

Connecting Engineers to Online Experts and Knowledge

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Kenneth Lebsock (OSC)

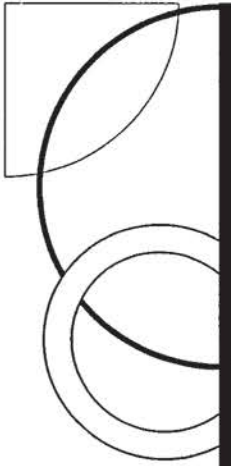
NASA Project Management Challenge 2010 9-10 February 2010
Moody Gardens Hotel & Convention Center
Galveston, TX



<http://nen.nasa.gov>

Presentation Overview

- Why does NASA have a need for online engineering experts and knowledge sharing?
- Who is creating the online engineering Community of Practice sites?
- What do the Community of Practice sites provide?
- How does one access these online engineering Community of Practice sites ?
- How does one navigate these sites? (Live Demo)

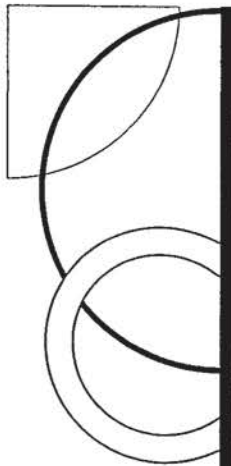


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Observations on the NASA Workforce

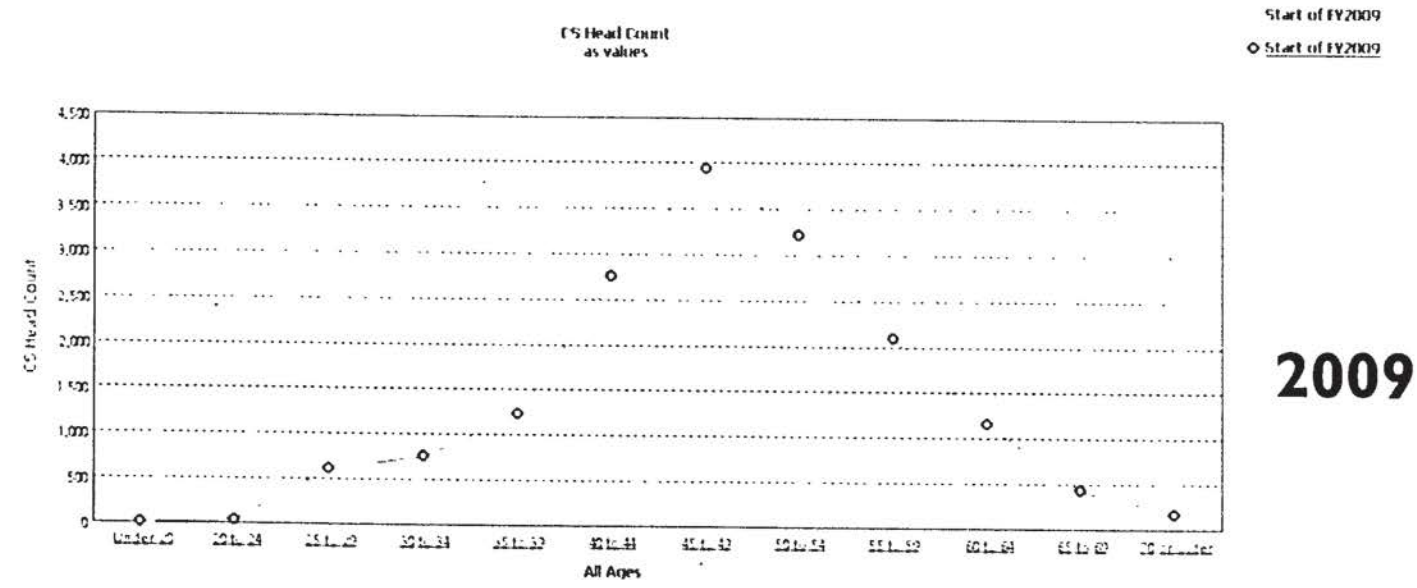
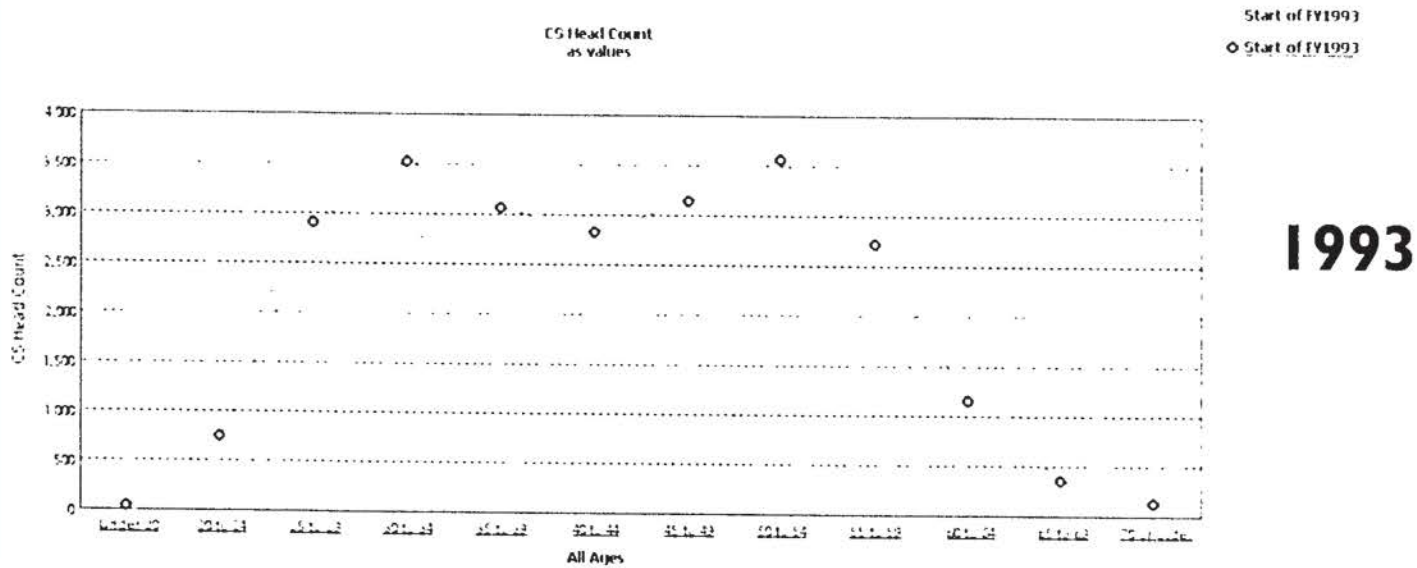
- NASA has an aging workforce population
 - Average age is 46
- Not enough engineers have worked up the ranks to compensate for those retiring*
- Many early career engineers are still in the process of building requisite skills to assume mid-career leadership roles
- Have multiple generations in workforce that communicate and learn in different ways

* Government Accounting Office (2003) NASA Major Management Challenges and Program Risks, Statement of Allen Li to the Columbia Accident Investigation Board, GAO-03-849T



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NASA's Changing Age Distribution



Source: Workforce Information Cubes for NASA (WICN). <http://wicn.nssc.nasa.gov>



Four Generations of Workers

Generation	Born	Characteristics
Traditionalists	1937-1945	Loyal to employer, like face-to-face communication
Baby Boomers	1946-1964	Idealistic, workaholics, first TV generation
Generation X	1965-1976	Value life/work balance, technologically savvy, not afraid to change jobs
Millennials	1977-1990	Using computers since children, comfortable w/instant messaging and texting

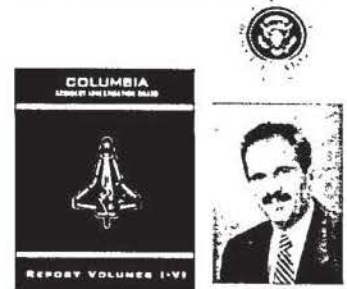
*According to a survey conducted by the Pew Research Center, 73% of respondents stated that younger and older people are very different in the way they use computers and new technology.**

* Pew Internet & American Life Project (2009). Generations Online in 2009 Report.

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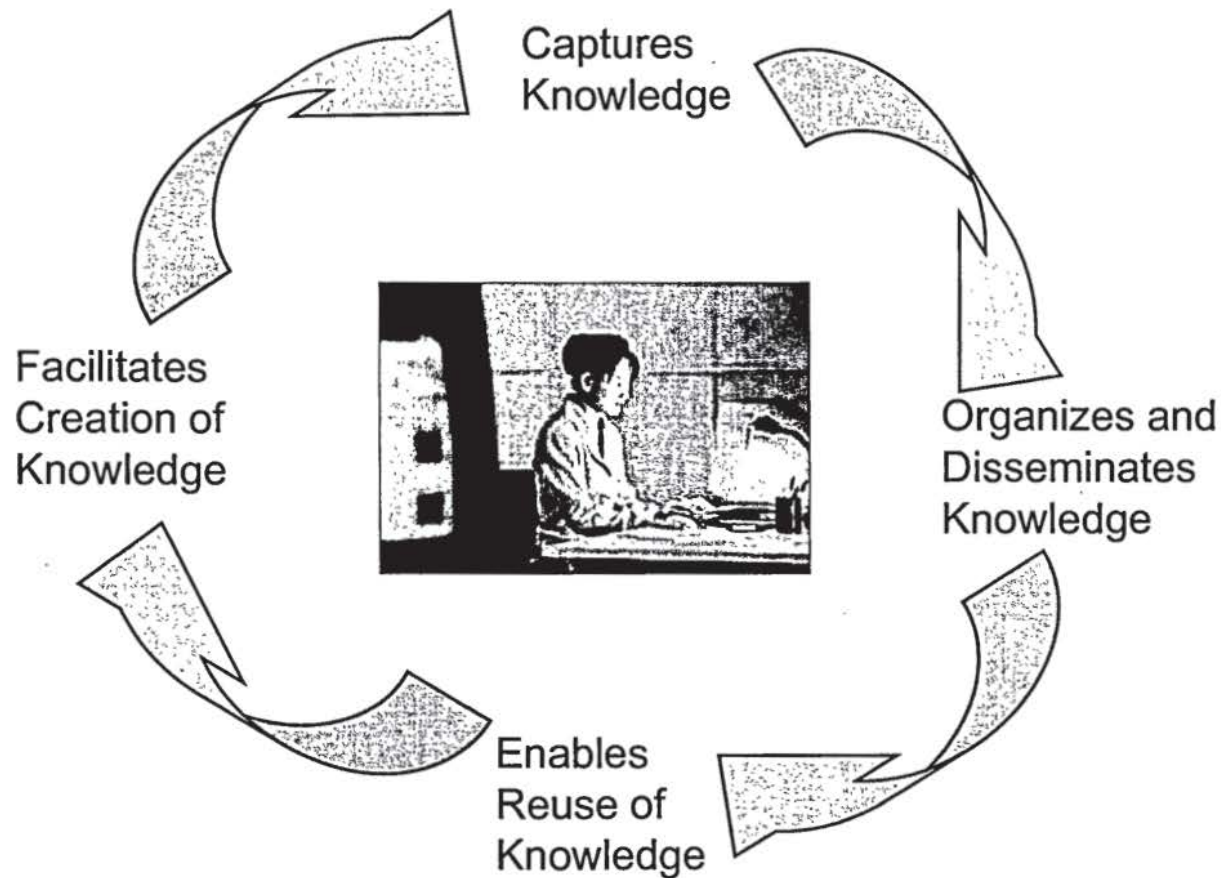
Beyond the Age Gap: CAIB Findings

- Columbia Accident Investigation Board found NASA isn't a learning organization
- Knowledge of problems is contained within each center and not shared
- Diaz Report urged NASA to develop a system that would assure knowledge retention and use of lessons learned

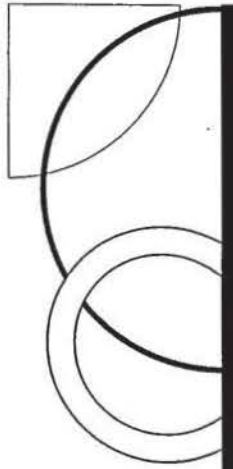


Sharing Knowledge & Lessons

Every engineer needs access to all NASA engineering knowledge



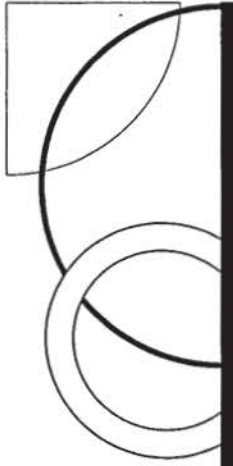
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NASA Engineering Network

- Funded by the NASA Chief Engineer
- Online knowledge sharing system focused on engineering
- Access engineering org charts
- Search over one million documents in 40+ repositories
- Submit and/or browse NASA Lessons Learned
- Connect, collaborate, learn, and share ideas via Communities of Practice



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Communities of Practice

A network of individuals who

- Have a passion for or level of experience in a given engineering discipline
- Want to share collective knowledge and learn from one another
- Identify common problems and explore solutions

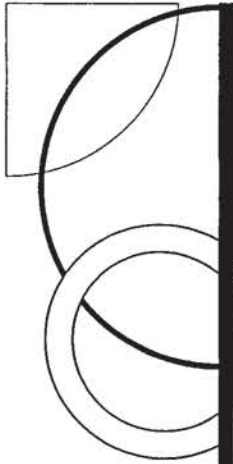




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Why create the Communities of Practice?

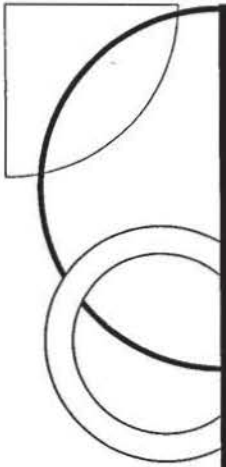
- Capture NASA's unique knowledge before brain drain hits
- Provide forum where engineers can learn, mentor/be mentored and collaborate
- Break down barriers between NASA's Centers
 - Stimulate cross-agency sharing of simulation tools, analytical methods, test facilities, etc.
- Welcoming to younger generation (communication, learning online communication vs. face to face)



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CoPs at NASA are

- Built along key engineering disciplines based on NASA's core competencies
- Led by NASA Technical Fellows, recognized experts in their field. Tech Fellows are:
 - Appointed by the NASA Chief Engineer
 - Resident in the NESC
- Housed within the NASA Engineering Network
- Available to all personnel with NASA intranet access



NASA Technical Fellow Roles & Responsibilities

- Serve as senior technical expert for the agency in support of the OCE, NESC, and NASA Programs
- Serve as an independent resource to the agency and industry to resolve complex issues
- Form, maintain, and lead Technical Discipline Team
- Lead agency-wide discipline working groups
- Foster consistency of agency-level standards and specifications and involved with levying standards & specs
- Promote discipline stewardship
- Ensure Lessons Learned are identified and incorporated into agency processes

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Current Engineering CoPs

Communities by Technical Discipline



**Environmental
Test &
Verification**
Contact: Ed
Strong



**Guidance,
Navigation &
Control**
Contact: Neil
Dennehy



**Loads &
Dynamics**
Contact:
Curtis
Larsen



**Mechanical
Systems**
Contact:
Joseph
Pellicciotti



**Nondestructive
Evaluation**
Contact: William
Prosser



**Passive
Thermal
Control
and
Protection**
Contact:
Steve
Rickman



Propulsion
Contact:
Robert Garcia



**Software
Engineering**
Contact: John
C. Kelly

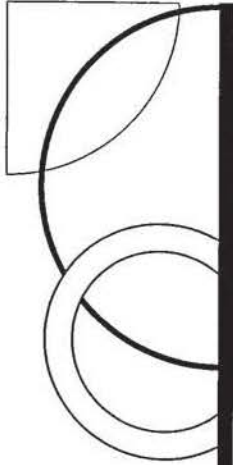


Structures
Contact:
Ivatury
Raju



**Systems
Engineering**
Contact: Steve
Kapurch

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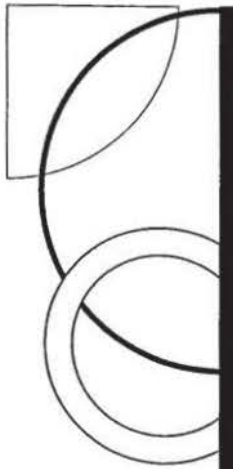
Communities Under Development

- Life Support/Active Thermal
- Aerosciences
- Flight Mechanics
- Human Factors
- Avionics
- Electrical Power
- and more

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What is on the Community Sites?

-  Standards and best practices
-  Ability to ask questions to experts
-  Lessons learned
-  Discussion boards/Forums
-  Facilities information for testing
-  Information on commonly used tools
-  Videos

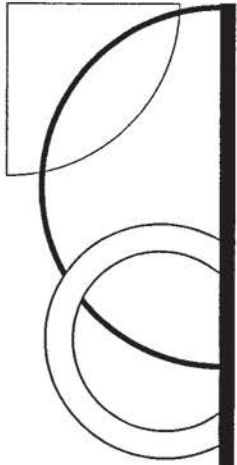


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Live Demo

- Guidance, Navigation & Control
- Passive Thermal
- Mechanical Systems
- Propulsion

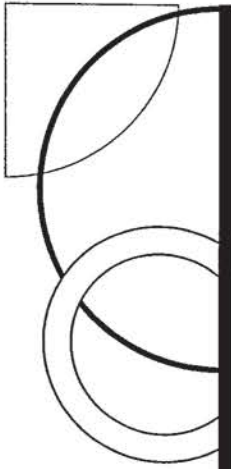
For those who missed the live presentation, see Slides 20-26 for screen captures from the live demo.



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Conclusion

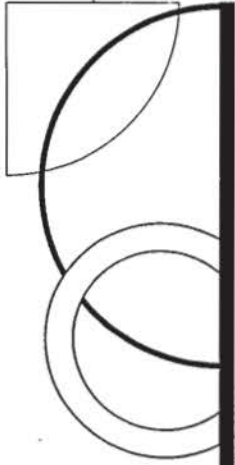
- Generational gap in NASA's workforce is a continuing issue that must be addressed
- Younger generations must have access to experienced engineers in order to grow technically
- Better technology will help attract and retain younger generations of workers
- CoPs provide one place to find authoritative documents and information
- Sites enable connections and collaboration



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How to Take Part

- Join a community of practice
- Volunteer to serve as an expert
- Share lessons learned from projects
- Pose questions to experts
- Take part in a discussion
- Suggest content for the site
- Provide feedback on the site



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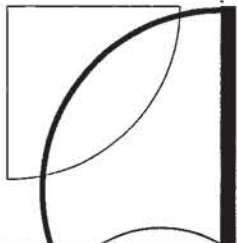
Contact Us

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 - Cornelius.J.Dennehy@nasa.gov
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 - JPL Phone: 818-314-8794
 - Daria.Topousis@jpl.nasa.gov



Screen captures from live demo

(for those who missed the live presentation)



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Organization Charts

Lessons Learned (11)

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Communities by Signt. Discipline

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Release of New Chief Engineer's Case Study: The Gravity Probe B Launch Decision

Release of New Chief Engineer's Case Study: The Gravity Probe B Launch Decision

Making it through launch with a 100% probability of success is the ultimate objective of any launch. In addition, it takes a combination of smart, consistent and prudent engineering decisions that are grounded in thorough requirements and analysis to interpret data, connect it to what is possible, make the call. The Gravity Probe B launch decision is a dramatic example of both and is at the program's center here.

Check out the new Case Study on the Gravity Probe B launch in the Chief Engineers Corner. Read more.

by [Nancy Yew](#)

Science Magazines Honor Cutting-Edge NASA Programs

SCHEDULED MAINTENANCE: Saturday, Nov 7, 2009, 9:00 a.m. - 9:00 p.m. EST

Mechanical Systems Experts Available to Answer Questions

APPEL Masters with Masters Event, October 29, 2009, NASA HQ

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Twitter / NASA

- NASA: Robotic lunar lander test, look promising for future space technology. Check it out at: <http://t.cn/xuncom/naaznmt>
- NASA: The new frontier is at the launch. Meteor Shower. Learn more about the event at <http://bit.ly/04028>. Link up for night and day!

NASA Engineering Network



What's Happening at the Office

- APTT
- Case Studies
- NASA TV: What's Happening at the Office
- News
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NASA's Lessons Learned Repository

- Ask an Expert
- Community Profile
- Share a Lesson
- What's Hot



Communities of Practice

- Mechanical Systems
- Test and Simulation



Search Repositories from Across NASA

- Apollo 13 Flight
- Earth Science
- Mechanical Systems
- Mission Management



Chief Engineer's Corner

Read more about the Chief Engineer's Corner.

Read more about the Chief Engineer's Corner.

Communities of Practice

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Looking for a theme test facility that will meet your needs, links to key data, tutorials and reference documents?

- Ask an Expert
- Community Profile
- Share a Lesson
- What's Hot

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What's Hot

November 03, 2009
Ask an Expert has been rolled out to NEN. To learn how search for and ask experts from across NASA and engineering, questions you may have visit [Ask an Expert](#) to start getting answers to your questions.

October 26, 2009
White Paper Report: Spacemat 4.0 Management Work in Progress: The Science Mission Directorate, Planetary Science Division is now available for download.

You can find this and many other documents on the [Library](#) page.

September 24, 2009
The new [Lessons Learned](#) repository is now available.



CoP Home Page (GN&C)

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NASA Engineering Network

Welcome to New MEN

NEW Home

Community for the Technical Discipline of Guidance, Navigation, and Control

Office of the Chief Engineer

Guidance, Navigation, and Control

Organization Charts

Lessons Learned (11)

Standards / Requirements

Communities by Technical Discipline

Guidance, Navigation, and Control

Best Practices

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Lore Discipline Team

Discussions / FAQ

Documents

GNC + NASA

Lessons Learned

Links for GNC

Reading Room

Environmental Test & Verification

Loads and Dynamics

Mechanical Systems

Nondestructive Evaluation

Passive Thermal Control and Protection

Propulsion

Software Engineering

Structures

Systems Engineering

Communities by Tqnt. Discipline

Search

Standards / Requirements

Solar Activity Predictions for Solar Cycle 24

Solar Activity Predictions for Solar Cycle 24



The progress of the systems for solar cycle 24 is being tracked and reported by the solar cycle prediction team. The team is currently working on the final report and will be releasing it in the next few weeks. The team is also working on the final report and will be releasing it in the next few weeks.

Tau Hery

Relative Navigation Sensor for HST SNA

Acquisition, Pointing, and Tracking System Being Developed for Lunar Laser Communications Demonstration

Successful Attitude Control Motor (ACH) Test Firing

GNC Engineers Win NASA Honor Awards

View all announcements | Support | Announcements | GNC | GNC | GNC

Community Links



Find best practices for GNC



Centering on GNC and a list of interests



Discussing and participating in GNC



Find GNC-related documents



Have a question or need advice



Links to sites of interest



Read frequently asked questions and participate in our discussion



List of recommended books and articles



Find journal articles, tech reports, and papers

Welcome to Guidance, Navigation, and Control



As the GNC Technical Fellow, Heil Dennehy leads the GNC community in the development of a high quality technical community. Heil Dennehy is currently a Senior Technical Fellow at NASA.

+ State of the Discipline
+ Summary / IESG GNC

Discipline Assessment

Tech Fellow: Heil Dennehy

Facilitator: Lisa Johnson

What's New

Updates to the CoP

Latest news from the GNC community

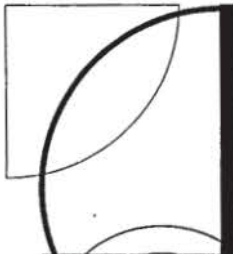
- A new lesson in engineering is available for the GNC community. The lesson is available for the GNC community. The lesson is available for the GNC community.

Suggestions (GNC)

Please enter your comment or suggestion in the field below and click Submit. To see the suggestions others have submitted, click View Suggestions.

More Home Page Links

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Highlighting Lessons Learned

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Mechanical Systems

Nondestructive Evaluation

Passive Thermal Control and Protection

Propulsion

Software Engineering

Structures

Systems Engineering

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Lessons Learned



Guidance, Navigation, and Control

LESSONS LEARNED

Lesson Learned in the Spotlight

X-43A Mishap, June 2001



The X-43A was the first flight attempt of NASA's Hyper-X program with the purpose of achieving a hypersonic Mach 7 flight in the 2000s. The X-43A stack was a combination of the Hyper-X booster, the X-43A vehicle, and the X-43A adapter. The X-43A vehicle was a small, lightweight, air-breathing hypersonic vehicle. The X-43A adapter was a small, lightweight, air-breathing hypersonic vehicle. The X-43A adapter was a small, lightweight, air-breathing hypersonic vehicle.

The flight attempt occurred in June 2001. The X-43A stack was launched successfully after the X-43A stack was dropped from the B-52. During the subsequent pitch-up maneuver, the stack experienced a diverging roll oscillation that caused the Hyper-X booster to separate from the X-43A adapter. This resulted in a loss of control and a sideslip divergence, followed by structural overload and failure of the Hyper-X booster. The severe loss of control caused the stack to diverge significantly from its planned trajectory, and it was destroyed by range safety less than a minute after release from the B-52.

The NASA mishap investigation identified several multiple contributing factors that caused the mishap. The flight failed because the vehicle's flight control system autopilot design was deficient in several analysis modeling areas. These deficiencies were related to an overprediction of the autopilot stability margins.

The flight test plans for the mishap were not taking into account the multiple contributing factors in the aerodynamic modeling of the Hyper-X booster for mass geometry of its fins. An overprediction of the actual aerodynamic forces was a significant modeling deficiency. The flight test should only be reproduced when all of the contributing conditions were incorporated in the analysis. An important lesson for control engineers is that stability margin requirements must be large enough to cover both model inaccuracies and parameter uncertainties.

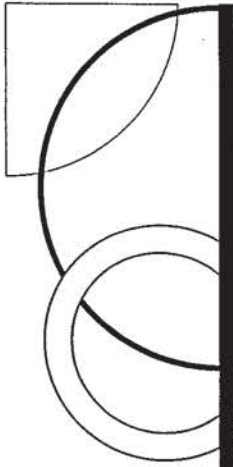
- Flight Test Findings (PDF)
- Spotlight on X-43A (PDF)
- X-43A Flight Report Summary and Conclusions
- Mission Report

Lessons Learned Links

Search Queries and Links

- NASA Lessons Learned in the Spotlight (PDF)
- NASA Technical Report Server (TRS) Search on Guidance, Navigation, and Control
- See also Learning from Other People's Mistakes, Paul Cheng and Patrick Smith, *Aviation Magazine*, The Aerospace Corporation
- X-43A Mission Report (PDF) from the NASA Safety Center





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How CoPs help engineers

- Engineer has a question on stability of a nonlinear control system
- He posts a question in the discussion board
- In this example two experts respond

Discussion Board

Discussions/FAQ

Discussion Board (GNC) > Stability analysis for nonlinear systems

2009-08-31 12:00

Question on stability analysis for a highly nonlinear system

2009-07-10 14:56

Author: [Scott Heathcote](#) Posted: 7/10/2009 1:47:56 PM

I am developing a controller (a thruster based controller) made for the GEM satellite. The controller scheme is fairly simple. Attitude and rate error for each spacecraft axis are fed through a set of gains which pass to a Schmitt Trigger (deadband with hysteresis) whose output is a -1, 0, 1. The output for all three axes are fed to a thruster selection algorithm which determines the thrusters that need to be on to provide that torque necessary for control.

The controller is a simple design and is stable, however proving stability has been an issue. Up to this point, GSFC has used describing functions for stability analysis of Schmitt Trigger controllers. However, in digging a little, I have determined that describing functions are inadequate for this problem. Lyapunov proofs don't work due to a discontinuous second derivative. Looking at a phase portrait, the system shows a stable limit cycle which indicates the system is stable. However, this method does little to indicate the margin for stability.

Up to this point, I have been doing a Monte Carlo style analysis to show that analytical predictions of system limit cycle amplitudes are accurate to show that the system is well behaved and stable. For margins, thruster forces have been increased in our HFI simulation to show gain margin and control commands have been delayed to show phase margin.

Currently, there is a requirement for a rigid body stability analysis to show 6 dB gain and 30 degree phase margin. This is possible for linear systems but for highly nonlinear systems, this does not hold very well.

Gain margin can be approximated through increases in control actuation force/torque. Phase margin is tougher since degrees of phase don't seem to fit a system where an input driving frequency will not be evident in the output. Delaying the controller commands is an approximate but determining the amount of delay needed to 'prove' robustness is hard to pin down and doesn't seem to capture what phase margin really is.

My question is what is the best method for proving robust stability for highly nonlinear systems?

Re:Question on stability analysis for a highly nonlinear system

2009-07-31 12:00

Author: [Robert Clarke](#) Posted: 7/31/2009 12:53:51 PM

I think you are on the right track with the finding the gain margin by increasing the loop gain until high frequency instability (limit cycle) is noted and then converting this to dB. If the system is conditionally stable then you also need to decrease the gain until you drive the system into low frequency instability (limit cycle). The frequency of each limit cycle would represent the crossover frequencies that you would have found in linear analysis (for a linear controller). Phase margin is equivalent to time delay, but you require a crossover frequency to do the conversion of time delay to phase margin. (Phase angle in radians = time delay in seconds * frequency in radians per second). If you don't have anything else, I would recommend that you use the system bandwidth that you desire to be able to control. Typically this is much lower (3 to 5%) below the sensor and/or actuator bandwidths. This again goes back to the definition of phase margin for a linear system. The phase margin is measuring how far away the phase is from the critical phase angle. For negative feedback systems this is 180 degrees (+ or - are equivalent) when the gain is at the critical value of 0 dB. The 3 to 5% below the sensor and/or actuator bandwidths is to make sure that you really have good control of the phase characteristics of the system at this frequency. Too close to either of these bandwidths and you lose control of the systems phase (you become very sensitive to small changes in time delay and therefore become unstable).

Re:Question on stability analysis for a highly nonlinear system

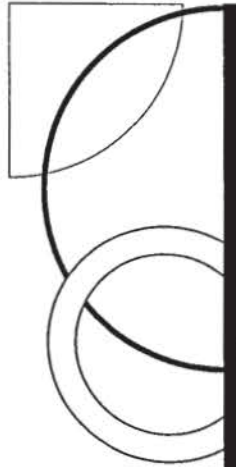
2009-08-31 12:00

Author: [John Hanson](#) Posted: 8/31/2009 12:02:49 PM

I sent out your question and got two responses:

1. From Tamer Vanziwieri

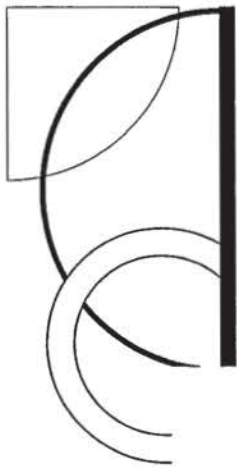
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How CoPs help engineers (2)

- An engineer is looking for information about what thermal testing facilities are available
- He/she checks the list on the community of practice



Thermal Facilities List

<http://nen.nasa.gov>

Facility Name or Designation	Center	Facility Type	Primary Use	Maximum Test Article Dimensions, Facility Characteristic Dimensions, Volume, Orientation (Note: In Units Provided by Facility Organization)
1 MW Power Test Facility	APC	Article	The 1-MW Power Test Facility is used to test aerodynamic heating in the thermal environment of the reentry module outer surface.	Standard configuration: max. test article length = 100 in; max. test article diameter = 30 in.
10 MW Transient Power Test Facility	APC	Article	The 10-MW Power Test Facility is used to test aerodynamic heating in the thermal environment of the reentry module outer surface.	Standard configuration: max. test article length = 100 in; max. test article diameter = 30 in.
10-Mach Supersonic Turbulent Flow Facility	ARC	Article	The 10-Mach Supersonic Turbulent Flow Facility is used to test high Mach number turbulent flow over a blunt body and a flat plate.	Standard configuration: max. test article length = 100 in; max. test article diameter = 30 in.
60 MW Aerodynamic Heating Facility (AHF)	ARC	Article	The 60-MW Aerodynamic Heating Facility is used to test aerodynamic heating in the thermal environment of the reentry module outer surface at high enthalpy flow field conditions.	Standard configuration: max. test article length = 100 in; max. test article diameter = 30 in.
Aerodynamic Heating Facility (AHF)	ARC	Article	The Aerodynamic Heating Facility is used to test aerodynamic heating in the thermal environment of the reentry module outer surface at high enthalpy flow field conditions.	Standard configuration: max. test article length = 100 in; max. test article diameter = 30 in.



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How CoPs help engineering (3)

- An engineer has a question
- He/she accesses the appropriate community of practice and asks the question
- Pre-identified experts are sent an email and answer the question
- Question and answer are stored online

http://nen.nasa.gov

Ask an Expert

Ask an Expert

Mechanical Systems

Search for questions

Search

All Categories

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What is the best way to design a...

Have engineering questions?

ASK A QUESTION



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Archived Questions

Electrical Systems (1/1/10)

Structural Analysis (1/1/10)

Control Systems (1/1/10)

Electrical Systems (1/1/10)

Control Systems (1/1/10)

Structural Analysis (1/1/10)

Electrical Systems (1/1/10)

Control Systems (1/1/10)