Connecting Engineers to Online Experts and Knowledge

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Galveston, TX

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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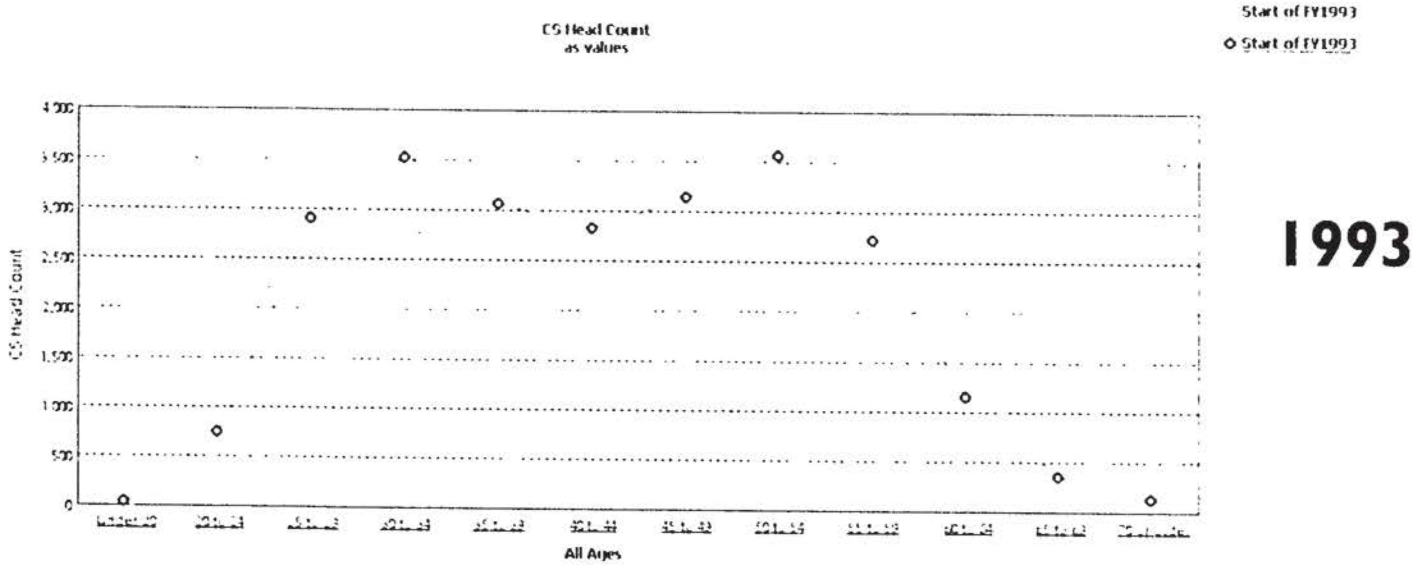
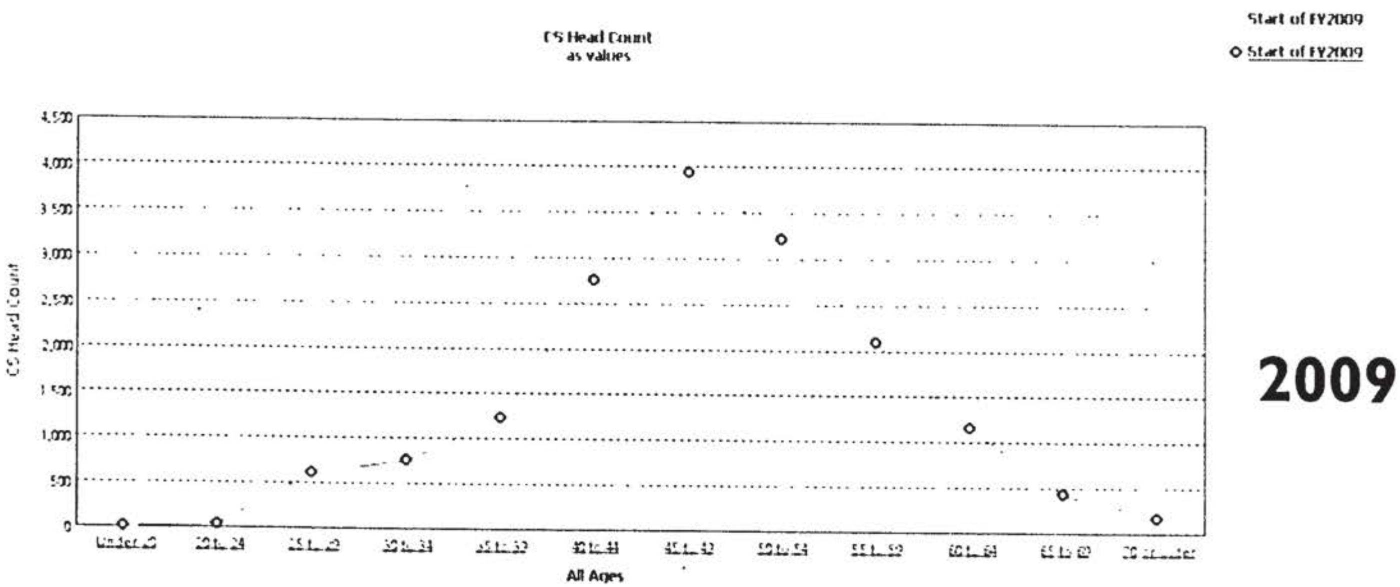
Observations on the NASA Workforce

- 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

NASA's Changing Age Distribution





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

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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.

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

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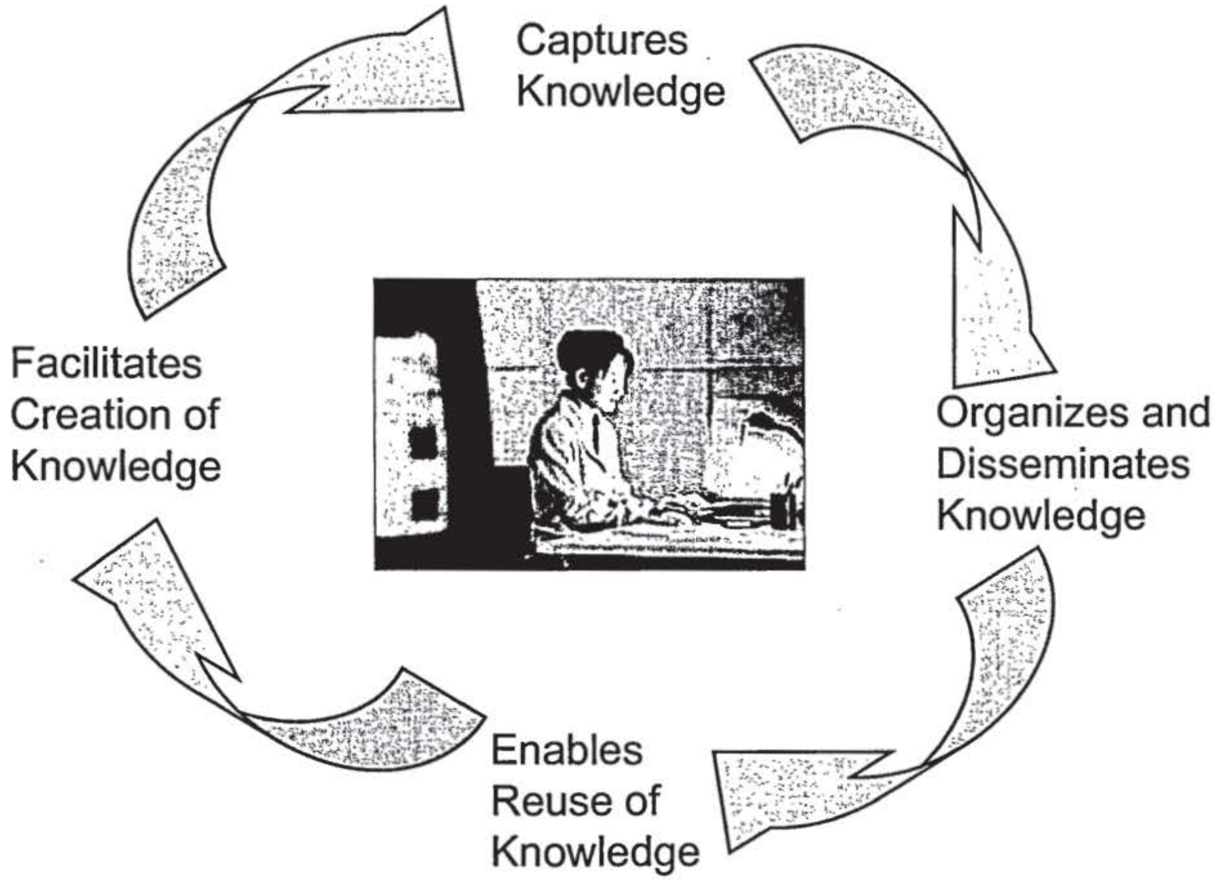
Sharing Knowledge & Lessons

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)

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

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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

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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

Communities Under Development

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

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.

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

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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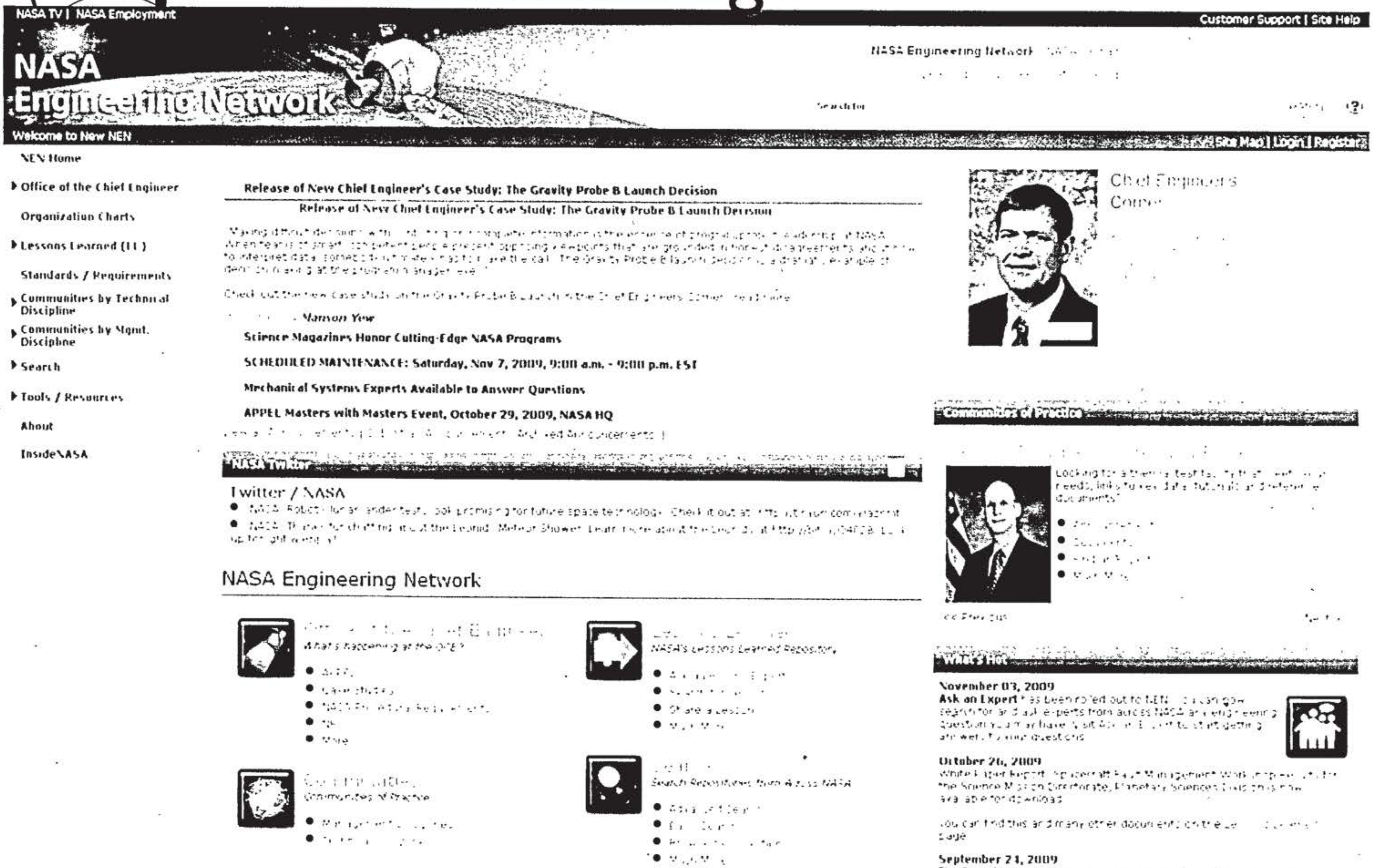
Screen captures from live demo

(for those who missed the live presentation)

NEN Home Page



NASA TV | NASA Employment

Customer Support | Site Help

NASA Engineering Network

Welcome to New NEN

Site Map | Login | Register

NEN Home
- Office of the Chief Engineer
- Organization Charts
- Lessons Learned (LL)
- Standards / Requirements
- Communities by Technical Discipline
- Communities by Mgmt. Discipline
- Search
- Tools / Resources
- About
- InsideNASA

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

Manson 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

NASA Twitter

Twitter / NASA

NASA Engineering Network

Chief Engineer's Corner

Communities of Practice

What's Hot

November 03, 2009

Ask an Expert

October 26, 2009

September 21, 2009

CoP Home Page (GN&C)

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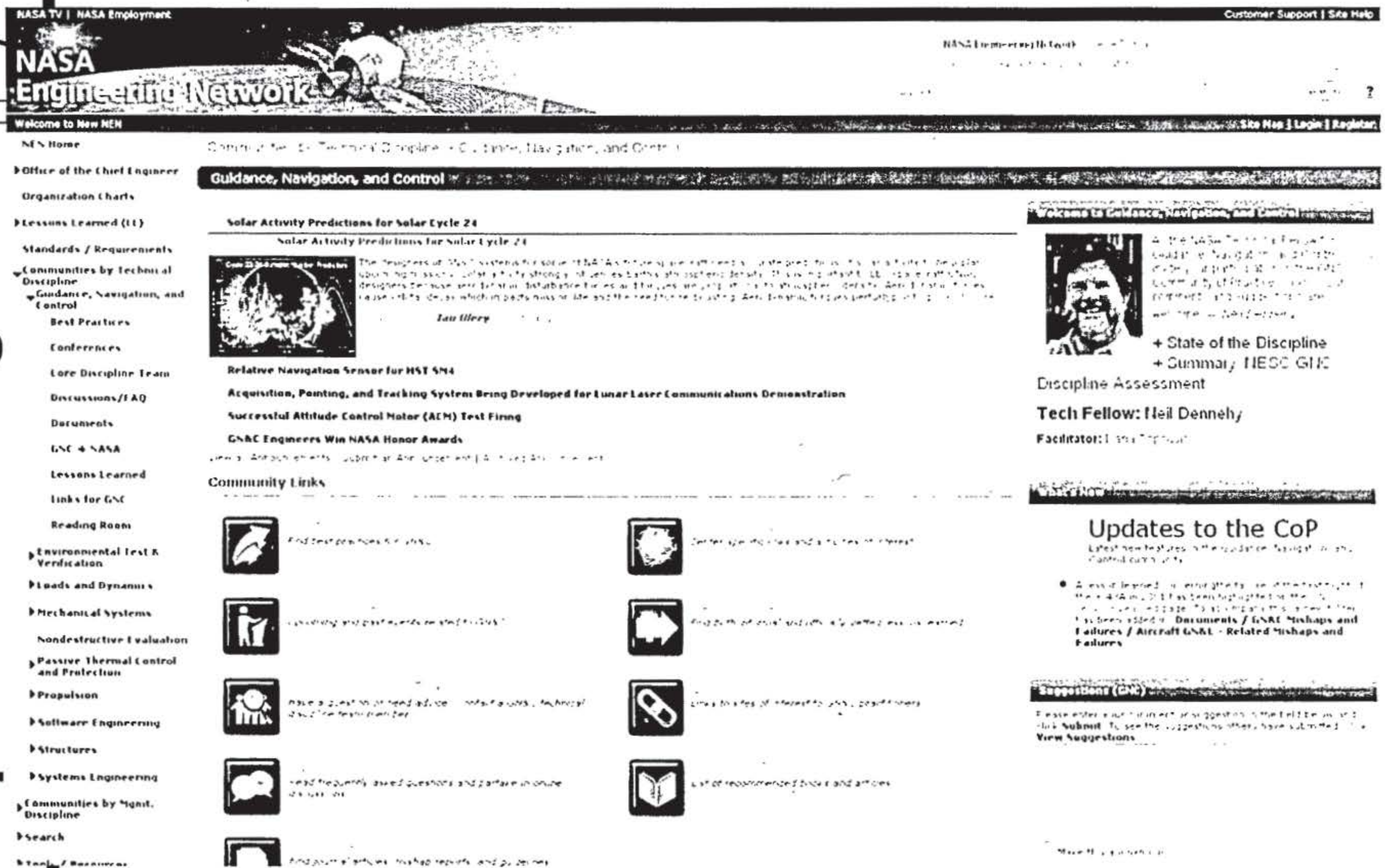
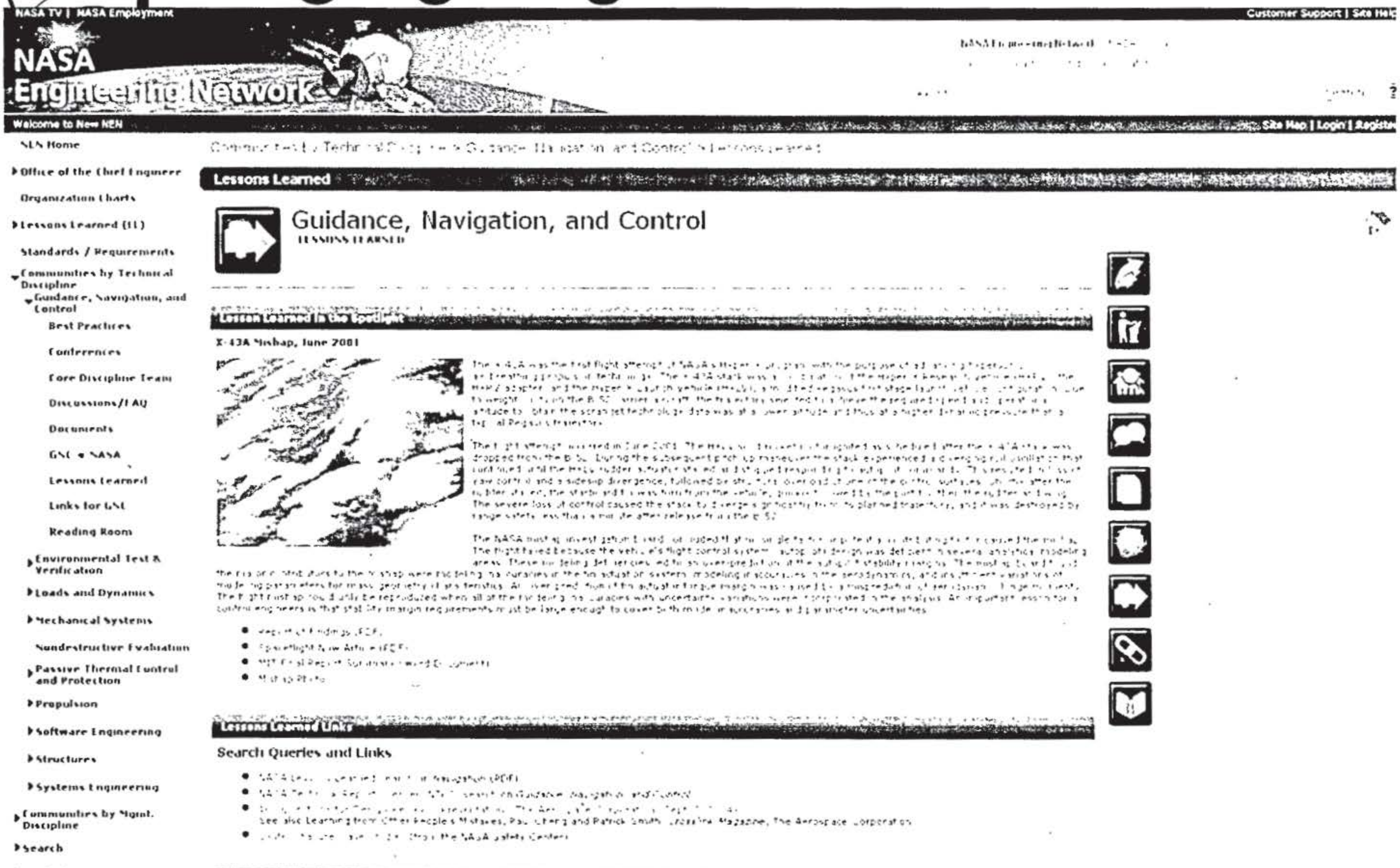


Highlighting Lessons Learned



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

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Discussion Board

Discussions/FAQ

Discussion Board (GN&C) › Stability analysis for nonlinear systems ›

Question on stability analysis for a highly nonlinear system

Author: Scott Heatwole   Posted: 7/10/2009 1:47:56 PM

I am developing a controller a thruster based controller mode for the GPM satellite. The controller's scheme is fairly simple. Attitude and rate errors 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 feed 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 margins 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 Hi-fi 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 degrees 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

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 5X) 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 5X 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

Author: John Hanson   Posted: 8/31/2009 12:22:49 PM

I sent out your question and got two responses:

1. From Tannen VanZwieten

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

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)	
[illegible] MW Panel Test Facility	ARC	Arc Jet	[illegible]	[illegible]	[illegible]
[illegible] MW [illegible] Panel Test Facility	ARC	Arc Jet	[illegible]	[illegible]	[illegible]
[illegible] inch Supersonic Turbulent Flow Duct	ARC	Arc Jet	[illegible]	[illegible]	[illegible]
60 MW Interaction Heating Facility (IHF)	ARC	Arc Jet	[illegible]	[illegible]	[illegible]
Aerodynamic Heating Facility (AHF)	ARC	Arc Jet	[illegible]	[illegible]	[illegible]

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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

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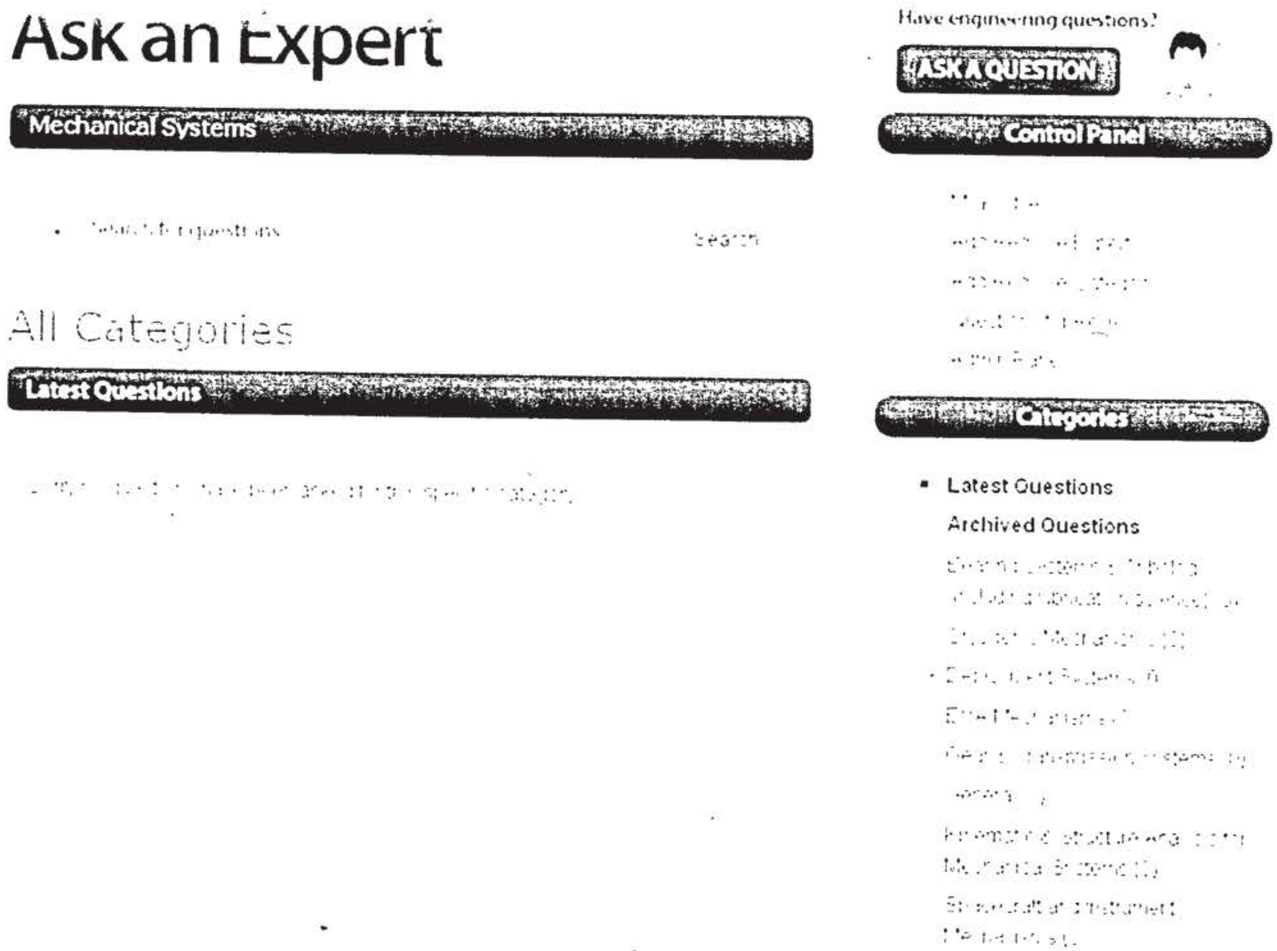
Ask an Expert



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