Building Communities of Engineers to Share Technical Expertise

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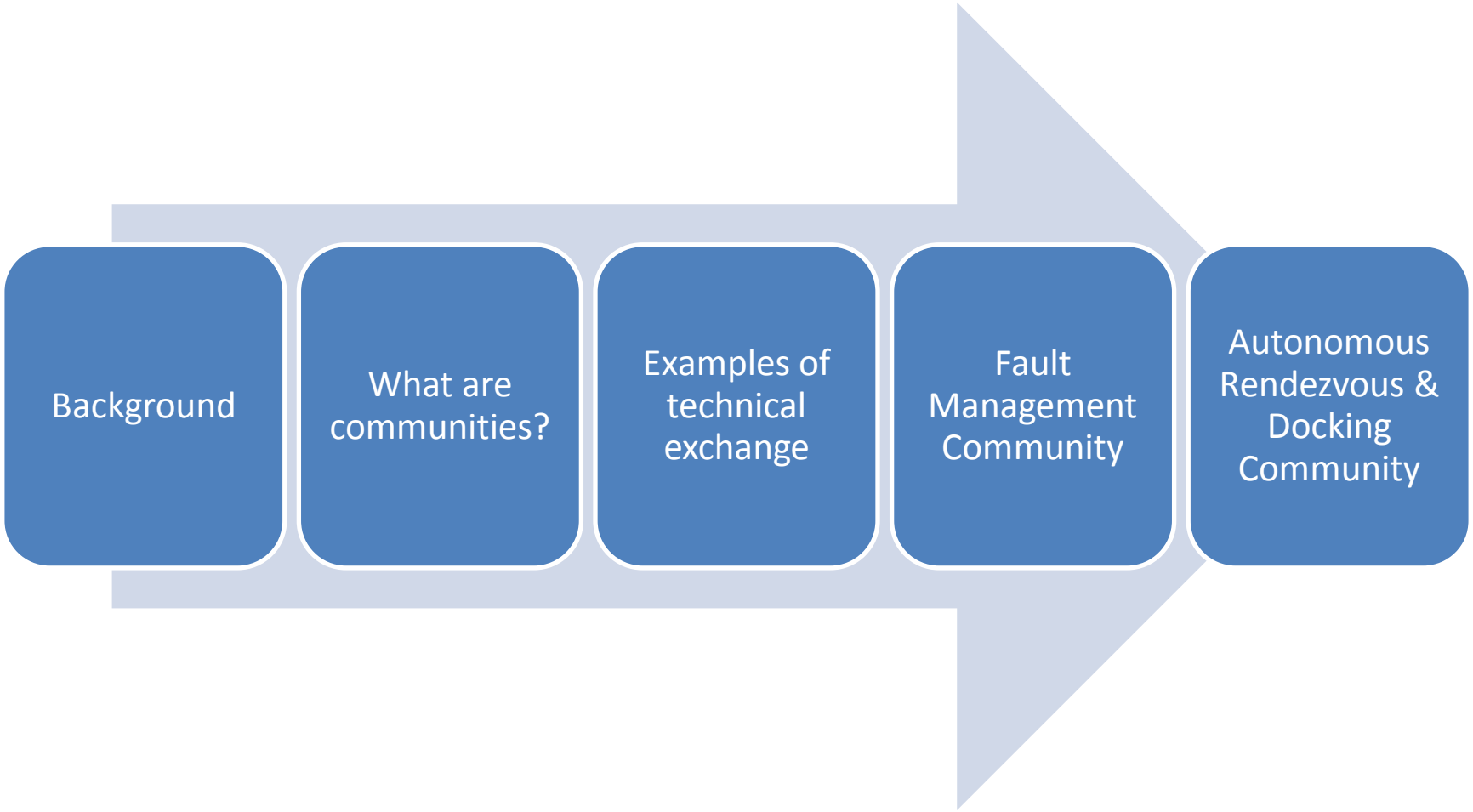
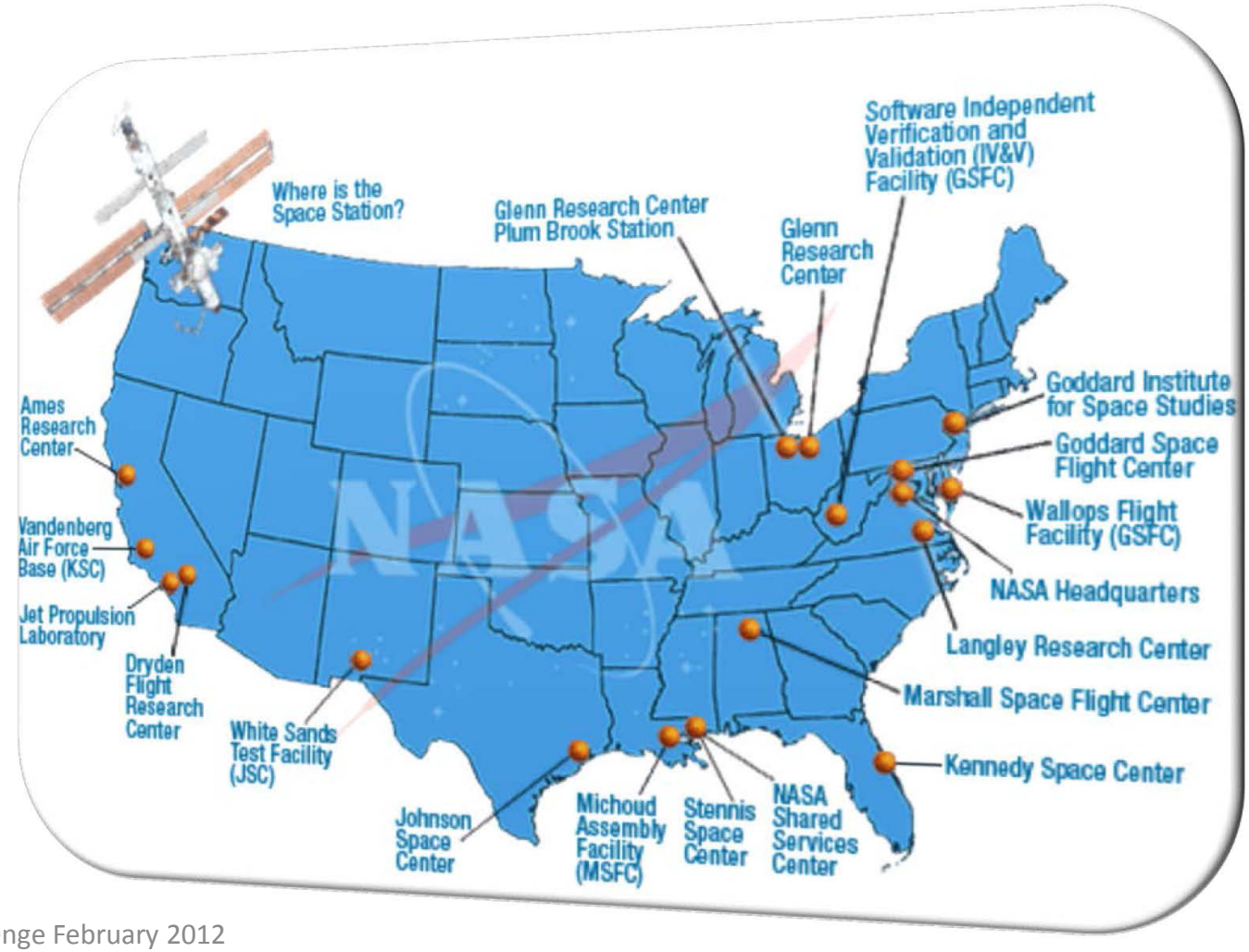
PM Challenge 2012

Jet Propulsion Laboratory, California Institute of Technology.

Agenda


Background
What are communities?
Examples of technical exchange
Fault Management Community
Autonomous Rendezvous & Docking Community

Driver: Distributed Geography

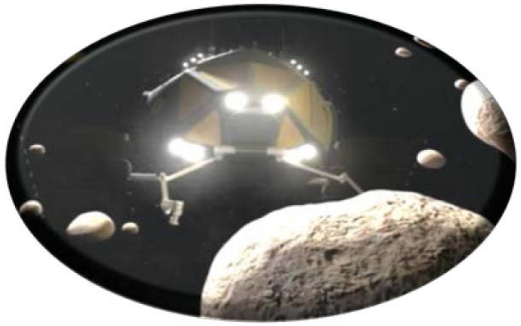


Driver: Columbia Accident

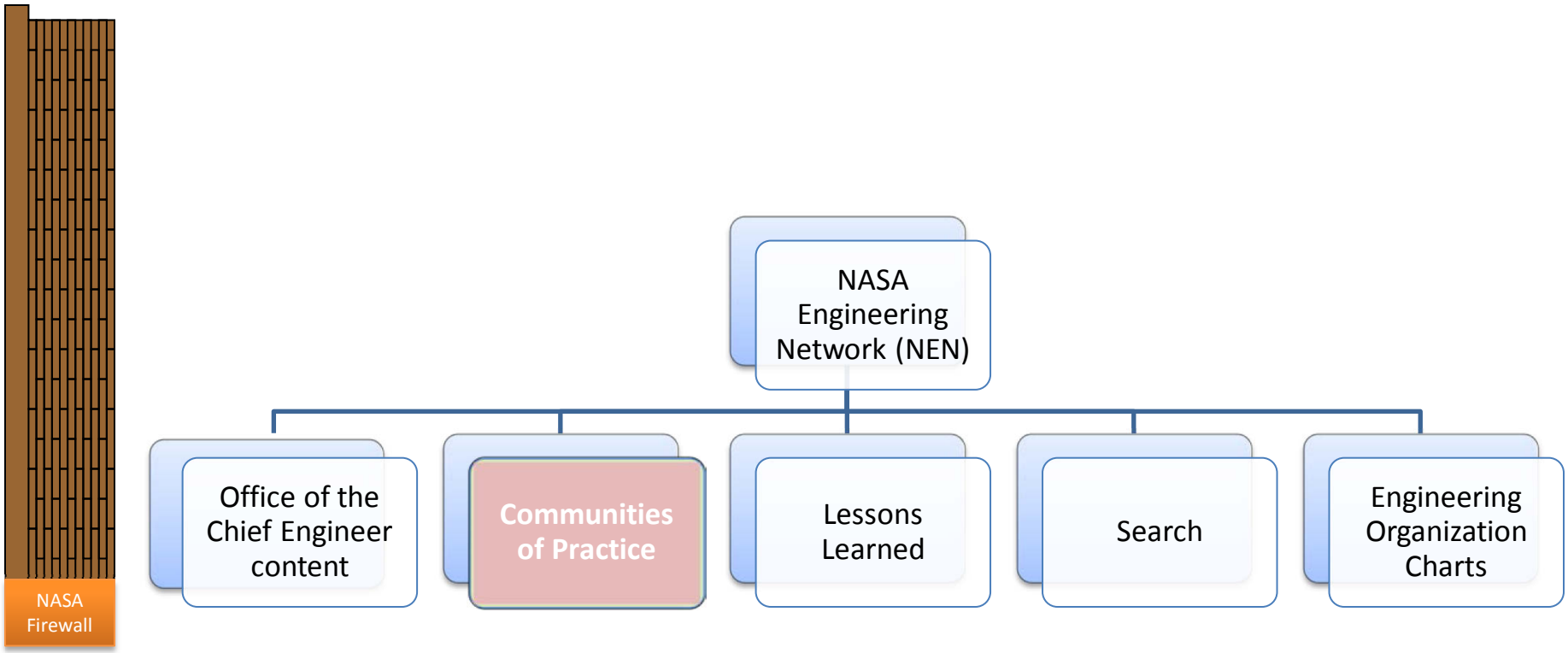
"NASA has not demonstrated the characteristics of a learning organization."

-Columbia Accident Investigation Board, 2003

Driver: Evolving Mission



NASA Engineering Network



A community of practice is…

A group of people who "share a concern, a set of problems or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis."

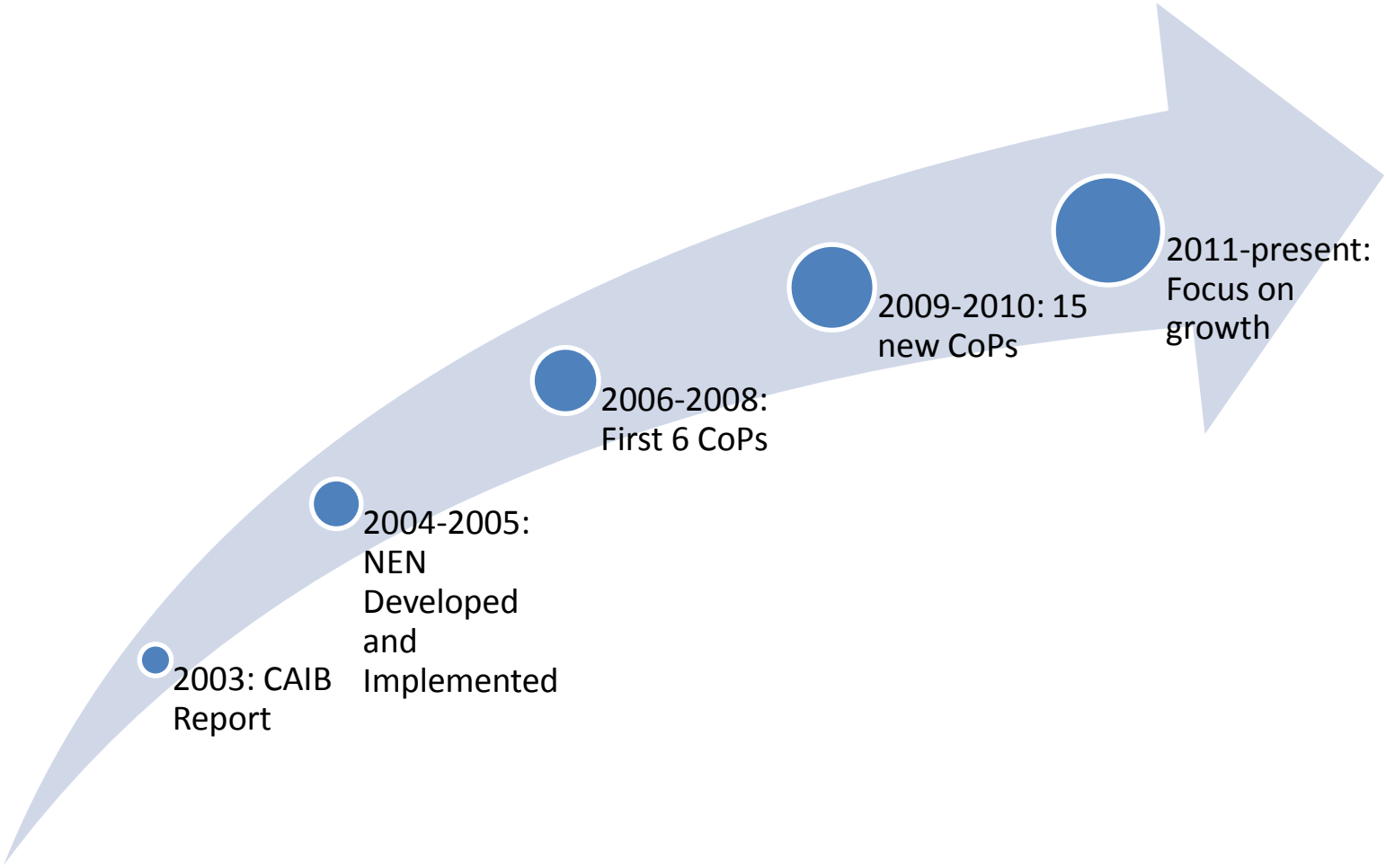
-Etienne Wenger

Role of the NESC

The NESC performs value-added independent testing, analysis, and assessments of NASA's high-risk projects to ensure safety and mission success.

NASA Technical Fellows, appointed by the OCE, lead most of the communities of practice.

Developing Online CoPs



Communities

Engineering →

Management ↓

Customer Advisory Committee
Contact: Michael Ryschkewitsch

Product Data and Life-Cycle Management (PDLM)
Contact: Harold (Hal) Bell

Earned Value Management
Contact: Jerald Kerby

Program/Project Management
Contact: Sandra Smalley

Aerosciences
Contact: Dave Schuster

Autonomous Rendezvous and Docking
Contacts: Neil Dennehy

Avionics
Contact: Oscar Gonzalez

Electrical Power
Contact: Denney Keys

Environmental Test & Verification
Contact: Ed Strong

Fault Management
Contact: Lorraine Fesq

Flight Mechanics
Contact: Dan Murri

Guidance, Navigation and Control
Contact: Neil Dennehy

Human Factors
Contact: Cynthia Null

Life Support/Active Thermal
Contact: Hank Rotter

Loads and Dynamics
Contact: Curtis Larsen

Mechanical Systems
Contact: Joseph Pellicciotti

Nondestructive Evaluation
Contact: William Prosser

Passive Thermal Control and Protection
Contact: Steve Rickman

Propulsion
Contact: Roberto Garcia

Software Engineering
Contact: John C. Kelly

Structures
Contact: Ivatury Raju

Systems Engineering
Contact: Joe Smith

Establishing a New Community

Phase 1

- NASA's core competencies
- NEN team and Tech Fellow collect key resources
- List center-by-center info
- Share papers

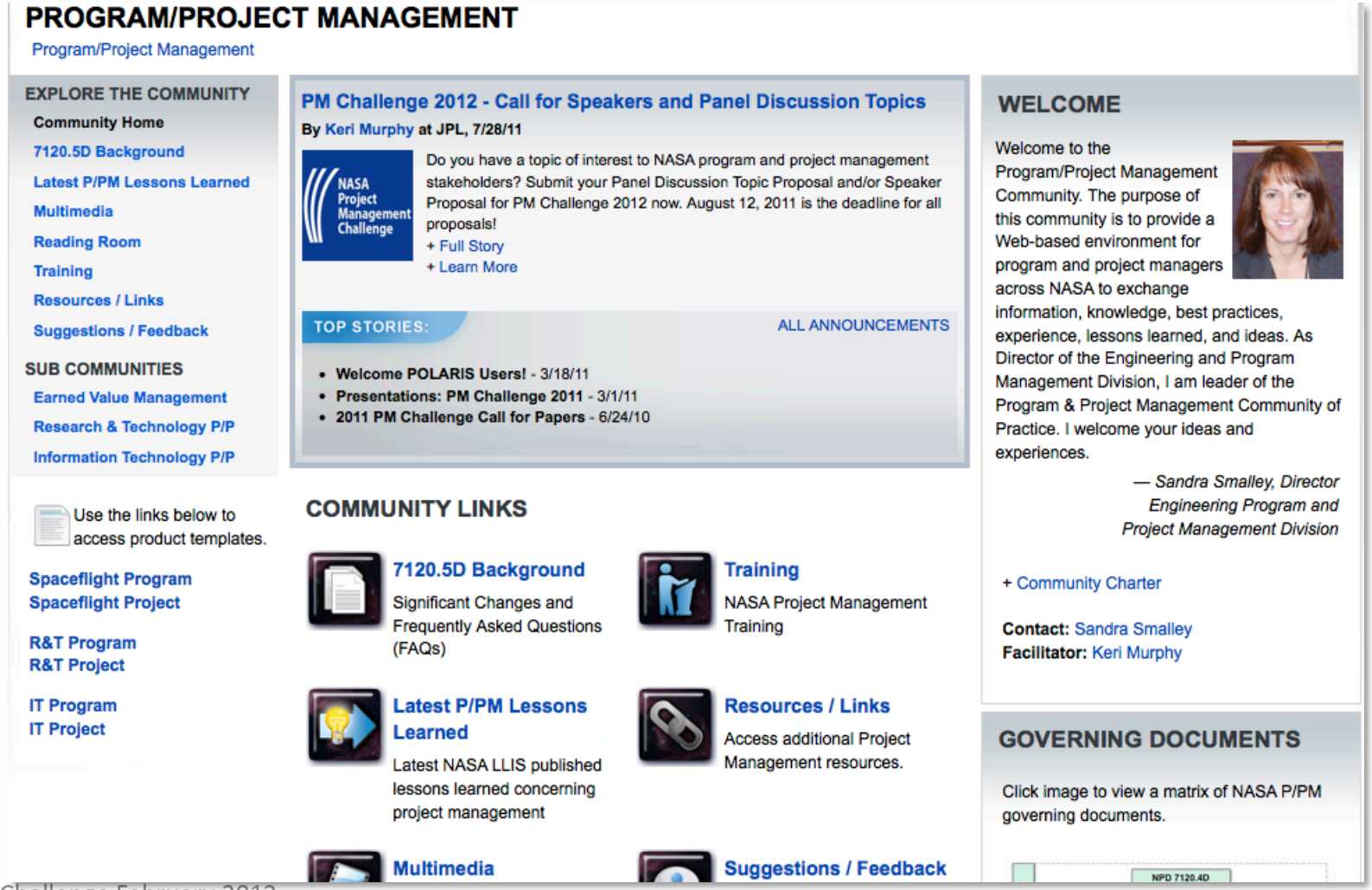
Phase 2

- Communication
- Encourage more user input
- Interactive online content
- Allow users to join a community

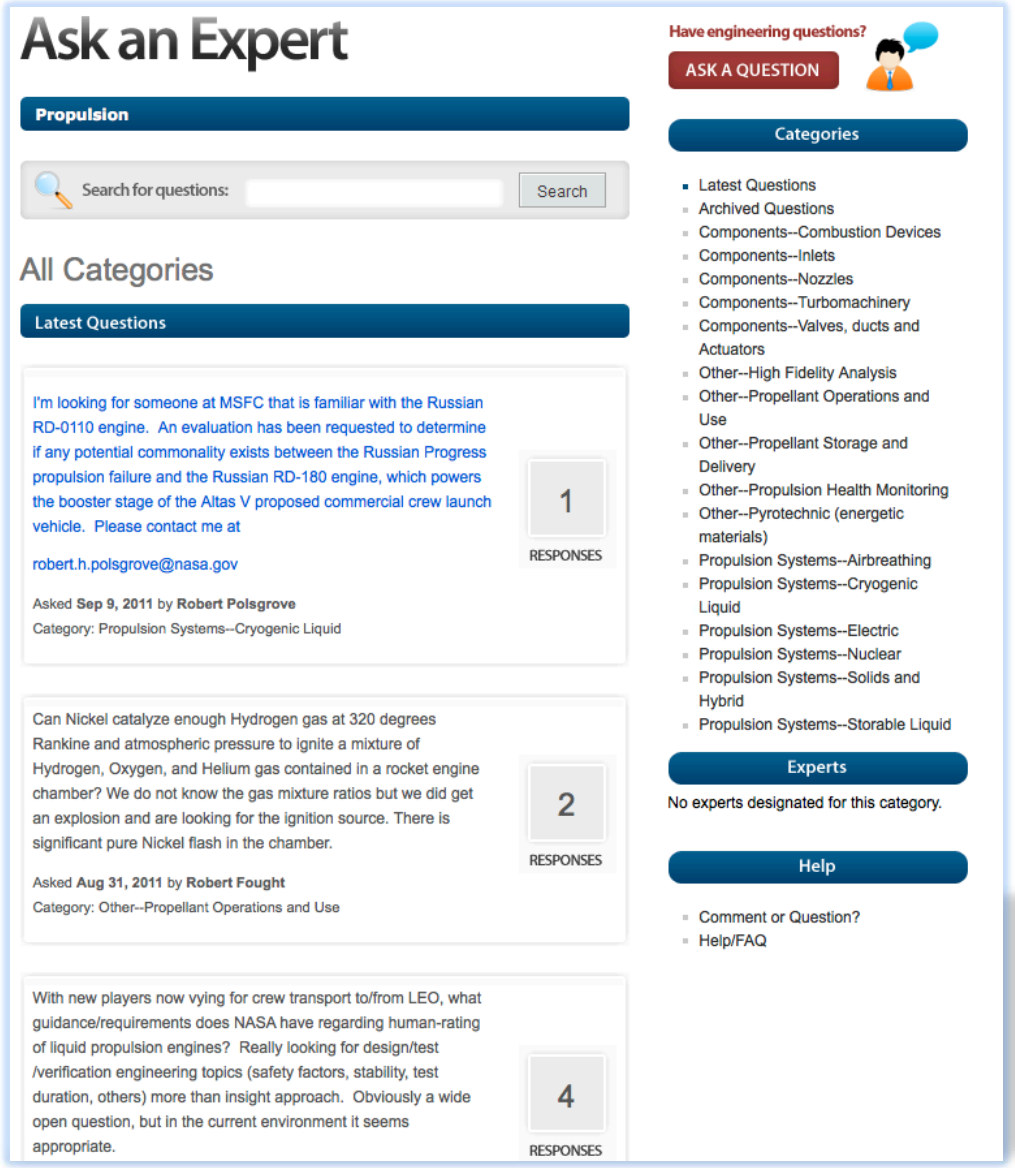
Phase 3

- Community-driven content
- Experts answer questions
- Tech Fellow champions, but not sole source of content

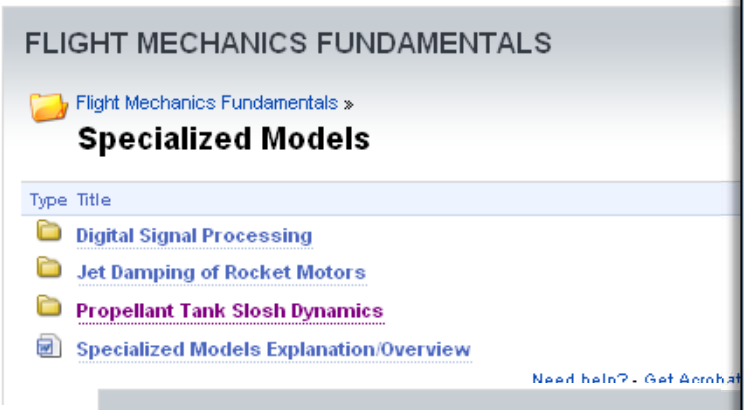
Standard Look and Feel



Getting Expert Input



Technical Exchange: MATLAB Scripts




```
%

function [ h , w , cg , wp ,  Ip , hp , wn , zn ] = slosh( R , L , bt , bb , rho , fill_ratio , nu , verbose )

% error checking of inputs and outputs:

if ( nargin < 6 || nargin > 8 )
  fprintf('\n\nwrong number of inputs!\n');
  error ('slosh usage:  [ h , w , cg , wp , Ip , hp , wn , zn ] = slosh( R , L , bt , bb , rho , fill_ratio  [ , nu ]  [ , verbose]  ) \n');
end

if ( nargin < 7 )
  nu = [];
end

if ( nargin < 8 )
  verbose = [];
end

if ( isempty( nu ) )
  nu = 0;
end

if ( isempty( verbose ) )
  verbose = 0;
end

if ( nargout > 8 )
  fprintf('\n\nwrong number of outputs!\n');
  error ('slosh usage:  [ h , w , cg , wp , Ip , hp , wn , zn ] = slosh( R , L , bt , bb , rho , fill_ratio  [ , nu ]  [ , verbose]  ) \n');
end

if ( R <= 0 )
  fprintf('\n\ninput parameter, R, must be positive!\n');
  error ('slosh usage:  [ h , w , cg , wp , Ip , hp , wn , zn ] = slosh( R , L , bt , bb , rho , fill_ratio  [ , nu ]  [ , verbose]  ) \n');
```

Facilities Information

FACILITIES

Facility Name or Designation	Facility Type
High Temperature Bushing Test Rig	Bearing Systems
Pin-On-Disk Tribometer	Bearing Systems
Thrust Foil Gas Bearing Test Rig	Bearing Systems
Ambient Pressure Foil Gas Journal Bearing Test Rig	Bearing Systems
Vacuum Roller Contact Rig	Bearing Systems
High Pressure Foil Gas Journal Bearing Test Rig	Bearing Systems
Rotordynamic Simulator Test Rig	Bearing Systems
High Temperature, High Speed Foil Gas Journal Bearing Rig	Bearing Systems
Vacuum Bearing Rig	Bearing Systems
High Frequency Cameron-Plint TE-77 Tester	Bearing Systems
Cryogenic To High Temperature Pin-On-Flat Tribometer	Bearing Systems
Spiral Orbit Tribometer (SOT)	Bearing Systems
GOES-Bearing Vacuum Tribometer	Bearing Systems
Ball-On-Plate Vacuum Tribometer	Bearing Systems
Simulated Lunar Operations (SLOPE) Lab	Spacecraft and In
Grouser Rupture-Plane Imaging (GRIP) Test Rig	Spacecraft and In
Spur Gear Fatigue Test Rig	Gear and Transmi
Spiral Bevel and Face Gear Test Rig	Gear and Transmi
400 kW Helicopter Transmission Test Stand	Gear and Transmi
Gear Noise Dynamic Rig	Gear and Transmi
High Speed Helical Gear Test Facility	Gear and Transmi

Close

Facility Name or Designation

Pin-On-Disk Tribometer

Location

Glenn Research Center (GRC)

Facility Type

Bearing Systems and Tribology

General Description

Measures tribological properties with a pin-on-disk contact arrangement under controlled atmosphere (inert, oxidizing, etc) and temperature.

Maximum Test Article Dimensions/Facility Characteristic Dimensions

Pins/Balls range from 1/8 to 1/2-in;

Operating Range/Parameters

Unidirectional sliding at 100 to 3000 rpm (0.27 to 8 m/s). Dead weights load a hemispherically-tipped pin against the disk. Friction force continuously measured with load cell. Low frequency induction coil heats

Webcasts (Partnership with NESC)

WEBCASTS

The GN&C community, in conjunction with the NASA Engineernig & Safety Center, is offering regular webcasts led by subject matter experts. They are held the third Wednesday of every other month at 2 pm Eastern. See below for the schedule, session abstracts and speaker bios. If you are interested in attending the next webcast, please register in advance. Details about how to attend will be posted soon.

Upcoming Courses

Fundamentals of Aircraft Engine Control
November 16, 2011
Abstract
Presentation
Sanjay Garg (Bio)

Watch Webcast

Fundamentals of Spacecraft Handling Qualities
January 18, 2011
Abstract
Karl Bilimoria (Bio)

Register

Fundamentals of Deep Space Mission Design
March, 2012
Abstract
Dennis Byrnes

Check back soon!

Fundamentals of Launch Vehicle Flight Control
May, 2012
Abstract
John Rakoczy

Check back soon!

Fundamentals of Spacecraft Attitude Control
July, 2012
Abstract
Dave Mangus

Check back soon!

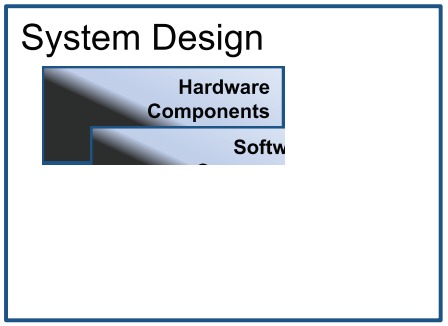
Other Knowledge Sharing

- One of a kind documents
- Discussion Forums
- Blogs

Fault Management and Autonomous Rendezvous & Docking

BUILDING COMMUNITIES FOR COALESCING DISCIPLINES

FM CoP Domain



ments, design solution

assessment results

assessment results

V&V results

Recent FM Developments

2008

2006-2008: FM causes cost overruns and schedule slips on multiple missions

Apr '08: SMD/PSD sponsors **S/C FM Workshop** (J. Adams)

2009

Mar '09: FM Workshop **White Paper** published

Jul '09: NASA OCE endorses white paper; directs to "**Coalesce the field**" (M. Ryschkewitsch)

2010

*

Jul '08: Constellation (CxP) identifies FM as potential risk; forms **FM Assessment/Advisory Team (FMAAT)** (B. Muirhead)

2010

Dec '09: CxP publishes FMAAT **Position Papers** addressing key FM issues

Jan'10: CxP **establishes FM Team** within Level 2 SE org (M. Goforth)

*

Apr '10: NESC/SMD launch **FM Handbook** – robotic focus (L. Johnson/N. Dennehy)

Oct '10: **FM CoP** established on OCE's NEN website – nen.nasa.gov (L. Fesq)

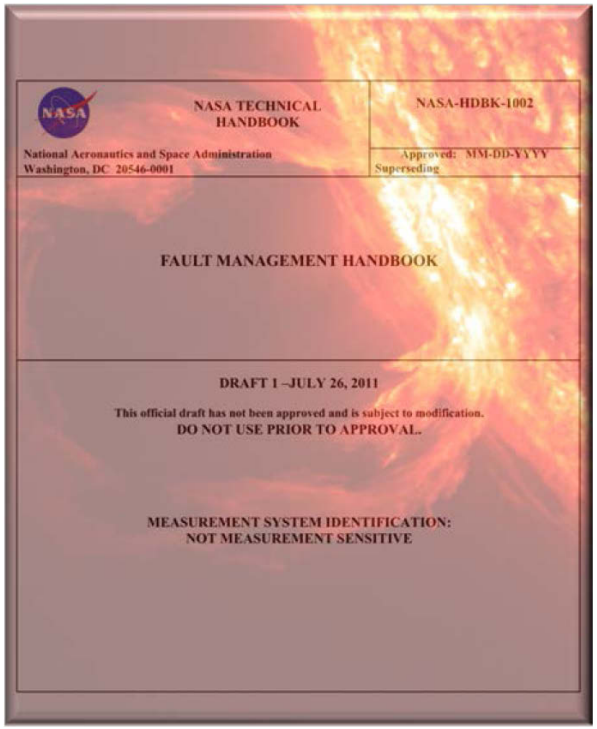
2011

Jul '11: **FM Handbook Draft** delivered to NESC/SMD and NTSPO and Centers for review

2012

Apr '12: SMD/PSD sponsors **2nd S/C FM Workshop** (J. Adams)

FM Handbook – Table of Contents



1. **Scope**
2. **Applicable Documents**
3. **Acronyms and Definitions**
4. **Concepts and Guiding Principles**
5. **Organization, Roles and Responsibilities**
6. **Process**
7. **Requirements Development**
8. **Design and Architecture**
9. **Assessment and Analysis (TBS)**
10. **Verification and Validation**
11. **Operations and Maintenance (TBS)**
12. **Review and Evaluation**
13. **Conclusion**
14. **Future Directions (TBS)**

Appendix A: References
Appendix B: Work Product Templates (TBS)
Appendix C: Relevant NASA Lessons Learned
Appendix D: Acknowledgements, historical background

Fault Management Products

NASA Handbook

- Lessons Learned
- Process for developing FM systems
- Guidance and options to address technical issues

Lessons Learned

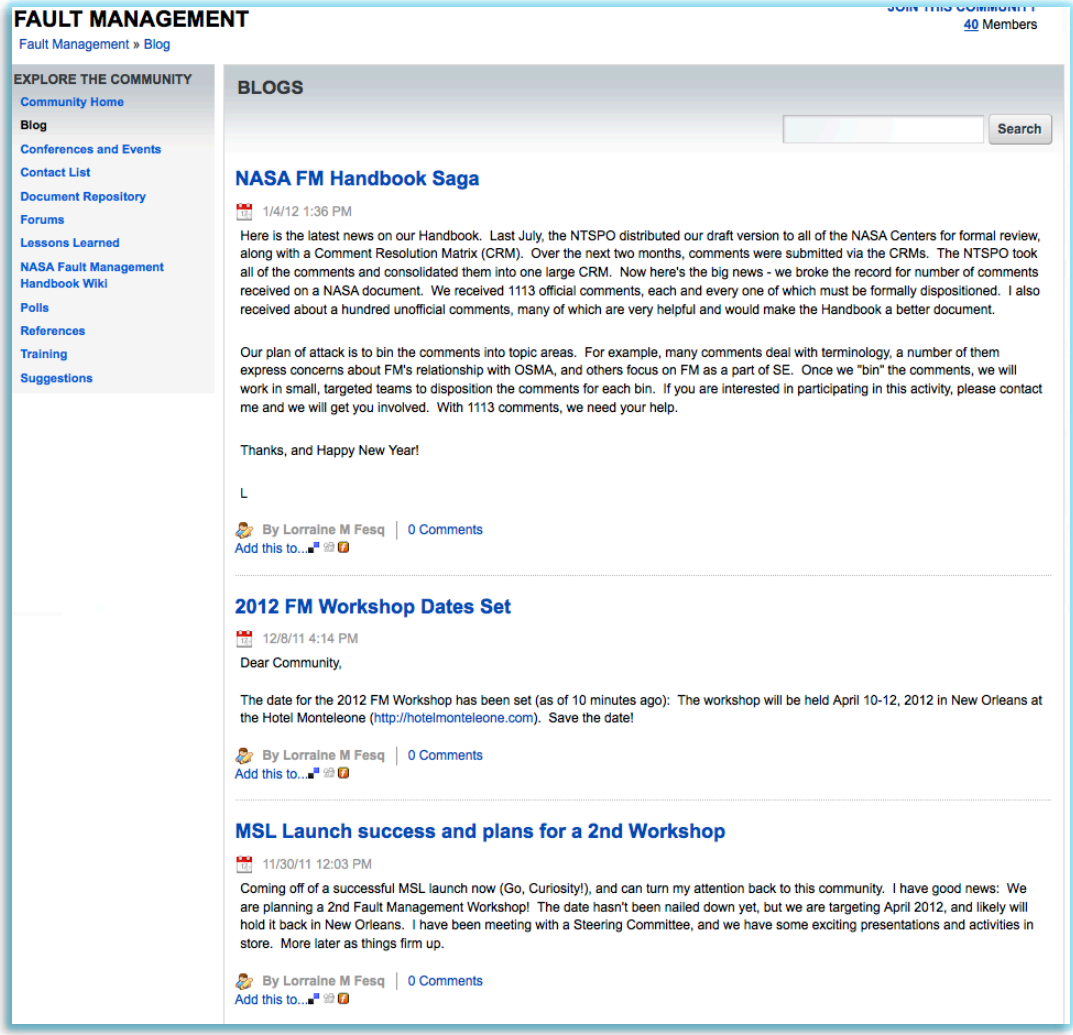
- Hyperlinked list of all FM-related lessons
- Robotic and human spaceflight lessons

Networking

- Contact list
- Conferences with FM focus
- Suggested training courses
- 2nd FM Workshop: April 2012

Fault Management Blog

- Captures latest activities in FM community
- Allows CoP Lead to "get the word out" quickly



FAULT MANAGEMENT

40 Members

Fault Management » Blog

EXPLORE THE COMMUNITY

- Community Home
- Blog
- Conferences and Events
- Contact List
- Document Repository
- Forums
- Lessons Learned
- NASA Fault Management Handbook Wiki
- Polls
- References
- Training
- Suggestions

BLOGS

Search

NASA FM Handbook Saga

1/4/12 1:36 PM

Here is the latest news on our Handbook. Last July, the NTSPO distributed our draft version to all of the NASA Centers for formal review, along with a Comment Resolution Matrix (CRM). Over the next two months, comments were submitted via the CRMs. The NTSPO took all of the comments and consolidated them into one large CRM. Now here's the big news - we broke the record for number of comments received on a NASA document. We received 1113 official comments, each and every one of which must be formally dispositioned. I also received about a hundred unofficial comments, many of which are very helpful and would make the Handbook a better document.

Our plan of attack is to bin the comments into topic areas. For example, many comments deal with terminology, a number of them express concerns about FM's relationship with OSMA, and others focus on FM as a part of SE. Once we "bin" the comments, we will work in small, targeted teams to disposition the comments for each bin. If you are interested in participating in this activity, please contact me and we will get you involved. With 1113 comments, we need your help.

Thanks, and Happy New Year!

L

By Lorraine M Fesq | 0 Comments

Add this to...

2012 FM Workshop Dates Set

12/8/11 4:14 PM

Dear Community,

The date for the 2012 FM Workshop has been set (as of 10 minutes ago): The workshop will be held April 10-12, 2012 in New Orleans at the Hotel Monteleone (http://hotelmonteleone.com). Save the date!

By Lorraine M Fesq | 0 Comments

Add this to...

MSL Launch success and plans for a 2nd Workshop

11/30/11 12:03 PM

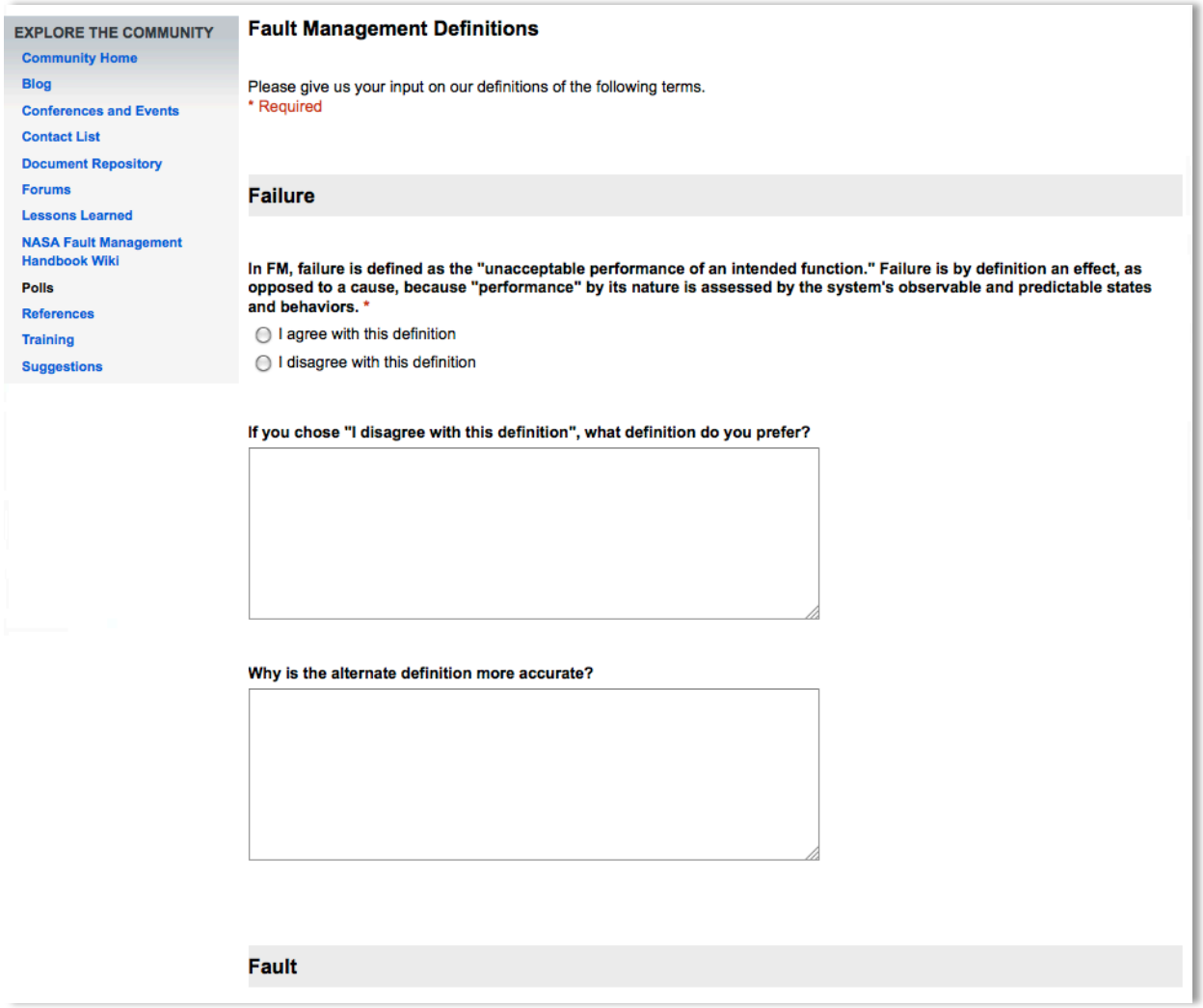
Coming off of a successful MSL launch now (Go, Curiosity!), and can turn my attention back to this community. I have good news: We are planning a 2nd Fault Management Workshop! The date hasn't been nailed down yet, but we are targeting April 2012, and likely will hold it back in New Orleans. I have been meeting with a Steering Committee, and we have some exciting presentations and activities in store. More later as things firm up.

By Lorraine M Fesq | 0 Comments

Add this to...

Fault Management Poll

- Solicit input from across the community
- Provide a forum for differing opinions
- Goal: move toward consensus on definitions of FM terms



Upcoming Workshop: April 2012

2nd NASA Spacecraft Fault Management Workshop

FEE

View Event Summary

View Event Agenda

RSVP
Monday, 03/12/12

Please respond by clicking one of the buttons below

YES NO

Summary of FM Community Objectives

Establish online forum for knowledge sharing

NASA-wide consensus on FM nomenclature

Capture FM approaches at NASA and other orgs

Educate FM engineers

Share latest developments

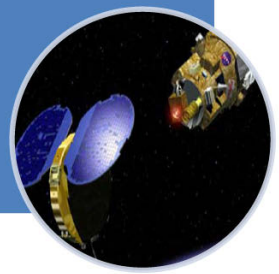
AR&D CoP Background

- **Autonomous/Automated Vehicle Rendezvous and Docking (AR&D) was identified as an Agency-level technical cross-cutting issue at December 2007 BPR meeting at NASA HQ**
  - **Tech Cross-cutting Issue Description:** ***"This a critical exploration technology in that it enables two vehicles to perform autonomous/automated docking with at least one vehicle without humans present. Supports cargo transport and robotic sample return. The US is behind where we need to be. Russia, Europe and Japan have operational systems. Internationally, the technology is still a high risk as has been demonstrated by the Issues/lessons learned from Progress/Mir docking (Russia), ETS-VII (Japan) and XSS-11, DART and Orbital Express (USA). A more robust development and validation strategy in needed."***
- **To close this issue, the NESC, OCE, and the AR&D engineering organizations across the Agency jointly establish the AR&D CoP in May 2010.**
- **Active participants from ARC, DFRC, GRC, GSFC, JSC, JPL, LaRC, MSFC, NESC, and the HQ Office of the Chief Engineer (OCE)**

Autonomous Rendezvous & Docking (AR&D) CoP

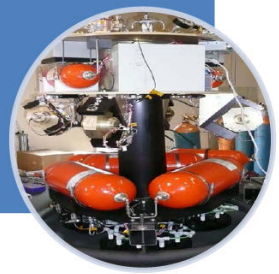
- Formed in May 2010 to enable collaboration across the Agency and develop the relationships to utilize the experience, expertise, and skills of each center.
- Established as a peer network of AR&D technical practitioners and subject matter experts
- Hold monthly CoP telecons and an annual face-to-face meeting

Formation driver was the need for cross-Agency collaboration on RFI responses and technology proposals



- AR&D Systems engineering
- AR&D Systems integration
- Relative navigation sensor design and development
- Relative navigation algorithms
- 6 Degree-of-Freedom relative control algorithms
- Docking mechanisms

AR&D CoP is Multidisciplinary encompassing GN&C, Fault Management, Software, Avionics, Mechanisms disciplines



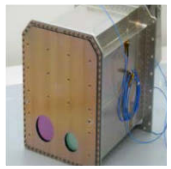
AR&D CoP Purpose

- Promote cross-directorate communication on AR&D in order to facilitate maximum leverage of agency resources for technology road-mapping and informal peer reviews
- Develop an Agency AR&D strategy
- Steer AR&D technologies and developments in the future
- Provide a source of independent technical expert support at formal design reviews and for anomalies
- Enable simple periodic sharing of data, lessons learned and best engineering practices
- Leverage Agency hardware and/or software/algorithms across directorates
- Increase awareness of partnership, collaboration, and cost-leveraging opportunities inside and outside the Agency

AR&D Community Products

Strategy White Paper

- NASA and U.S. space industry need to develop mainstream AR&D capability suite
- Proposes strategy
- Used to explain and promote AR&D



Vision Navigation Sensor EDU

- Goal was an in-space relative navigation sensor technology demonstration on ISS as part of DPP
- Initiated by CoP, sponsored by NESC
- Low-cost way to mature relative navigation sensor component technology

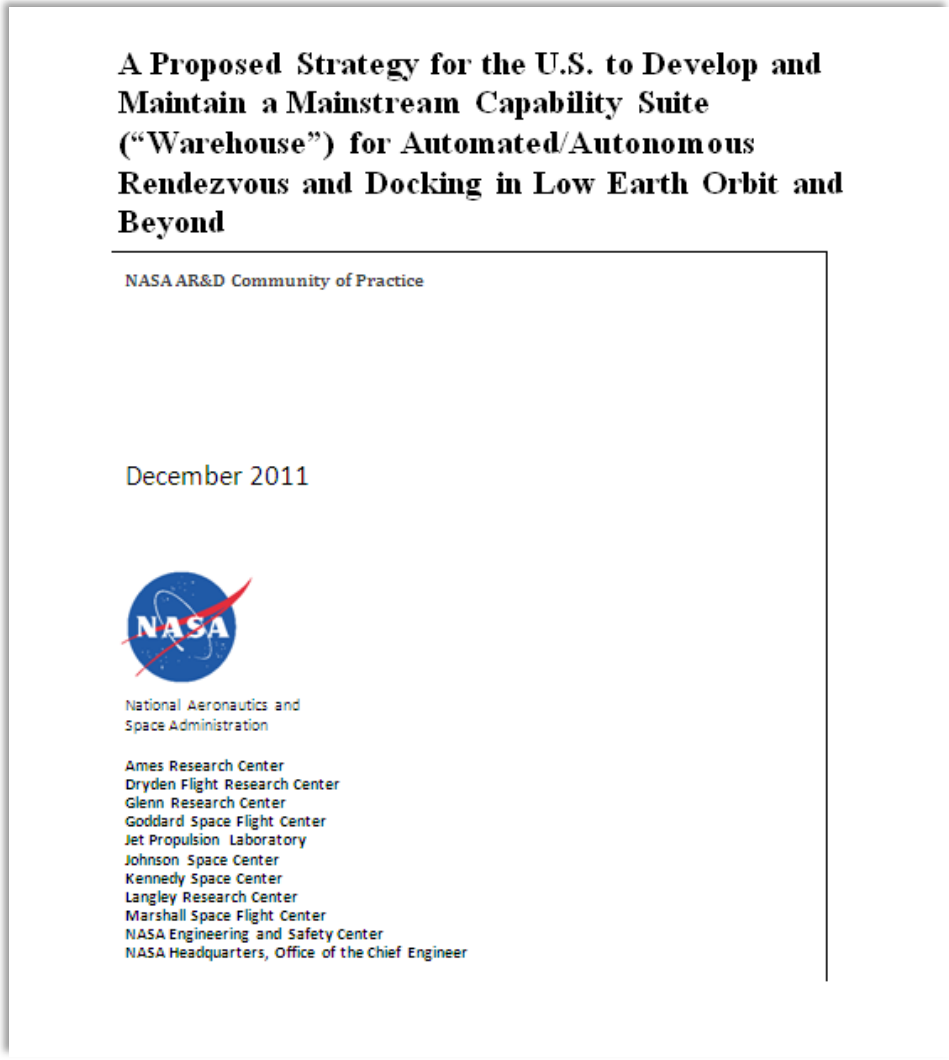
Products & Tools

- Relative navigation sensors database
- Catalog of AR&D algorithms to share
- AR&D test facility database

AR&D Strategy White Paper from the CoP

- Developed by the core community to describe our vision of an approach to ensure a sufficiently technically advanced and affordable AR&D technology base is available to support future NASA missions.

- The goal of this strategy is to create an environment exploiting reusable technology elements for an AR&D system design and development process which is:
  - Lower-Risk
  - More Versatile/Scalable
  - Reliable & Crew-Safe
  - More Affordable



A Proposed Strategy for the U.S. to Develop and Maintain a Mainstream Capability Suite ("Warehouse") for Automated/Autonomous Rendezvous and Docking in Low Earth Orbit and Beyond

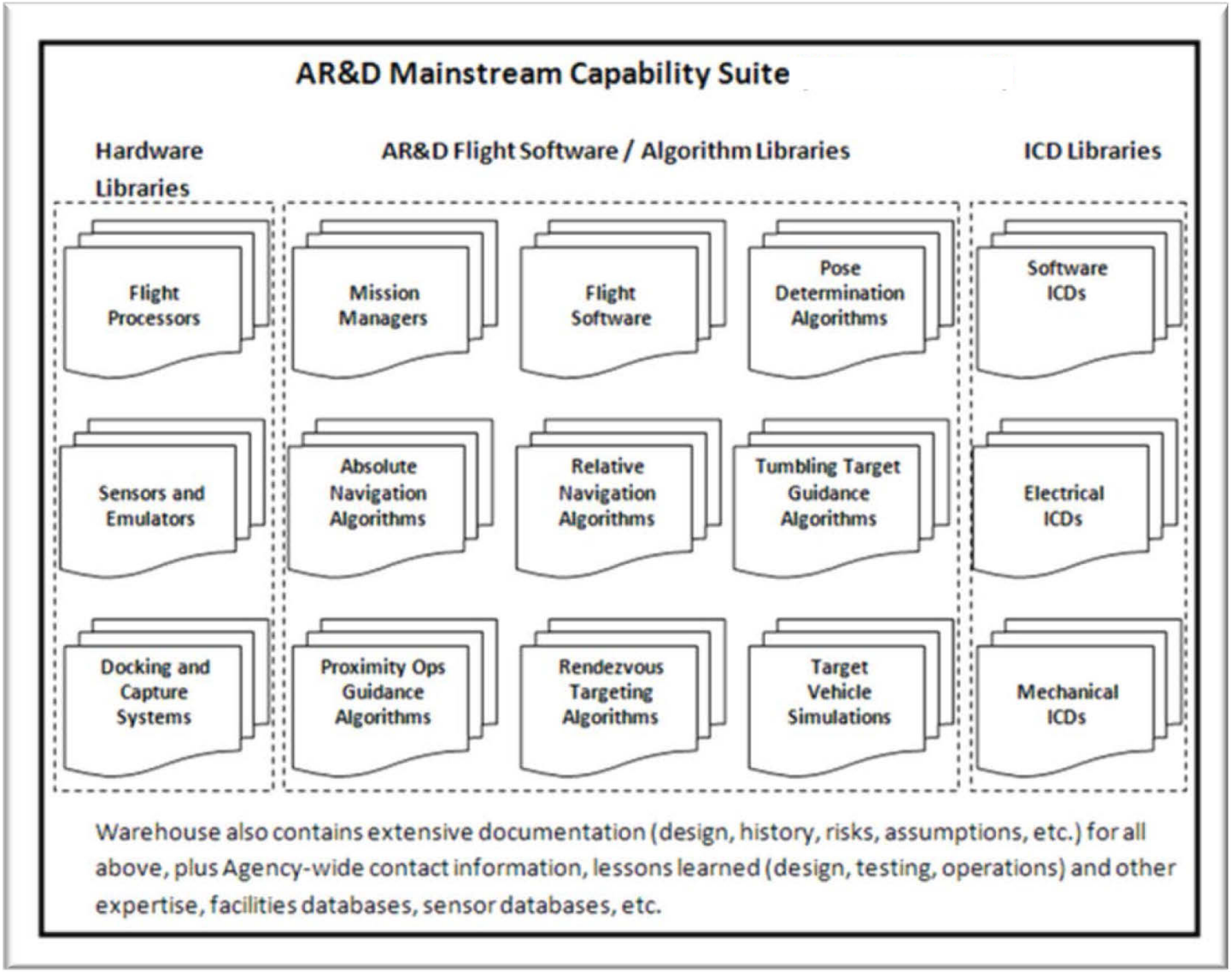
NASA AR&D Community of Practice

December 2011

National Aeronautics and Space Administration

Ames Research Center
Dryden Flight Research Center
Glenn Research Center
Goddard Space Flight Center
Jet Propulsion Laboratory
Johnson Space Center
Kennedy Space Center
Langley Research Center
Marshall Space Flight Center
NASA Engineering and Safety Center
NASA Headquarters, Office of the Chief Engineer

AR&D Mainstream Capability Suite ("Depot" Concept)



Key Tenants of the AR&D CoP's Strategy

- Focuses on development of an AR&D *capability suite,* which primarily involves four specific subsystems that can enable AR&D and its required integration for all these missions.

- The focus is not on the development of a single complete AR&D package capable of being wired into a spacecraft which supports all mission types ("AR&D-in-a-box").

- The four subsystems most impacted by adding an AR&D requirement to a vehicle:
  - Relative navigation sensors and integrated communications
  - Robust AR&D GN&C & real-time FSW
  - Docking/capture mechanisms
  - Mission/system managers for Autonomy/Automation

- The AR&D capability suite would be populated with various solutions for each of these four areas, and all solutions would have standardized interfaces.
  - The recently agreed-to "International Docking System Standard" is an excellent example.

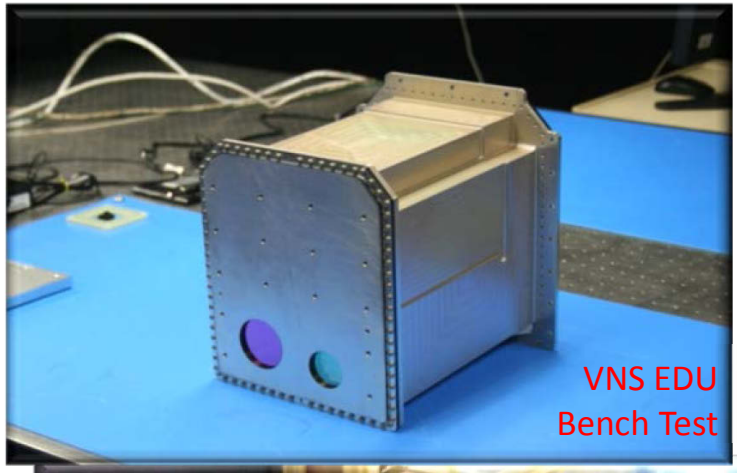
- Each mission would then pick-and-choose which solutions in the AR&D suite are most useful for implementing their design.

AR&D CoP Creates, Vets, and Disseminates Best Practices Products

Products like this "Navigation Filter Best Practices" report were initially created to capture expert knowledge for next generation of NASA GN&C engineers.

However the AR&D CoP has found that sharing products such as this with our NASA industry partners is an effective way to communicate our NASA design and development best practice "expectations"

Vision Navigation System (VNS) EDU for Ground Test/Flight Test



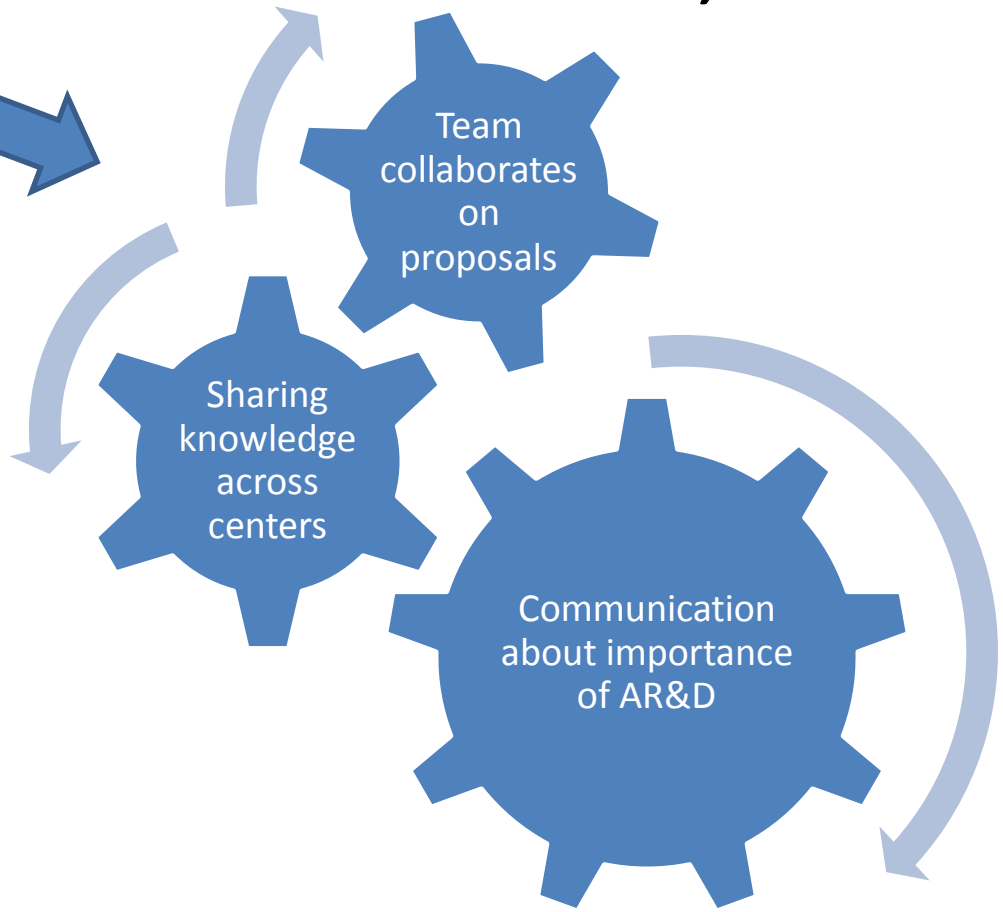
- Vision Navigation System (VNS) is the Relative Navigation Flash LIDAR rendezvous sensor baselined for Orion Multi Purpose Crew Vehicle (MPCV)
- The NASA AR&D Community of Practice led the cross-Agency effort to build, calibrate, and test an existing Orion “on the shelf” VNS EDU hardware at Ball
- A more advanced version of the STORRM VNS unit was flown on STS-134 in April 2011
- Will be a shared asset for the AR&D CoP
- Delivered on October 2011
- First use in GSFC’s Spacecraft Servicing Capabilities Program Argon ground testbed
- Currently searching for on-orbit flight test opportunity for VNS EDU

AR&D CoP Formulated Multi-Program/Project Team Partnership for VNS EDU Effort

Group	Investment
Orion	• Provide existing "on the shelf" VNS EDU components • Allow use of VNS emulator and other GSE
Satellite Servicing Capabilities Program	• Provide integration of VNS onto DPP • Perform system testing (now ground testing) • Provide operations planning/ support
Flagship Technology Development Program	• Provide Civil Servant FTEs for AR&D "science" • Provide Civil Servant travel funding
Ball Aerospace	• Early integration activities • Make components flight-ready
NASA Engineering and Safety Center	• Provide funding to Ball to assemble, test and calibrate VNS EDU H/W and complete embedded flight software

AR&D Community Success: Founded Upon A Common Strategy, Trusting Relationships, Communications, and Sharing

A Common AR&D Strategy



Conclusion

- Engineers are sharing what they know
- Knowledge is captured and stored
- Center barriers are more porous
- Enabling key fields to coalesce