuously driven to zero so that the output or vehicle pitch rate actively tried to match the commanded input (type 1 system). To effect the necessary integration, positive feedback was implemented around just the actuator loop, as shown in figure 19. To provide lead in the system, a first order lag was programmed in the actuator loop feedback path. Also, the preselected or priority rate limit plus the travel limitations were programmed in the forward path of the actuator loop. However, for this particular investigation, travel restriction was not necessary; consequently, for this study that gain factor was always unity. Because of the nonlinear nature that existed in just this part of the system, it was felt worthwhile and convenient to define and investigate the actuator loop separately.

In general, what was desired was an input/output relationship that was a function of the same input. In the development of the nonlinear algorithm, it was found expedient and useful to begin with a linear input/output relationship. This was accomplished by iterating around the loop with both nonlinear elements, G6 and G7, equal to unity. With reference to the following subroutine, consider first the input signal XX (line 7), which is a vector having amplitude, phase, and frequency.

```
         SUBROUTINE TING(XX,Z)
         COMMON /TFS/S
         COMMON /JAKE/X(5),ZX,YNEW,Y,W,A,PHI,XX2
         COMPLEX S,XX,Y,Z,W,X,YNEW,G6,G7
 5       COMPLEX ZX,XX2
         N=100
         Y=XX
         DO 10 K=1,N
         X(1)=Y+XX
10       X(2)= S*X(1)
         X(3)=X(2)
         X(4)= (1/S)*X(3)
         X(5)= X(4)
         Z= (20/(S+20))*X(5)
15       YNEW=(1.5000/(S+1.50000))*Z
         IF(ABS(CABS(Y)-CABS(YNEW)).LE.0.00001) GO TO 11
         Y    = YNEW
      10 CONTINUE
      11 CONTINUE
20       X(2)= S*X(1)
         X(3)=G6(X(2))
         X(4)= (1/S)*X(3)
         A=CABS(X(4))
         SIG =REAL(X(4))
25       OMG =AIMAG(X(4))
         PHI = 1.570796
         IF(SIG.EQ.0.0) GO TO 6
         PHI =ATAN2(OMG,SIG)
       6 CONTINUE
30       DEL = 0.0
         IF(CABS(X(1))*AIMAG(S).LE..548) GO TO 7
         VV = .548/(CABS(X(1))*AIMAG(S))
         DEL = 1.570796*VV -1.570796
       7 CONTINUE
35       TPD =PHI + DEL
         U = A* SIN(TPD)
         V = A*COS(TPD)
         X(4)= CMPLX (V,U)
         X(5)= X(4)
40       Z= (20/(S+20))*X(5)
         Y    =(1.5000/(S+1.50000))*Z
         W = Z/(X(1)-Y)
         Z =W*XX
         A=CABS(W)
45       SIG=REAL(W)
         OMG=AIMAG(W)
         PHI=90
         IF(SIG.EQ.0.0) GO TO 12
         PHI= ATAN2(OMG,SIG)*57.296
50    12 CONTINUE
         ZX=Z
         XX2=XX
         RETURN
         END
```

Next, sum the input signal with Y and initialize for the first iteration by setting Y equal to XX. The vector X(1) will then be differentiated to obtain the rate vector necessary for subsequent computations. Throughout the first series of iterations the rate restriction G6 is equal to unity gain, or X(3) = X(2). The vector X(3) is integrated to get back to a position vector X(4). Since there is no appreciable amount of travel limitation, the vector X(5) will equal the vector X(4), or the gain of G7 will be unity. A first-order lag was used to approximate the power actuator characteristics. That is,

$$Z = \frac{20}{(s + 20)} X(5)$$

and

$$YNEW = \frac{5}{(s + 1.5)} Z$$

A test follows at this point to determine whether the desired convergence (1×10^{-5}) has been obtained. If not, Y is replaced by YNEW and the procedure is repeated until the desired convergence is reached. When the "if statement" is satisfied, the computation continues or leads into the nonlinear computation (FORTRAN statement 11 on). The final value of the vector X(1) from the previous iteration is differentiated to get X(2). The rate restriction is then applied to X(2). In other words, X(3) = G6 (X(2)).

However, the maximum gain for the sawtooth type of wave form rate limiting is used for these computations, as follows:

$$X(3) \leqslant (20/57.3)\pi/2 = 0.548 \text{ rad/sec}$$

The rate limit (0.548) is entered into the following function subprogram.

```
COMPLEX FUNCTION G6(X)
COMPLEX X,CLIM
COMPLEX A
A=X
A=CLIM(A,.548)
G6=A
RETURN
END
```

A general limiting algorithm is represented by another function subprogram.

```
  COMPLEX FUNCTION CLIM(A,X)
  COMPLEX A,B
  Y=CABS(A)
  IF(Y.EQ.0.0) GO TO 1
  B=A
  IF(Y.GT.X) B=(X/Y)*A
  CLIM=B
  RETURN
1 CONTINUE
  CLIM=CMPLX(X,0.0)
  RETURN
  END
```

APPENDIX B— BASIC NONLINEAR ANALYSIS AND COMPUTATIONAL PROCEDURE

The flow diagram shown in figure 20 represents the shuttle's basic control system, aerodynamics, and normal acceleration at the cockpit.

In the diagram, T1 represents the pilot transfer function, and for this study T1 will be considered a pure gain term. T2 is the nonlinear shaping function shown in figure 5. All transfer functions or the inverse functions of T1, T2, T3, and T4 are presented in tables 3 and 4, except for the actuator algorithm T7, and that function is derived and presented as a subroutine in appendix A.

To obtain an open-loop frequency response for the pilot loop, an absolute value is assigned to X1, which will be the pilot input to the shaping function for unity pilot gain. The task in general is to find an absolute value for X2 that is close to X1. For example; let δ_{e_p} equal 5° of pilot input, or X1 equal 0.0873 radian. The desired accuracy is ABS(CABS(X1) - CABS(X2) $\leqslant 1 \times 10^{-5}$.

The first iteration is initiated through a "do loop" by assigning a number to the real part of X7, such as

I = 1, 1000

SIG Z7 = 1.0 X I

Next, the vector signal is traced around through each block, including the inverse functions to the left of the augmentation summation junction.

Now, if and when CABS X2 > X1, the previous computation for I is used. So RBASE = I - 1 or a new index is J = 1, 10 and SIG X7 = RBASE + J(0.1).

The above scheme is repeated six times, moving to the left one decimal point at a time and proceeding with a new "do loop" until the desired accuracy is obtained. The complex value of each vector is successively computed through each block and summation junction. A final computation then yields the input/output amplitude and phase relationship as a function of pilot input and frequency.

The logic, vector arithmetic, and transfer functions shown in the tables and appendix A for various configurations were programmed on a digital computer. In the equations, $s = j\omega$, where ω is a discrete frequency.

Dryden Flight Research Facility
Ames Research Center
National Aeronautics and Space Administration
Edwards, Calif., July 29, 1981

REFERENCES

1. Smith, Ralph H.: Evaluation of Space Shuttle Orbiter Longitudinal Handling Qualities in Approach and Landing. Systems Research Lab., Inc. (2800 Indian Ripple Rd., Dayton, OH 45440), Aug. 1979.

2. Hoey, Robert G., et al.: AFFTC Evaluation of the Space Shuttle Orbiter and Carrier Aircraft - NASA Approach and Landing Test. AFFTC-TR-78-14, Air Force Flight Test Center, Edwards AFB, May 1978.

3. Space Shuttle Orbiter Approach and Landing Test. JSC-13864, NASA Johnson Space Center, Feb. 1978.

4. Riley, Donald R.; and Miller, G. Kimball, Jr.: Simulator Study of the Effect of Control-System Time Delays on the Occurrence of Pilot-Induced Oscillations and on Pilot Tracking Performance With a Space-Shuttle-Orbiter Configuration. NASA TP-1588, 1980.

5. Mechtly, E. A.: The International System of Units—Physical Constants and Conversion Factors. Second Revision. NASA SP-7012, 1973.

6. Space Shuttle Orbital Flight Test: Level C: Functional Subsystem Software Requirements. SD 76-SH-0007B, Rockwell Internat., Space Systems Group, May 1979.

7. Smith, John W.; and Edwards, John W.: Design of a Nonlinear Adaptive Filter for Suppression of Shuttle Pilot-Induced Oscillation Tendencies. NASA TM-81349, 1980.

8. Powers, Bruce G.: Experience With an Adaptive Stick-Gain Algorithm To Reduce Pilot-Induced-Oscillation Tendencies. AIAA Paper No. 80-1571, Aug. 1980.

TABLE 1.—PHYSICAL CHARACTERISTICS

s, m^2 (ft^2)	249.91 (2690)
$\bar{c}$, m (ft)	12.06 (39.56)
c_{ref}, m (ft)	32.77 (107.5)
w, kg (lb)	68,038.50 (150,000)
cg, percent of c_{ref}	66.25
I_y, kg-m^2 (slug-ft^2)	6,833,703.42 (5,040,282)

TABLE 2.—FLIGHT CONDITIONS NEAR TIME OF PILOT-INDUCED OSCILLATIONS

α, deg	7
M	0.32
h_p, m (ft)	$\leqslant$694.94 ($\leqslant$2280)
$\bar{q}$, N/m^2 (lb/ft^2)	6654 to 5841 (139 to 122)
V, m/sec (ft/sec)	97.54 (320)
θ_0, deg	7

TABLE 3.—AERODYNAMIC STABILITY COEFFICIENTS AND TRANSFER FUNCTIONS

Body axis stability coefficients:

$C_{D_\alpha} = 0.0053$	$C_{m_q} = -2.00$
$C_{D_{\delta_e}} = 0.0016$	$C_{m_\alpha} = 0.001$
$C_{L_\alpha} = 0.048$	$C_{m_{\delta_e}} = -0.0088$
$C_{L_{\delta_e}} = 0.018$	

Transfer functions:

$$\frac{u}{\delta_c} = \frac{2.44\ (s + 18.48)\ (s + 0.436 \pm j\ 0.649)^2}{\Delta}$$

$$\frac{\alpha}{\delta_e} = \frac{-0.226\ (s + 5.99)\ (s + 0.0108 \pm j\ 0.0770)^2}{\Delta}$$

$$\frac{q}{\delta_e} = \frac{-1.30\ s(s + 0.648)\ (s + 0.0349)}{\Delta}$$

$$\frac{a_n}{\delta_e} = \frac{2.26\ (s + 2.089)\ (s - 1.754)\ (s + 0.0277)\ (s - 0.0156)}{\Delta}$$

where

$$\Delta = (s + 0.0945 \pm j\ 0.122)^2\ (s + 0.887)\ (s - 0.100)$$

TABLE 4.—TRANSFER FUNCTION DEFINITIONS

[|X1| designated input; (|X1| - |X2|) $\leqslant$ K;

see table 3 for aerodynamic transfer functions]

Function	Vector output
------	X1 = X2 (open loop)
T1 (inverse; pilot transfer function)	$X2 = \frac{1}{\tau + 1} e^{T*s} * X3,\ \tau = 0,\ T = 0$
T2 (inverse hand controller)	A = |X4| $B = (13.83 + 20.66 * 57.3 * A)^{0.5}$ C = -2.569 + B X3 = (C/A * 57.2) * X4
T3 (inverse)	$X4 = \frac{s + 50}{0.05} * X5$
T4 (inverse)	$X5 = \frac{s + 2.7}{s + 1.8} * 0.667 * X6$
T5	X8 = 1.64 * X7
T6	$X9 = e^{-T*s} * X8,\ T = 0.1,\ 0.2,\ 0.4$
T7	Subroutine TING (XX, Z) (app. A)
T8	X11 = 1.0 * X10 If $\|X11\| > 0.375$, $X11 = \frac{0.375}{\|X11\|} * X11$
T9	$X12 = \frac{\alpha}{\delta_e} * X11$
T10	$X13 = \frac{a_n}{\delta_e} * X11$
T11	$X14 = \frac{u}{\delta_e} * X11$
T12	$X15 = \frac{\dot{\theta}}{\delta_e} * X11$
T13	$X18 = \frac{50}{s + 50} * X15$
T14	$X19 = 1.5 * \frac{s + 1.8}{s + 2.7}$
T15	$X20 = \frac{1}{s} * X15$
T16	X16 = (1.55 * s) * X15
T17	X17 = 1.0 * X13 X6 = X19 - X7 } Summations X21 = X16 + X17 }

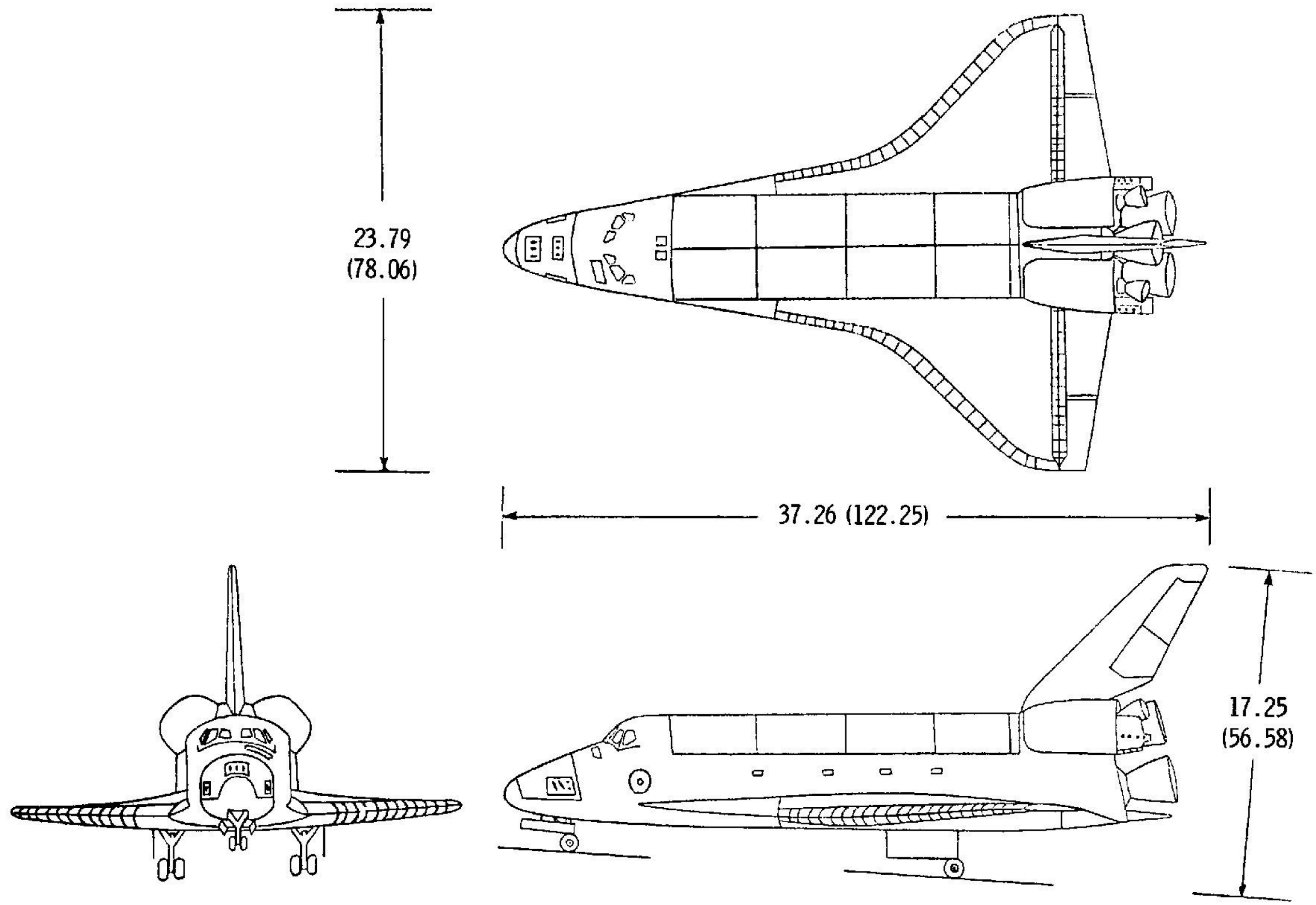


Figure 1. Three-view drawing of shuttle. Dimensions in meters (feet).

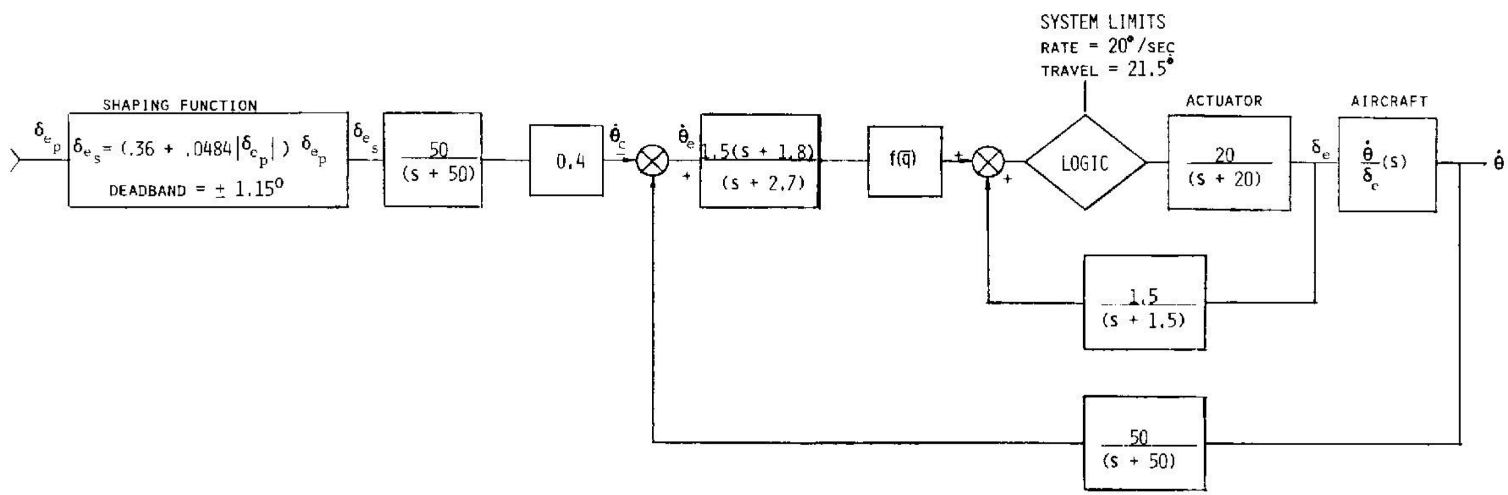


Figure 2. Mathematical description of shuttle pitch attitude control system.

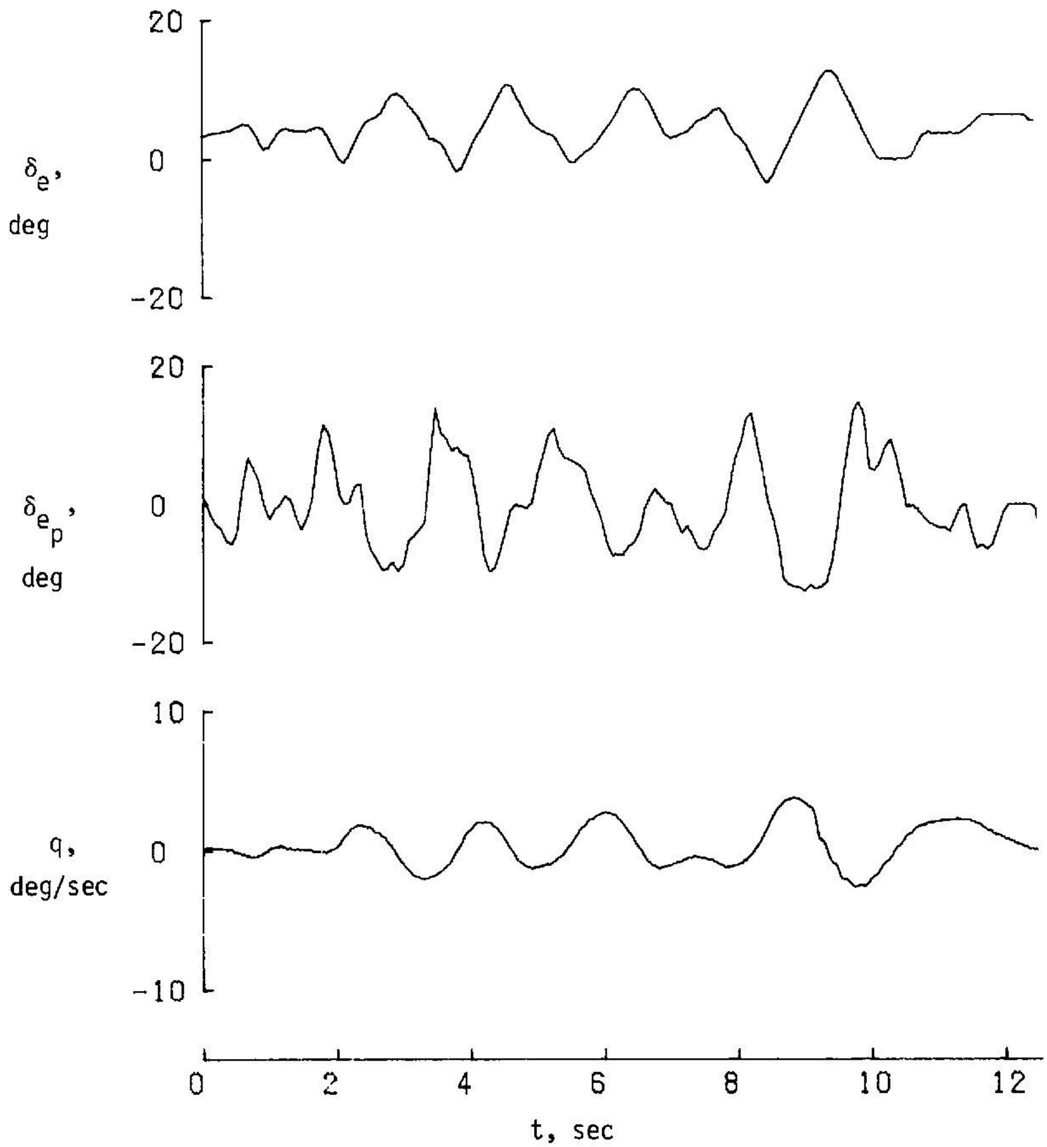


Figure 3. Time history of pilot-induced oscillation undergone by shuttle during approach and landing test FF-5.

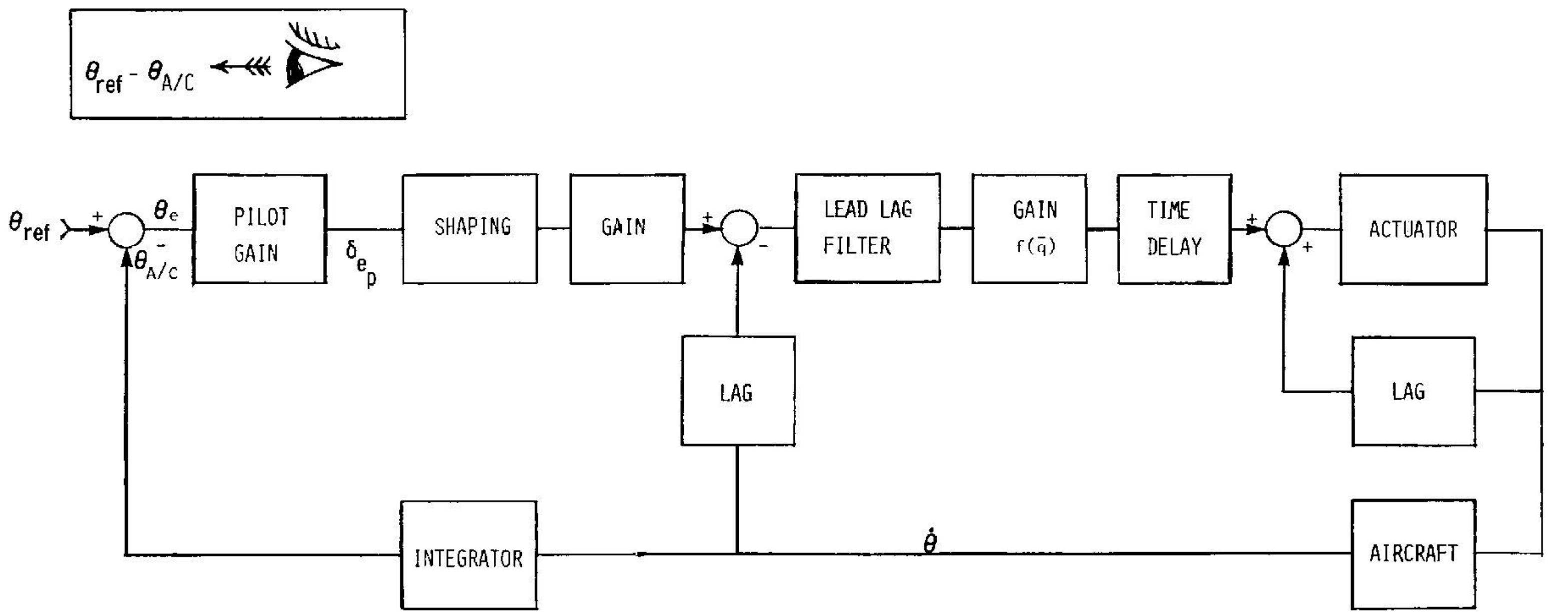


Figure 4. Conceptual block diagram of shuttle control system with pilot closing the pitch attitude loop.

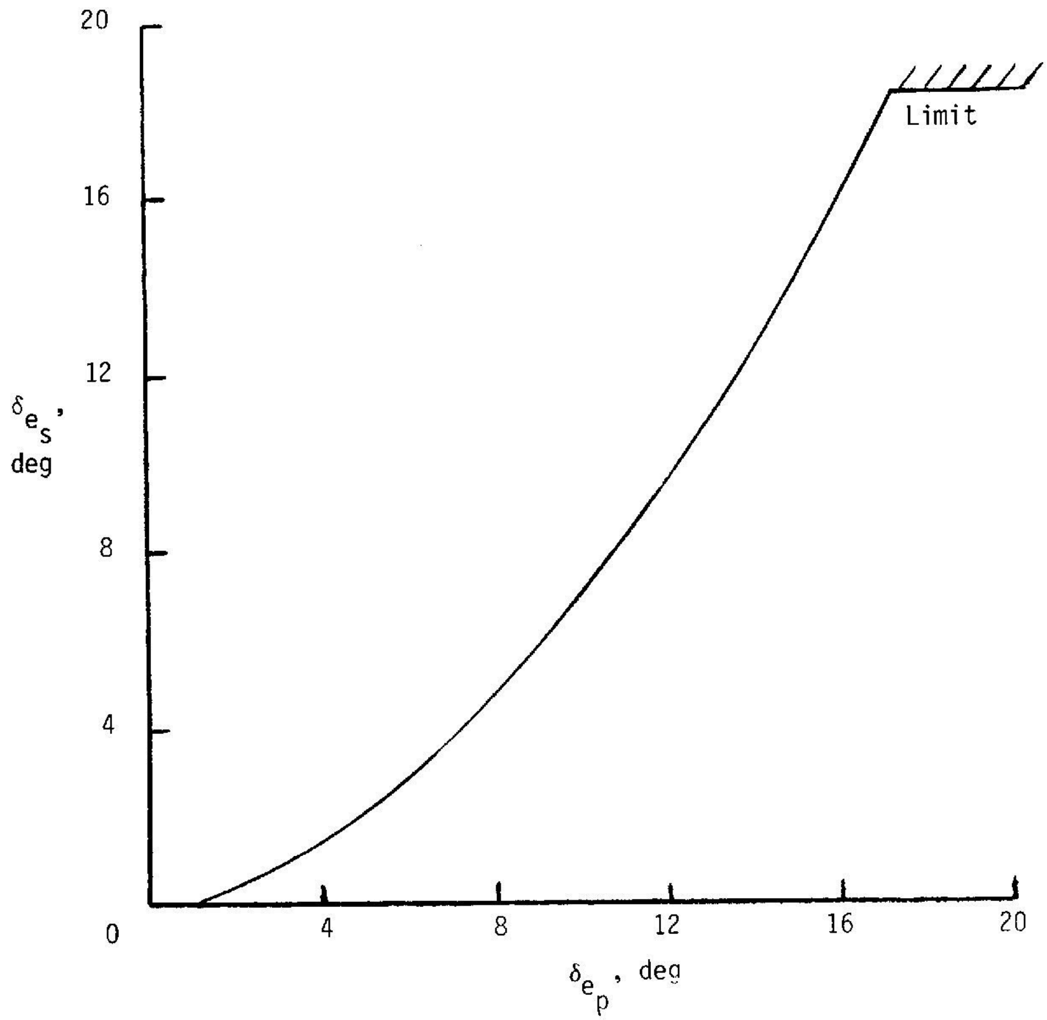


Figure 5. Shuttle longitudinal rotational hand controller shaping function. $\delta_{e_s} = \left(0.36 + 0.0484 \left|\delta_{e_p}\right|\right) \delta_{e_p}$; deadband = ±1.15.

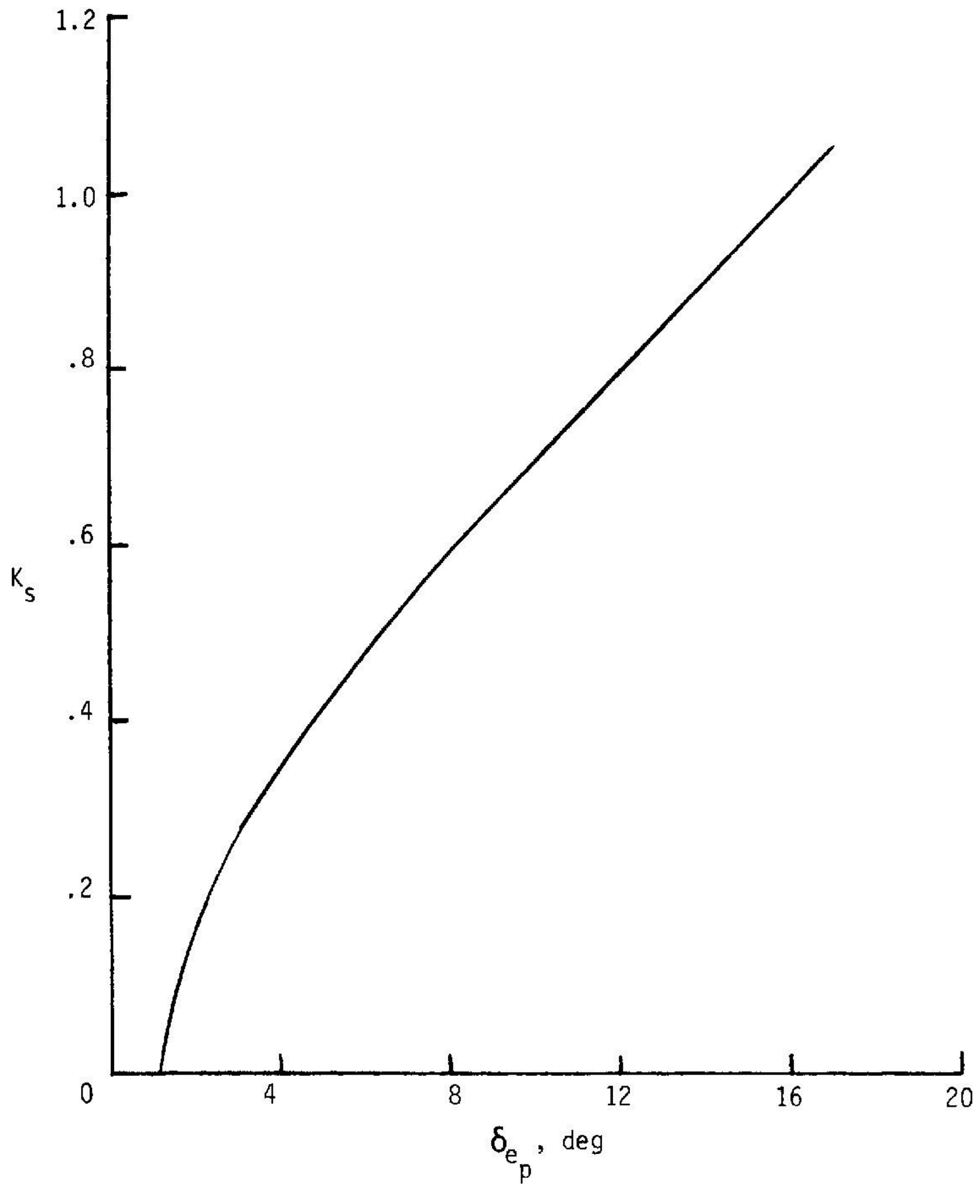


Figure 6. Shuttle longitudinal rotational hand controller shaping function gain. $K_s = \dfrac{\Delta\delta_{e_s}}{\Delta\delta_{e_p}}$

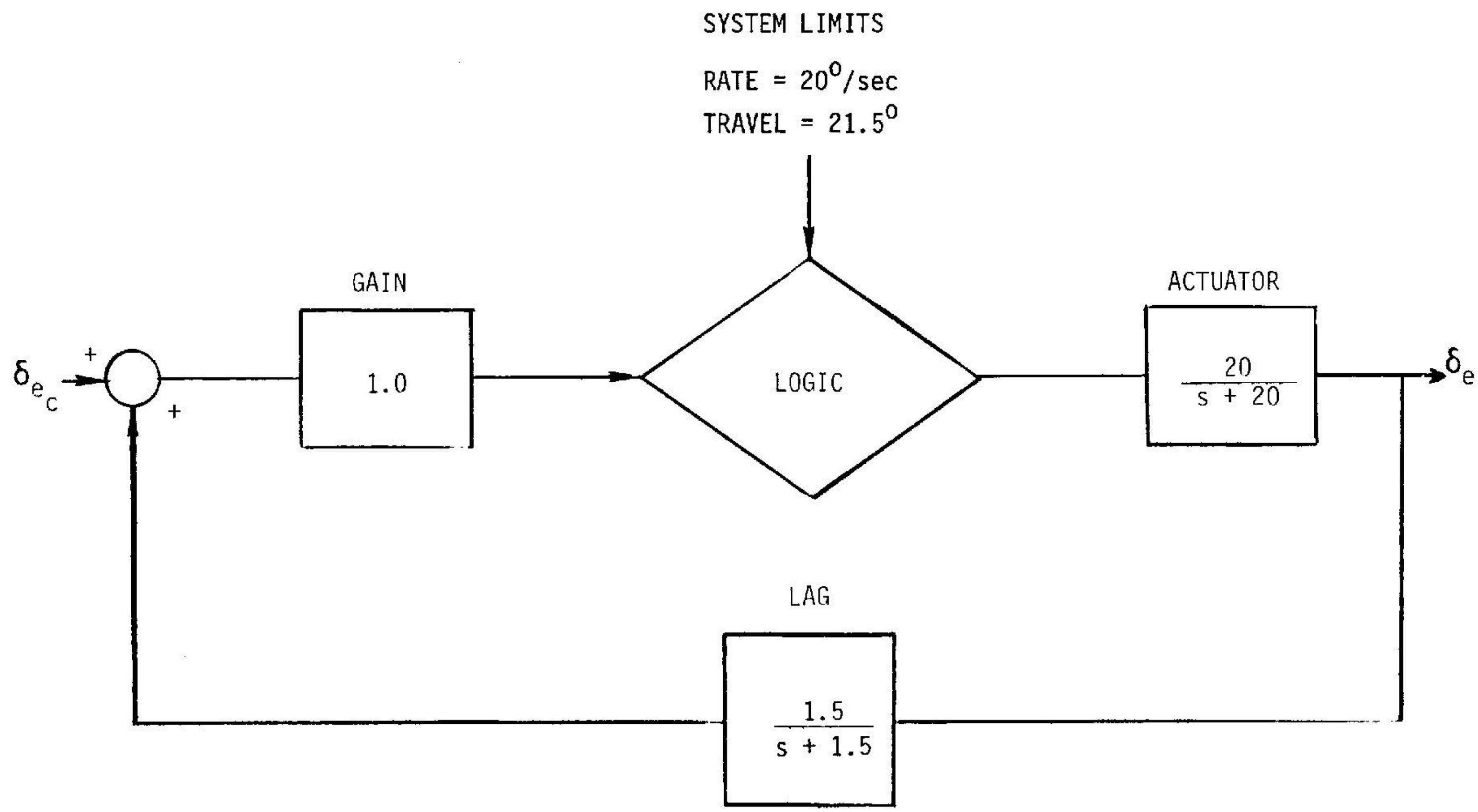


Figure 7. Simplified diagram of actuator loop used to obtain integration.

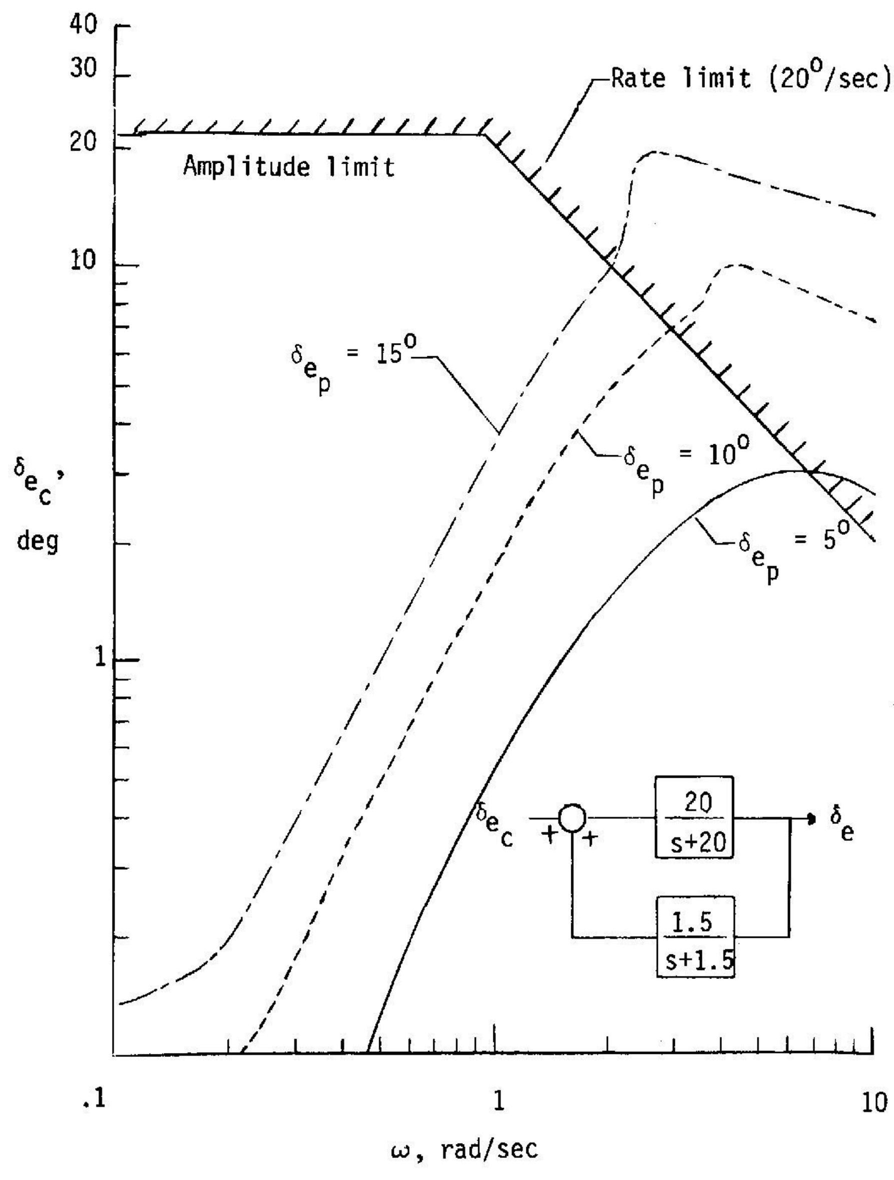


Figure 8. Commanded input to actuator loop as a function of pilot input and frequency.

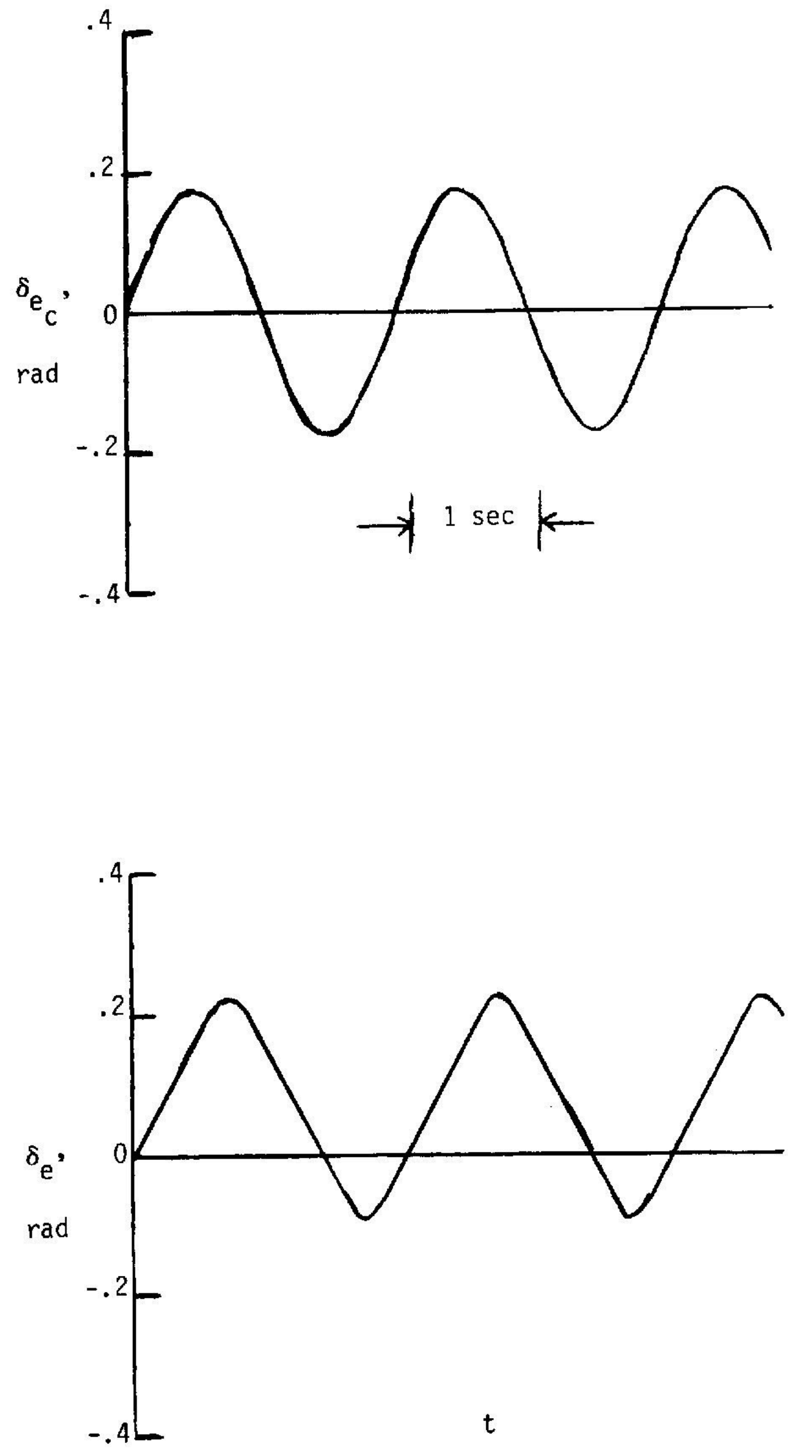
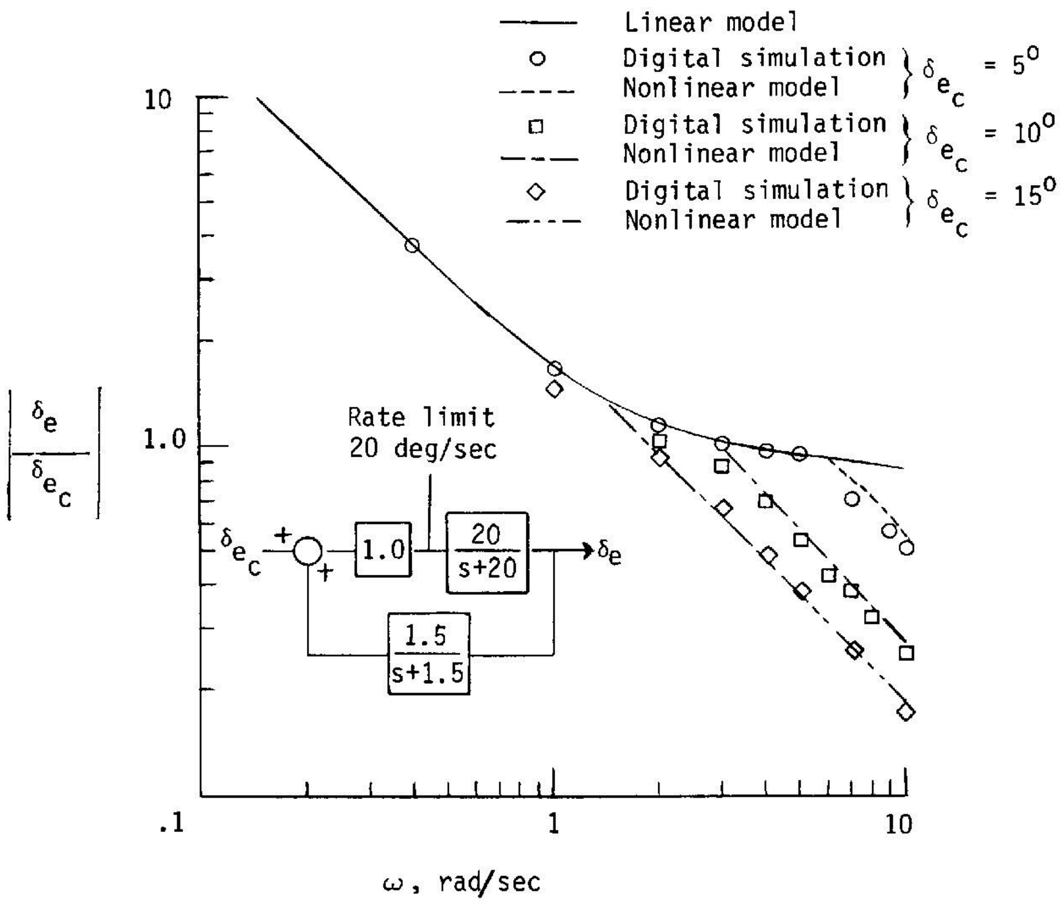
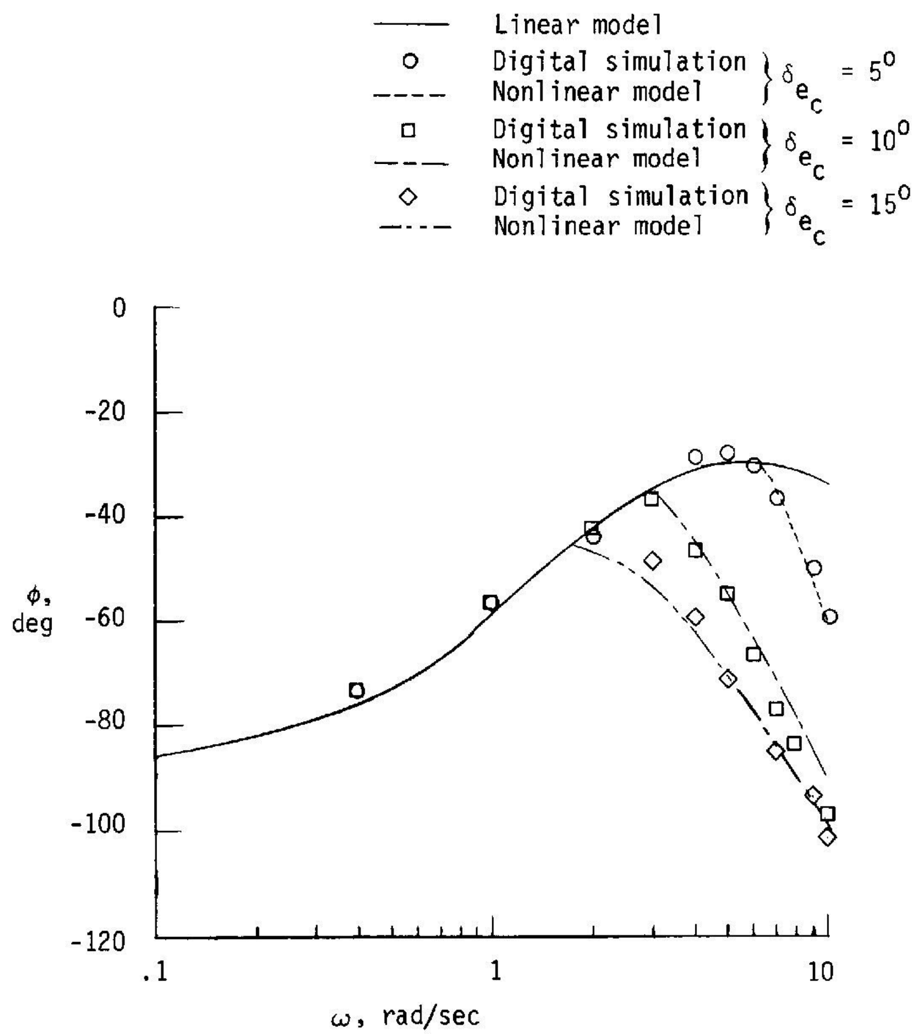


Figure 9. Digital simulation of actuator loop with a 20 degree per second rate limit. $\delta_{e_c} = A \sin \omega t$; $A = .174$ rad or 10^o; $\omega = 3$ rad/sec.



(a) Amplitude ratio.

Figure 10. Comparison of digital simulation with algorithm that describes actuator model.



(b) Phase angle.

Figure 10. Concluded.

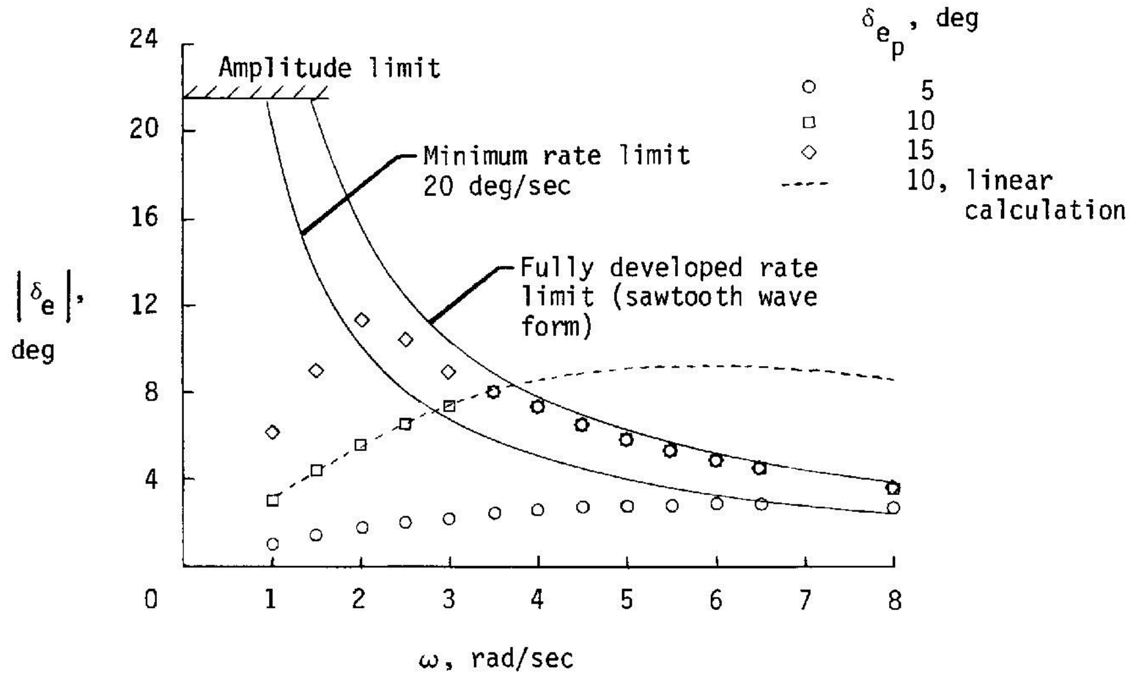


Figure 11. Elevon amplitude attenuation due to rate limiting as a function of frequency and pilot input. T = 0.1 second.

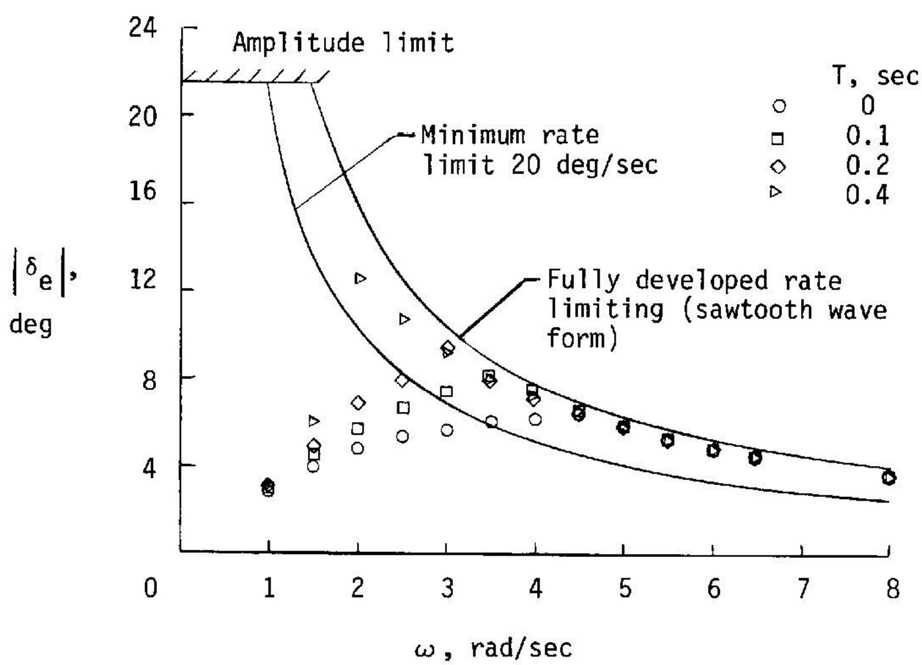
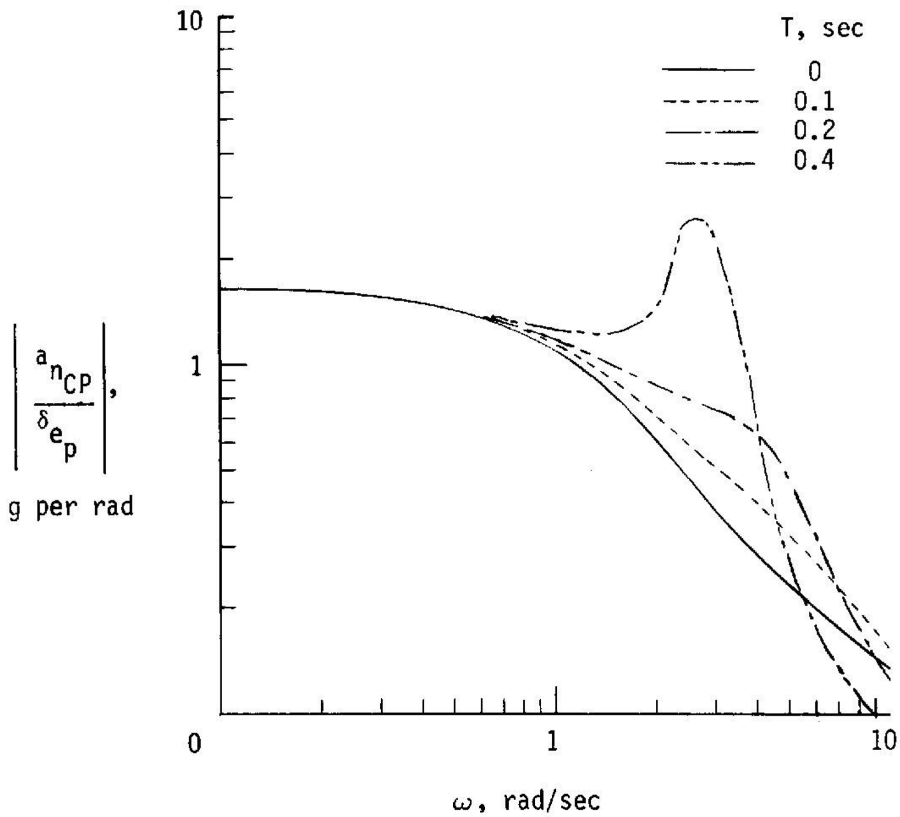
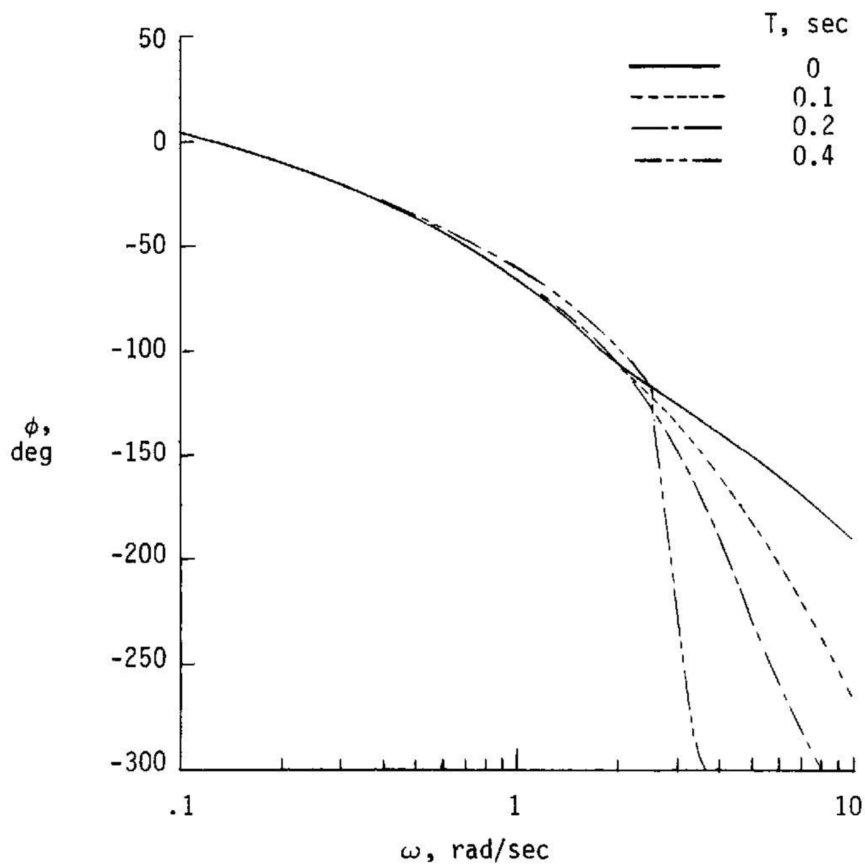


Figure 12. Elevon amplitude attenuation due to rate limiting as a function of frequency and time delay. $\delta_{e_p} = 10^{0}$.



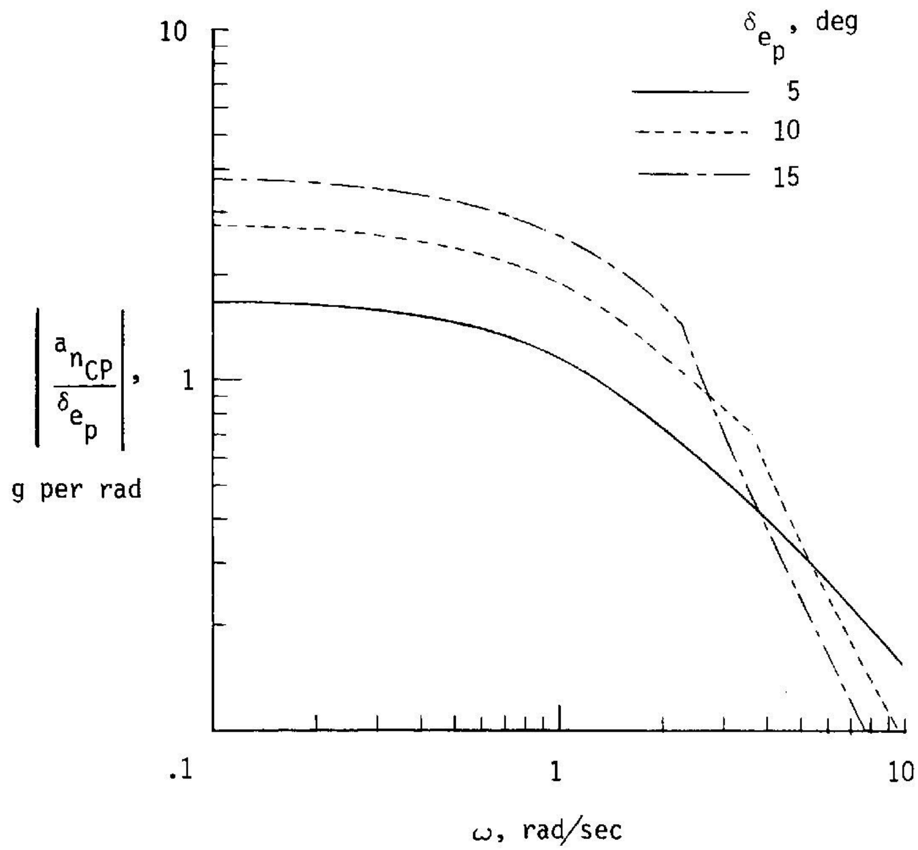
(a) Amplitude ratio.

Figure 13. Effect of time delay on normal acceleration at the cockpit. $\delta_{e_p} = 5^o$.



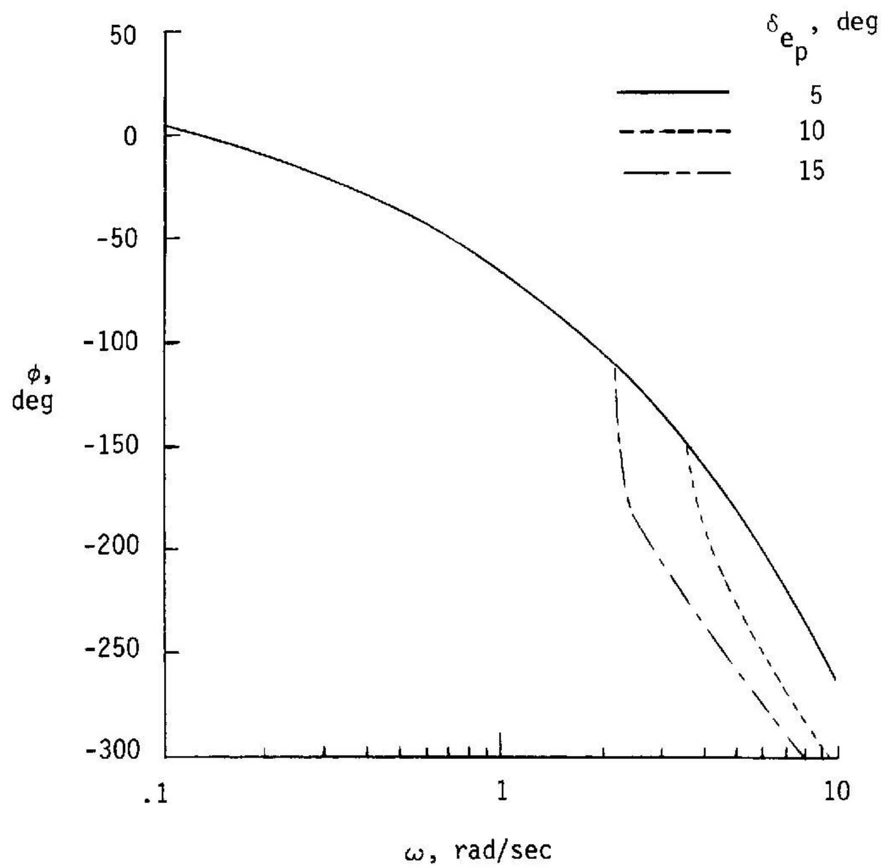
(b) Phase angle.

Figure 13. Concluded.



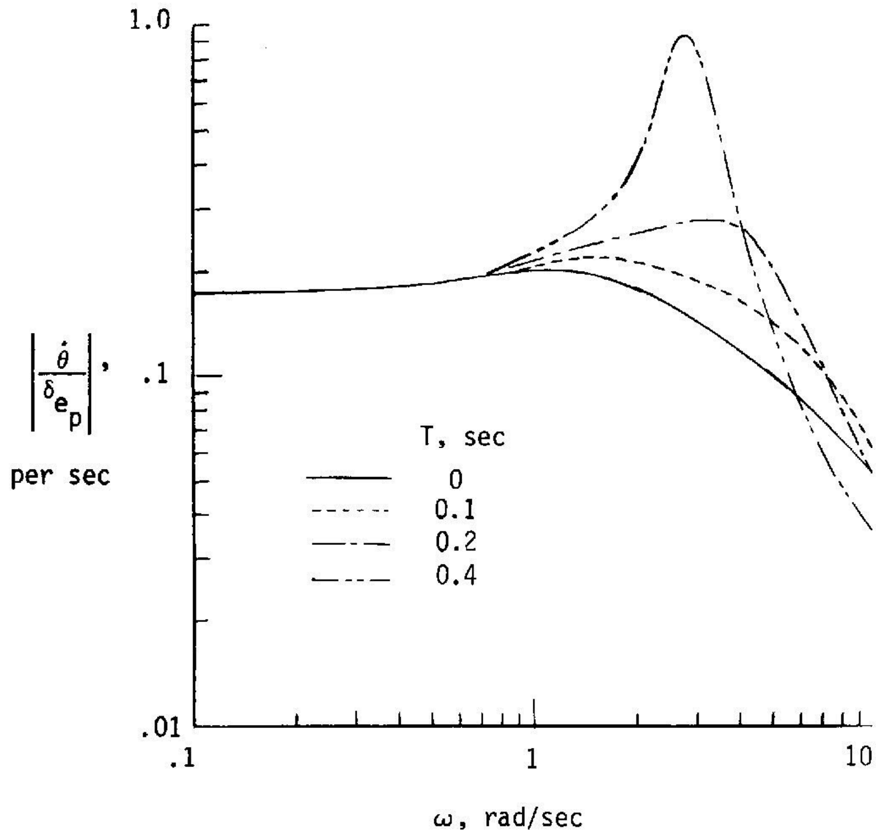
(a) Amplitude ratio.

Figure 14. Effect of pilot input on normal acceleration at the cockpit. T = 0.1 second.



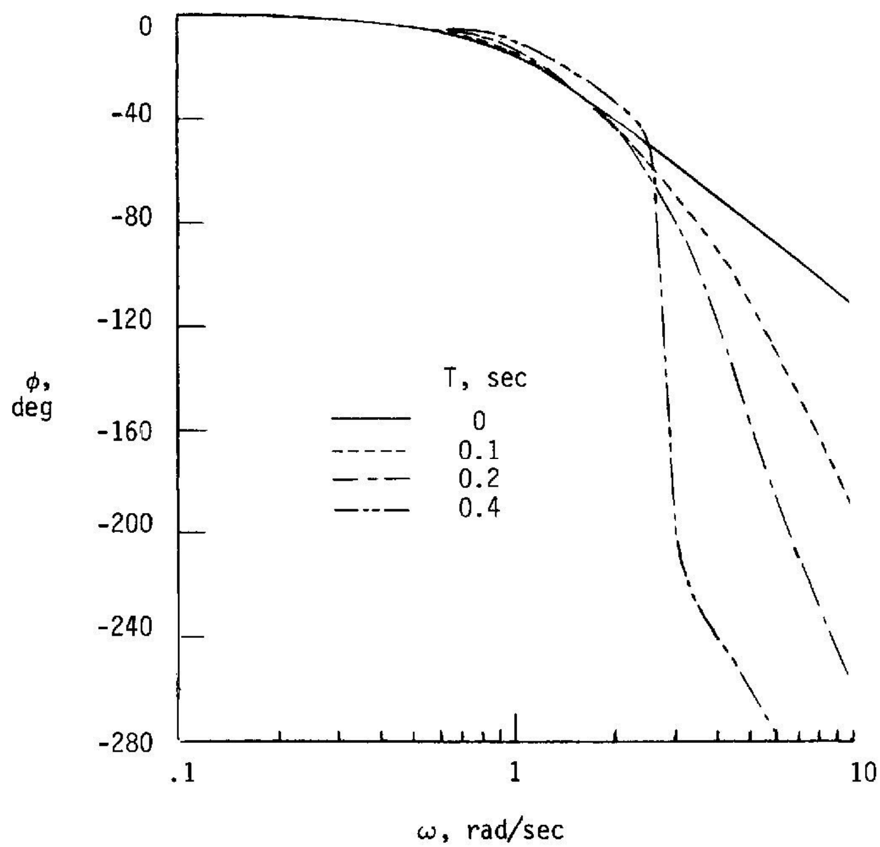
(b) Phase angle.

Figure 14. Concluded.



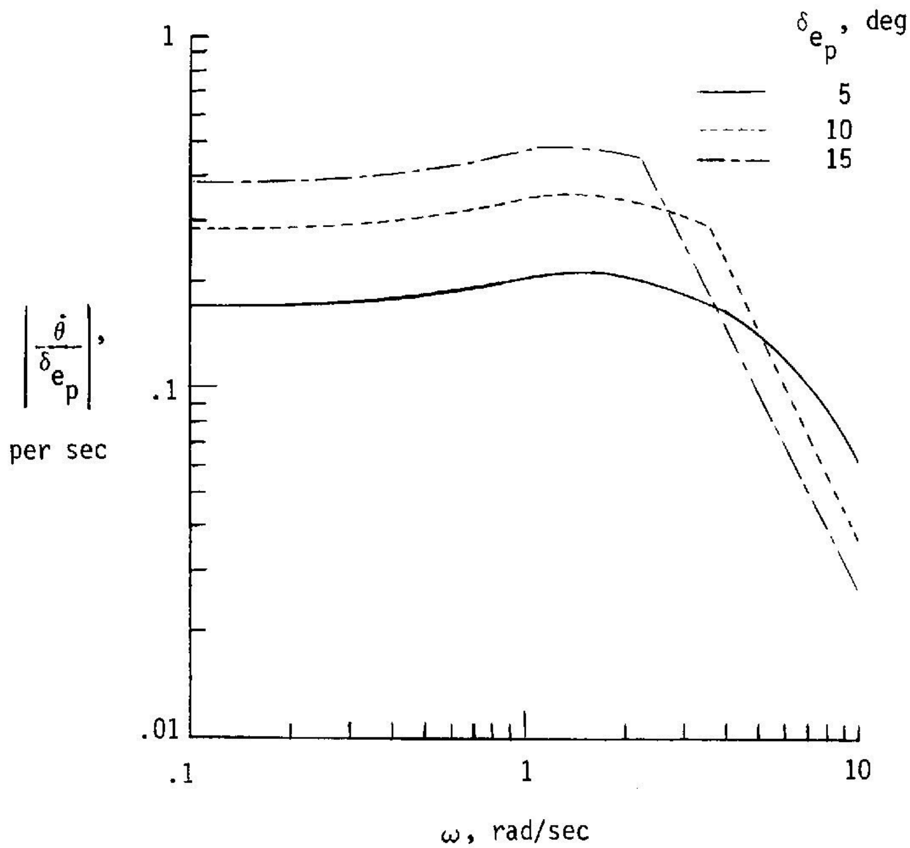
(a) Amplitude ratio.

Figure 15. Effect of time delay on pitch rate command system. $\delta_{e_p} = 5^o$.



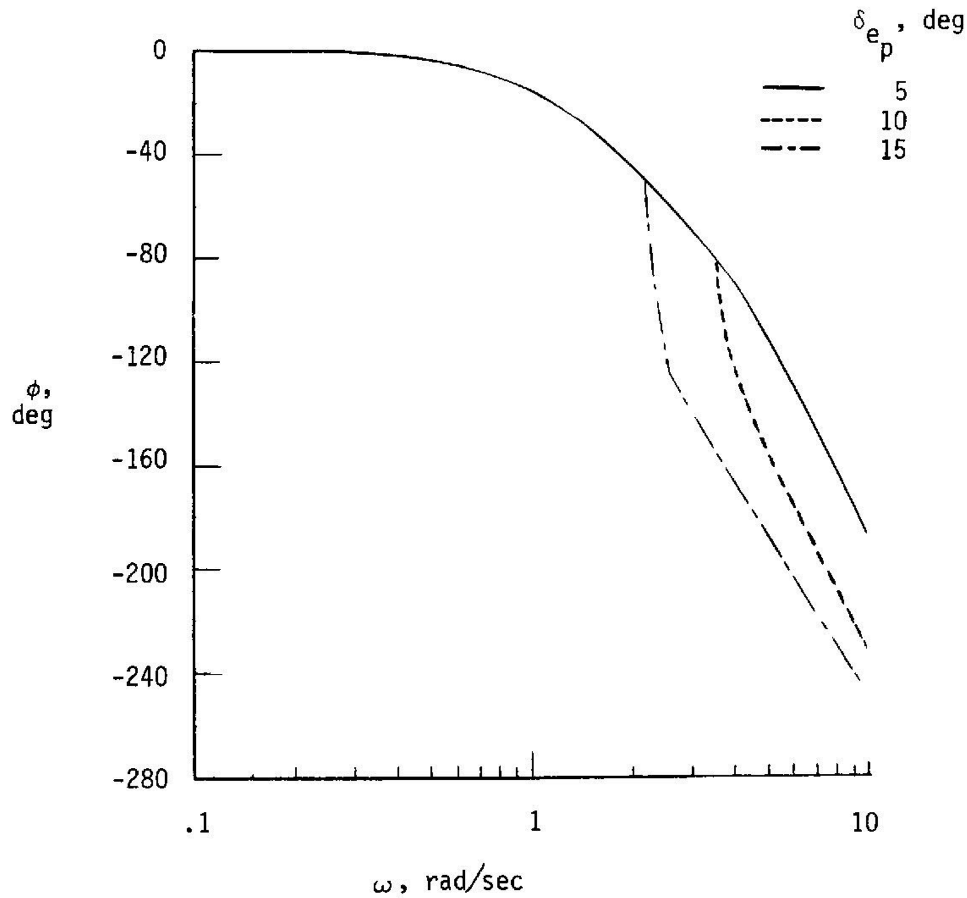
(b) Phase angle.

Figure 15. Concluded.



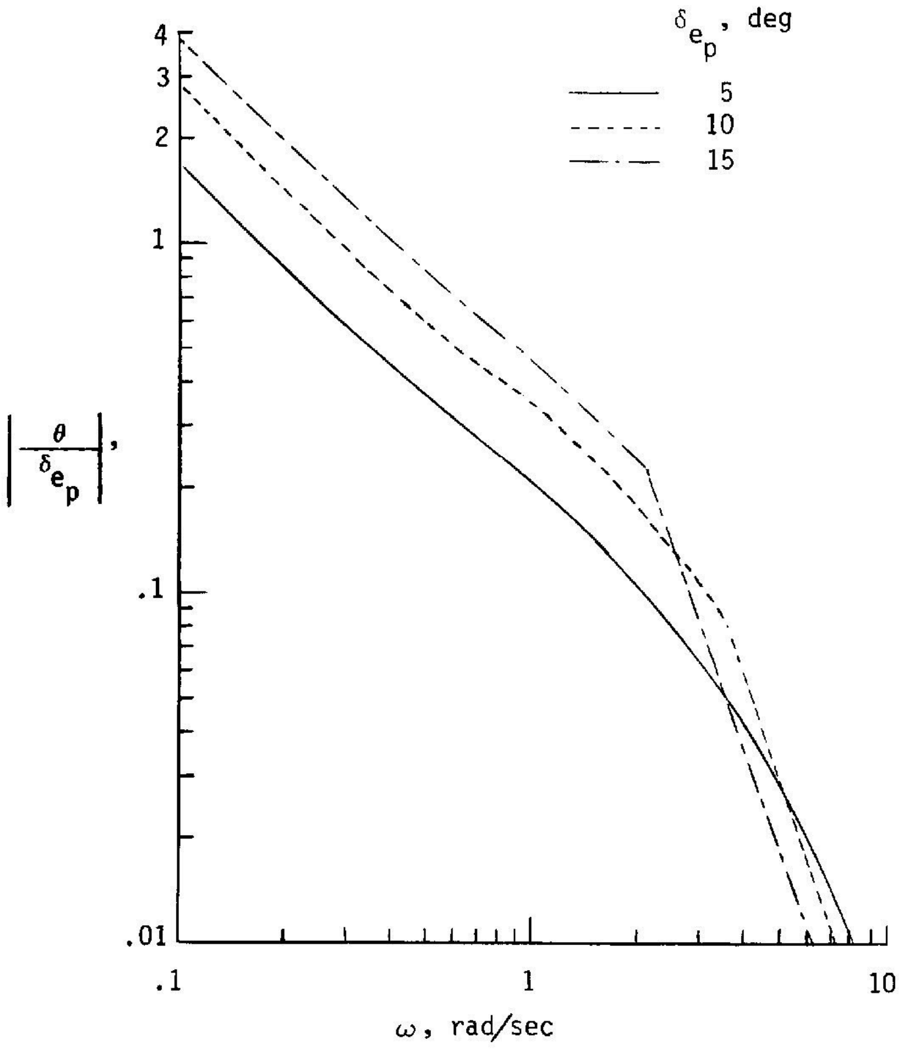
(a) Amplitude ratio.

Figure 16. Effect of pilot input on pitch rate command system. T = 0.1 second.



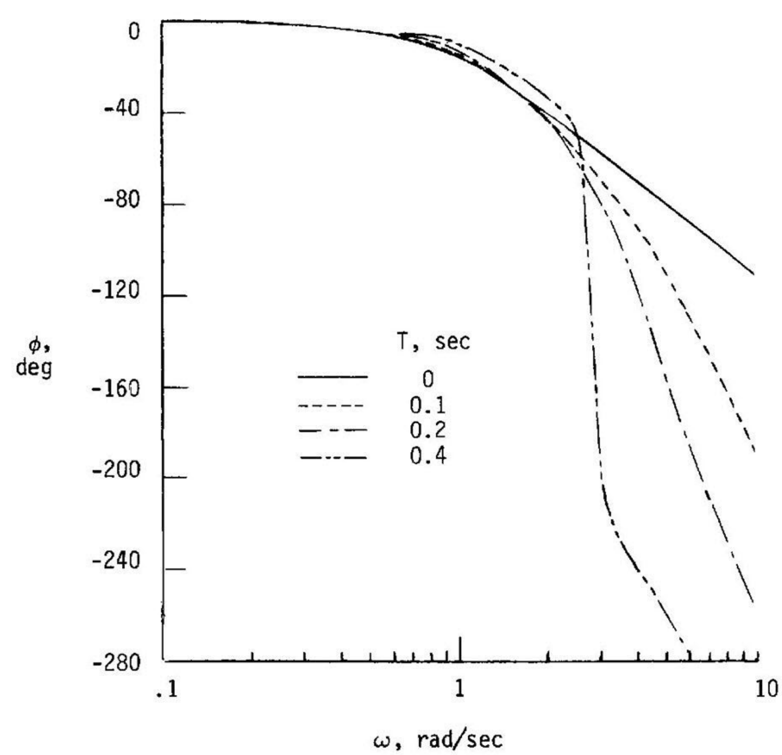
(b) Phase angle.

Figure 16. Concluded.



(a) Amplitude ratio.

Figure 17. Effect of pilot input on pitch attitude. T = 0.1 second.



(b) Phase angle.

Figure 15. Concluded.

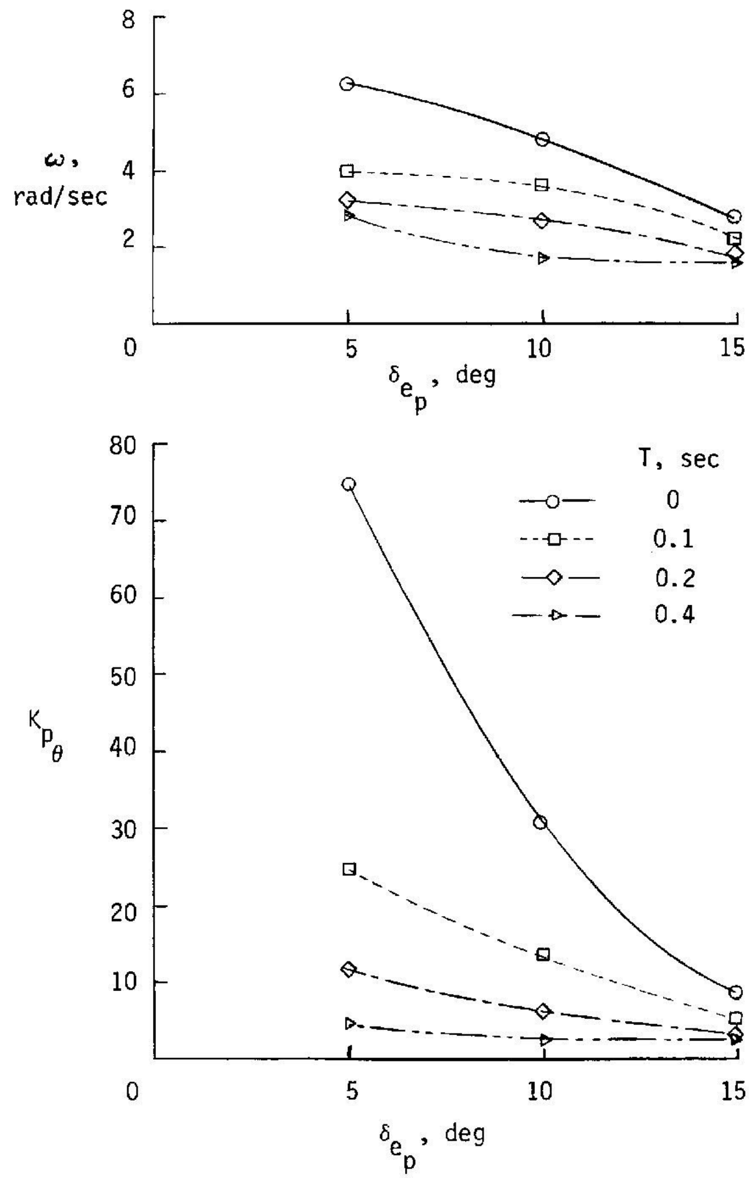


Figure 18. Frequency and minimum pilot gain required to PIO as a function of pilot input and time delay.

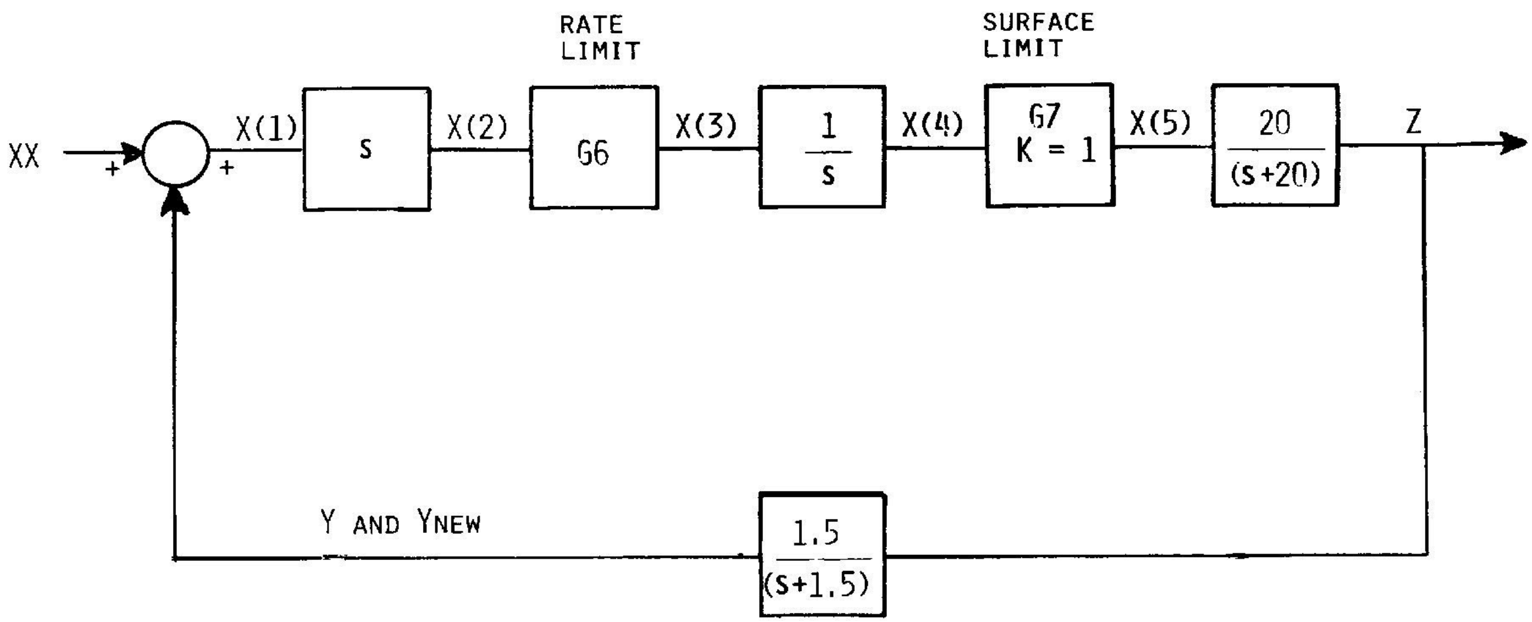


Figure 19. Actuator loop mathematical model.

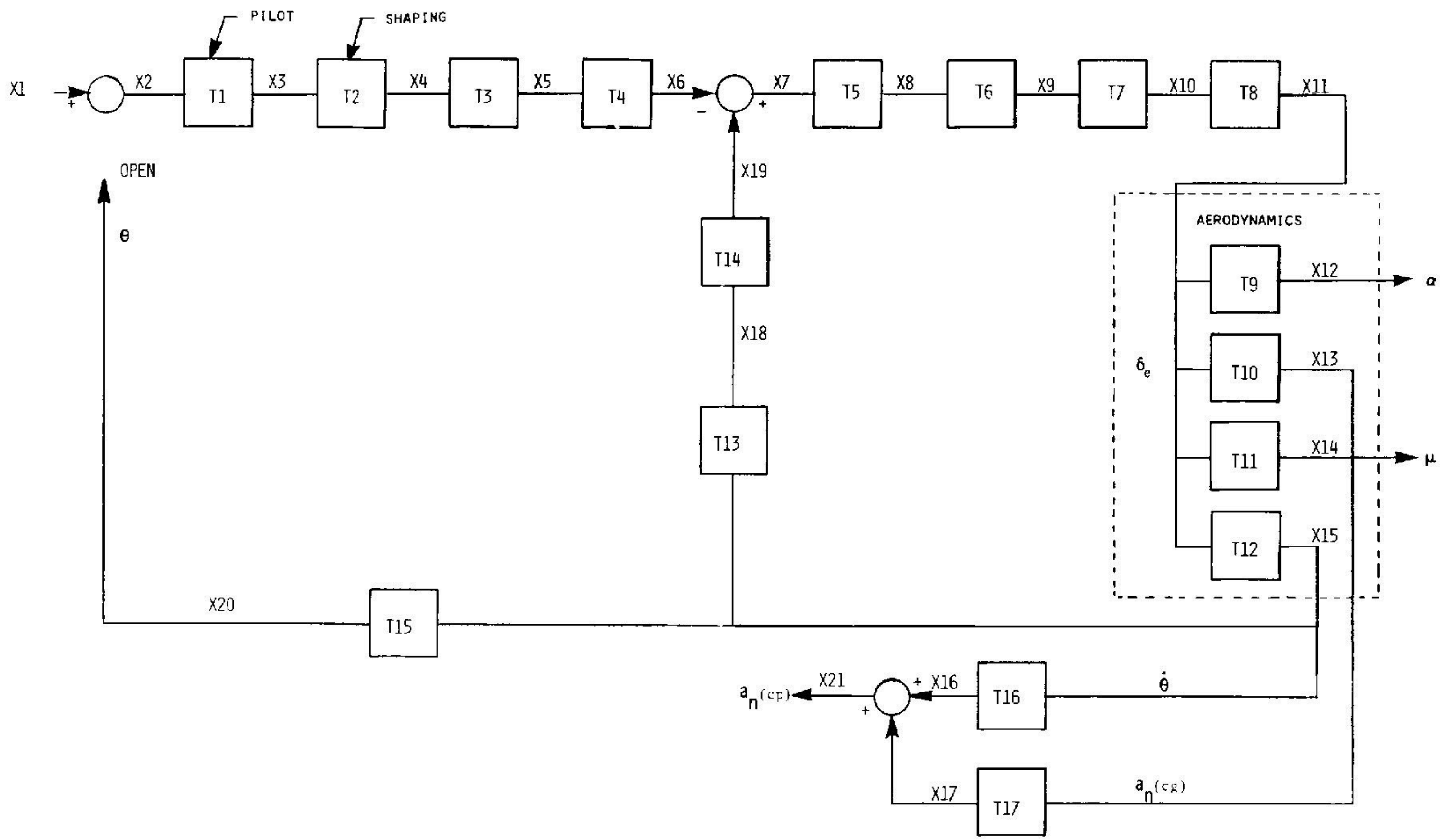


Figure 20. Shuttle mathematical model.

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15. Supplementary Notes		

16. Abstract

During the final free flight (FF-5) of the shuttle's approach and landing tests, the vehicle experienced pilot-induced oscillations near touchdown. The flight test data showed that pilot inputs to the hand controller reached peak-to-peak amplitudes of 20° at a frequency between 3 and 3.5 radians per second. The controller inputs were sufficient to exceed the priority rate limit set in the pitch axis.

A nonlinear analytical study was conducted to investigate the combined effects of pilot input, rate limiting, and time delays. The frequency response of the total system is presented parametrically as a function of the three variables.

In general, with no dead time, for controller inputs of 5° or less, the total system behaves in a linear fashion. For 10° of controller input, independent of the delay time, the elevon loop will be rate saturated above a frequency of 4 radians per second.

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IMPROVING UAV HANDLING QUALITIES
USING TIME DELAY COMPENSATION

THESIS

Presented to the Faculty of the Graduate School of Engineering and Management
of the Air Force Institute of Technology
Air University
In Partial Fulfillment of the
Requirements for the Degree of
Master of Science in Aeronautical Engineering

Andrew Joseph Thurling, B.S.
Major, USAF

March 2000

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Abstract

This study investigated control loop time delay and its effect on UAV handling qualities. Compensation techniques to improve handling qualities in the presence of varying amounts of time delay were developed and analyzed. One technique was selected and successfully flight-tested on a UAV.

Flight-testing occurred at a constant flight condition with varying levels of additional time delay introduced into the control loop. Research pilots performed a modified MIL-STD-1797A discrete pitch tracking task and gave Cooper-Harper ratings and comments. Tracking errors were used as a quantitative measure of Pilot/Display/UAV system performance.

Predictive pitch compensation was found to significantly reduce pilot workload and improve Cooper-Harper ratings. Using the predictive display doubled the amount of system time delay that research pilots could tolerate while tracking the task bars. Overall system tracking performance, however, was not improved.

Parameter variations in amount of time delay compensated did not result in degraded handling qualities. There was little significant difference in pilot opinion or performance for time delay uncertainties of ±33%. Parameter variations of ±20% in the aerodynamic model used to generate the predictive display produced statistically significant, although not operationally significant, changes in both pilot opinion and performance.

Analysis of UAV flight test data and follow-on simulations revealed that including UAV pitch attitude in the feedback signal greatly increased the gust rejection capability of the model-based predictive algorithm. For these simulations, algorithm accuracy was improved to the point of restoring system tracking performance to equal that of the system with no additional time delay.

Preface

The effects of control system time delays on manned aircraft handling qualities are well understood. Unmanned aircraft have similar control system delay, but have an additional latency caused by the datalink of the human operator's commands from control station to aircraft. The purpose of this thesis is to investigate the effects of time delay on the handling qualities of Unmanned Aerial Vehicles (UAV) and develop compensation strategies to mitigate the adverse effects of the delay. It is my hope that with techniques developed and investigated in this thesis future UAV operators will be able to employ UAVs from anywhere in the world thus increasing the flexibility of this already versatile platform.

I would like to thank the professors at the Air Force Institute of Technology, particularly my committee members Dr. Brad Liebst and Dr. Curtis Spenny, for their instruction and advice. My heartfelt appreciation is expressed to Tony Frackowiak, Alex Sim, Howard Ng, Jim Murray and the other outstanding individuals at NASA Dryden Flight Research Center for their excellent support and aid in preparing for and conducting the flight test. I also wish to thank Steve Bowline of Computer Sciences Corporation for his ceaseless efforts on my behalf. A big "thank you" goes to the Have Reckon test team of Dana Purifoy, Kevin Ford, Andy Adams, Kelly Greene, and Shahnaz Punjani without whom all the effort would have been for naught. My sincere thanks to Dr. Tom Buter for supporting this research from beginning to end and wading through endless drafts of this document.

Finally, I'd like to thank my long suffering wife, Lesley, who has put up with this research being a part of my life for the last two years. Her support and encouragement when obstacles obscured my path kept me focused and sane enough to carry on until the way was once again clear.

Andrew Joseph Thurling

2.3.4 Time Delay Effects on Handling Qualities. Control difficulties during the 1977 Space Shuttle Approach and Landing Tests and YF-17 development resulted in efforts to investigate whether time delays associated with digital flight computers might be a contributing factor to the handling qualities problems. As discussed above, delays in flight control systems may come from a variety of sources. The effects of phase lag due to higher order effects, or analog time delay, had been studied (15) and were relatively well understood. A detailed study of the effects of pure delay, transport delay due to digital systems, had yet to be accomplished. In 1978 a NASA study employed an F-8 fighter aircraft modified with a digital flight control system to accomplish a detailed study of the effects of pure time delays on aircraft handling qualities (7, 4, 6). In 1979, Hodgkinson and others (29) conducted a study on the USAF/Calspan NT-33 inflight simulator in which they tested how mismatches between the higher order system and the LOES affected pilot opinion. They also investigated how well the delay term, $e^{-s\tau}$, in the LOES approximated the higher order phase lags and if the difference caused variations in pilot opinion. Both studies showed a strong correlation between pilot rating and the magnitude of the time delay, see Figures 2.8 and 2.10. The NT-33 data also showed that the degradation in pilot rating was similar for both digital transport delay and analog delay, or delay due to phase lag from higher order effects. The insidious nature of time delay's effects on handling qualities is demonstrated in a pilot comment during the F-8 research (7)

> Pilots desire some response immediately upon stick input. It doesn't have to be much, but if he doesn't get response, his gains skyrocket.

The pilots in the NT-33 study also voiced similar concerns with delay after control inputs and the rapidity of the response following the delay. The authors of the F-8 study (7) make a further observation that aircraft dynamics have an impact on system sensitivity to time delay.

the joystick as an example, moving the joystick left or right establishes a roll rate. The airplane continues to roll until the joystick is returned to the center position, after which the airplane remains in the bank angle thus established. The foot pedals are used to counteract the adverse yaw as previously described. Moving the joystick forward or backward establishes a pitch rate. The airplane continues to pitch until the joystick is returned to the center position, after which the airplane remains in the pitch angle thus established. Both the roll rate and the pitch rate are subject to the limits of the airplane's design.

Since the joystick is directly connected to the control surfaces, the aerodynamic forces on the control surfaces are transmitted back to the pilot, giving him or her valuable feedback on how the airplane is flying.

The successful operation of the second order system with the pilot in the loop depends on several factors such as the area and placement of the control surfaces, how much the control surfaces move in response to the movement of the pilot controls, and how long the airplane takes to respond to changes of the control surfaces. The total system characteristics also depend on the reaction time of the pilot. If the resulting system is poorly designed it may be unstable, which means it may not be possible for a human pilot to fly it safely. An example of an unstable system is where the pilot desires to perform a gentle roll to the right and so moves the joystick to the right, the airplane's roll rate is faster than the pilot desires so he/she attempts to compensate by moving the joystick to the left, the airplane rolls left at a rate that is faster than the pilot desires so he/she moves the joystick to the right, and so on, with the pilot constantly overcorrecting and with the aircraft's rolling motions constantly getting larger and larger until the aircraft gets into a condition from which it may not be possible to recover, (e.g., spinning into the ground). The type of loss of control described is usually referred to as 'pilot induced oscillation' and although it may be caused by an inexperienced or inattentive pilot, it is more often caused by poor airplane design. Therefore, new airplane designs are extensively tested to make sure they can be safely flown. Examples of airplanes that use direct control of the control surfaces (Direct Control Second Order Systems) are the Cessna 150 and the Piper Cub.

Computer Mediated Non-Remotely Piloted Vehicles

Computer mediated control systems use a computer between the pilot controls and the control surfaces. The pilot controls are read by the computer, the data are modified in a particular way, and the computer sends control signals to the control surfaces. The computer may also sense the forces on the control surface and use it to control force feedback to the pilot controls. This type of computer mediated control may be used to fly an airplane that would otherwise be unstable, such as the F16 or the F117. Aircraft such as the F16 and F117 are also second order systems because the position of the pilot's joystick represents rate of rotation.

There are risks inherent in a computer mediated system. Although the program can be simulated extensively before using it in an actual airplane, the computer program may be quite large and therefore difficult to simulate under all possible conditions. An example of this is the Swedish JAS 39 Gripen Fighter. Despite extensive simulation of the flight control system, during a test flight a Gripen crashed due to "... the flight control system's high amplification of stick commands combined with the pilot's" large, rapid stick movements"." The pilot had entered a low-speed high-banked turn at a 280 meter altitude with lit afterburners and was leaving the turn when his actions led to 'pilot-induced oscillation'. (Aviation Week & Space Technology, Aug. 23, 1993, pages 72–73).

Having described techniques for operating non-remotely piloted vehicles, the Fight Control Modes for RPVs will be described.

Second Order RPV Flight Control Mode

A second order control system for an RPV is inherently computer mediated because the remote pilot must interact through two computers: the computer in the remote aircraft and the computer in the remote pilot station.

Flying an RPV is further complicated because there are additional time delays in the loop. The computer in the remote aircraft must first determine the aircraft's position and orientation. The additional processing for transmitting a secure signal by encryption and/or spread spectrum techniques may create additional delays. Transmission delay of signals between the remote aircraft and remote pilot station is negligible for a direct path. However, if the signals are relayed through other facilities the delay time may be appreciable, especially if an orbiting satellite is used. There are additional delays in the remote pilot station as the remote aircraft's position and orientation are used to transform the data from the digital database to present the pilot with the synthesized 3D projected view from the remote aircraft. In one embodiment, the RPV system measures the various delays and modifies the control laws used by the computer in the remote pilot aircraft and in the feedback provided by the computer in the remote pilot station to the remote pilot. For example, the computer may adjust the sensitivity of the User Flight Controls **408** according to the delay (e.g., as the delay increases, the computer will decrease the sensitivity of the flight controls). The system also displays the measured delay to the remote pilot.

First Order RPV Flight Control Mode

The stability of the flight control system, and thus the flyability of an RPV, can be improved considerably by using a first order system. In one embodiment of such a first order system the position of the remote pilot's joystick represents an angle relative to the horizon, instead of representing a rate of rotation as in a second order system. The position of the joystick is transmitted to the computer in the remote aircraft which moves the control surfaces as required to place the remote aircraft in the requested orientation. The control system in the remote aircraft is still a second order system but the delays in the communications link and the remote pilot station are no longer a part of the system's loop.

When a joystick is centered, the remote aircraft will fly straight and level. When the joystick is to the right of center the remote aircraft will be in a right banked turn. When the joystick is to the left of center the remote aircraft will be in a left banked turn. When the joystick is backward from center the remote aircraft will be in a pitch up orientation. When the joystick is forward of center the remote aircraft will be in a pitch down orientation.

The amount of bank and pitch permitted depends on the design of the remote aircraft. A high performance remote aircraft will be capable of a greater amount of pitch and bank than will a low performance remote aircraft.

Referring again to FIG. **4**, Computer **405** may optionally be coupled to Control Panel **402**, Keyboard **403**, Simulation Port **404**, Video Interface **410**, VCR **411**, and/or Video Display **412**. In one embodiment, Control Panel **402** con-

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October 13, 2006

Robert Adams, CEO
Optima Technology Group
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Irvine, CA 92612

Margolin Patent Nos. 5,566,073 and 5,904,724

Dear Mr. Adams:

We represent Rapid Imaging Software, Inc. (RIS), which has referred to us your letter of September 19, 2006. At the outset, we are unable to discern that Optima has an interest in the patents it attempts to assert. Assuming that it does, however, and has merely neglected to record its interests, RIS does not infringe the Margolin patents.

As you know, RIS creates computer software, and does not use or manufacture UAV systems or ground control stations. RIS software is used in UAVs to provide situation awareness for sensor operators. It is not used for piloting air vehicles. The sensor operator does not pilot the aircraft, and instead sits at a separate workstation operating a payload containing one or more cameras, which may be controlled using a joystick to point the camera package during search or tracking operations.

As you know, RIS refuses to allow its products to be used as a pilot aid, and RIS product licenses specifically prohibit use for piloting. None of RIS's customers use its software for piloting, for very good reason. Serious military regulations control placement of anything—synthetic vision included—on a pilot workstation. Before anything can be placed on the display in front of a pilot, it has to have met stringent criteria (MIL-STD 1787C, DO-178B, etc.), it must have been thoroughly ground tested, and it must have been fully flight tested. RIS software has never been through this process, and thus is prohibited from use for piloting. Accordingly, UAV manufacturers have purchased RIS products for use on the sensor operator console, but none for the pilot console. This is a matter of Army doctrine and applies to Shadow, Warrior and Hunter.

Nor does RIS have its software in a form that would make it marketable for piloting. RIS software products are all based on the Microsoft Windows operating system. This offers many advantages, but is inappropriate to piloting aircraft because it is a not a POSIX compliant real-time operating system. POSIX compliance is required by flight safety regulations. To create such a version would entail a one- to two-year conversion program in which RIS has not invested.

It is important to realize that the market for RIS products is quite different from the relaxed civilian world. If a military pilot chose to use synthetic vision in spite of military regulations or in defiance of a software license agreement, his career would be damaged or destroyed. Military pilots cherish their wings and would not consider risking them on something like synthetic version.

Finally, it appears from your correspondence that you regard research activities like NASA's X-38 prototypes (before the program was cancelled in 2002) as infringing the Margolin patents. This was not the case because of the claim limitations of the Margolin patents. However all RIS work for government agencies, including NASA, was authorized and consented to by the U.S. Government, and is protected under 28 U.S.C. § 1498(a). As you are aware, any remedies you may have are against the government and are circumscribed by that statute and related law.

Although we need not discuss the invalidity of the Margolin patents given the above circumstances, you should be aware that both patents were anticipated by profound prior art dating back to 1977. If it should ever become necessary, we are confident that both would be held invalid.

Very truly yours,

Benjamin Allison
Santa Fe Office

BA:gmr
Enclosures
841473

cc: Mike Abernathy