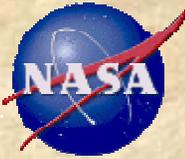


# NASA's Knowledge Management Architecture

Jeanne Holm  
Chief Knowledge Architect  
NASA/Jet Propulsion Laboratory

July 18, 2007



# NASA

*Collaborate*



*Communicate*



*Innovate*



*Motivate*



- ◆ U.S. government space agency is charged with
  - Establish a program to develop a sustained human presence on the Moon, including a robust precursor program to promote exploration, science, commerce and U.S. preeminence in space, and as a stepping stone to future exploration of Mars and other destinations
- ◆ \$17.3B annual budget from Congress
- ◆ 80,000 personnel (18,000 civil servants)
- ◆ Focus is on science, exploration, aeronautics, space operations, and cross-agency support programs

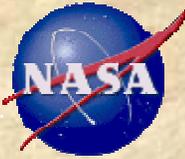


July 18, 2007



NASA KM





### *Collaborate*



### *Communicate*



### *Innovate*

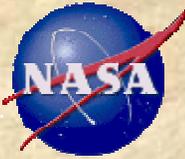


### *Motivate*



# Key Areas for NASA's KM Strategy

- ◆ Sustain knowledge across missions and generations
- ◆ Help people find, organize, and share the knowledge we already have
- ◆ Increase collaboration and to facilitate knowledge creation and sharing



# Framework for KM at NASA

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*Innovate*



*Motivate*



## Sharing and Using Knowledge

People	Process	Technology
<ul style="list-style-type: none"> <li>• Enable remote collaboration</li> <li>• Support communities of practice</li> <li>• Reward and recognize knowledge sharing</li> <li>• Encourage storytelling</li> </ul>	<ul style="list-style-type: none"> <li>• Enhance knowledge capture</li> <li>• Manage information</li> </ul>	<ul style="list-style-type: none"> <li>• Enhance system interoperability</li> <li>• Utilize intelligent agents</li> <li>• Exploit expert systems and semantic technologies</li> </ul>

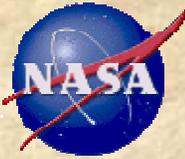
### Supporting Activities

Education and Training

IT Infrastructure

Human Resources

Security



# Making Progress on Knowledge Capture

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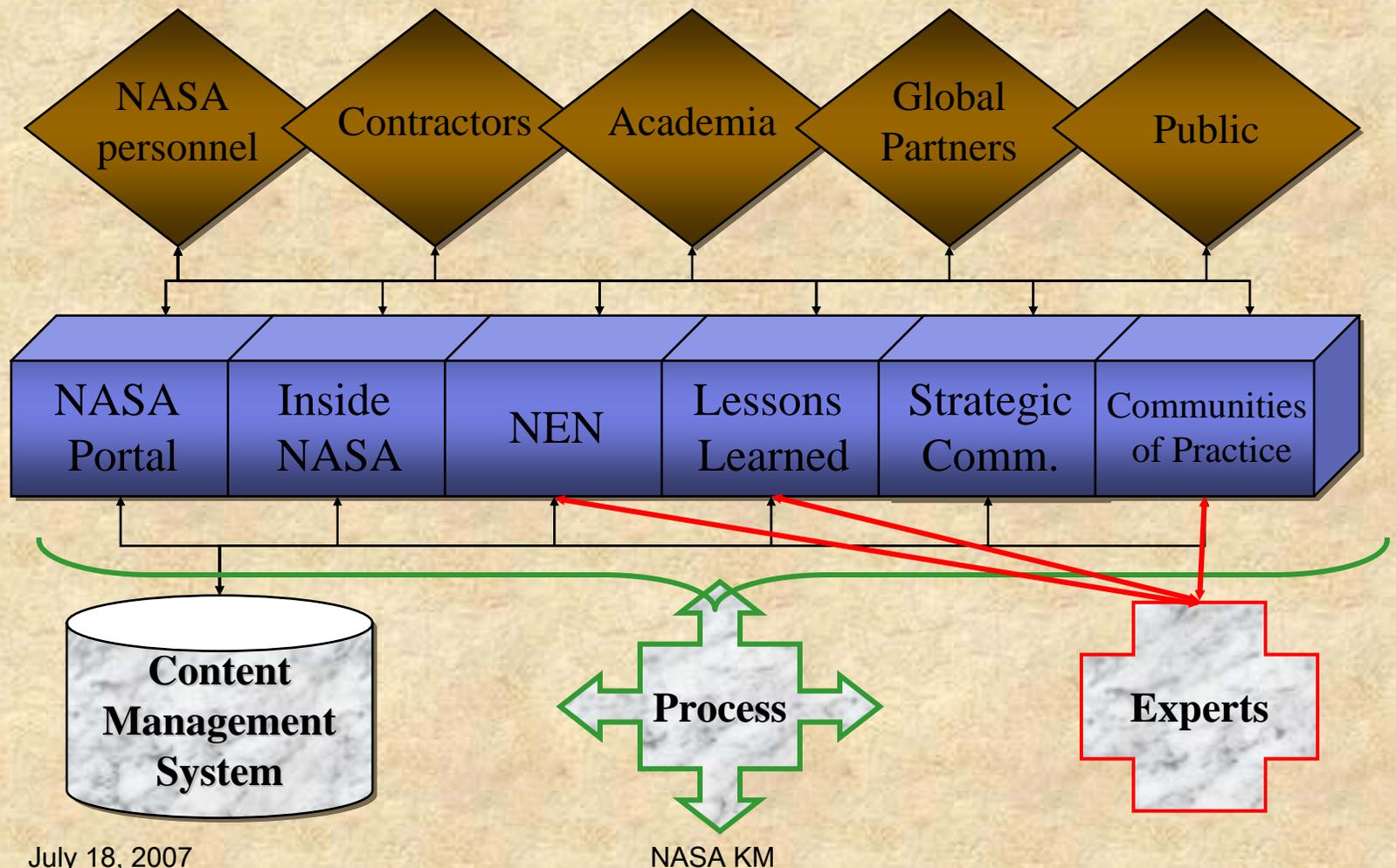
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- ◆ Integrating knowledge management into our engineering and project management lifecycle



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NASA KM

5



# NASA KM Team Accomplishments

## Collaborate

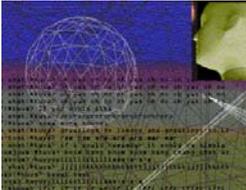


Year	Accomplishments	Recognitions
2000	CIO forms NASA KM Team	
2001	KM Strategic Plan; Portal study Lessons learned prototype	Competia Best Practice in KM
2002	NASA Portal development Collaboration study	APQC Best Practice: Using KM to Drive Innovation
2003	NASA Portal deployed Inside NASA pilot Collaboration pilot	International Champion for KM Two Webby awards for #1 Gov site Fastest Site Response Time in Gov
2004	NASA Portal provides 17.5B items of information Collaborative tools deployed	Form International Working Group for KM for Aerospace Form Knowledge Retention Group for U.S. Gov
2005	Deep Impact event breaks Internet usage records NASA Engineering Network creates communities of practice	eGov best practice NASA Exceptional Service Award
2006	Integration of web architecture Application of KM techniques to manage project risks	APQC best practice: Retaining and transferring knowledge Most Admired Knowledge Enterprise (MAKE) award
2007	Semantic expertise locator piloted Integrated search for engineering knowledge	Top employee satisfaction in KM and learning in Gov

## Communicate

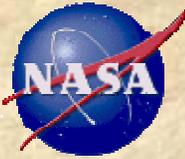


## Innovate



## Motivate





# KM System Milestones

## Collaborate



## Communicate



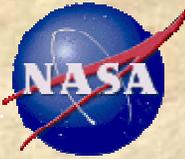
## Innovate



## Motivate



	2003	2004	2005	2006	2007
<b>Cus-tomers</b>	<ul style="list-style-type: none"> <li>• Public</li> <li>• Educators</li> </ul>	<ul style="list-style-type: none"> <li>• NASA personnel</li> </ul>	<ul style="list-style-type: none"> <li>• Engineers</li> <li>• Projects and teams</li> </ul>	<ul style="list-style-type: none"> <li>• Disciplines</li> <li>• Communities of practice</li> </ul>	<ul style="list-style-type: none"> <li>• Engineers and partners</li> </ul>
<b>Stake-holders</b>	<ul style="list-style-type: none"> <li>• CIO</li> <li>• Public Affairs</li> <li>• Education</li> <li>• Training</li> </ul>	<ul style="list-style-type: none"> <li>• CIO</li> <li>• Strategic Comm-unications</li> </ul>	<ul style="list-style-type: none"> <li>• Engineers</li> <li>• Mission directorates</li> </ul>	<ul style="list-style-type: none"> <li>• Employees</li> <li>• Senior management</li> </ul>	<ul style="list-style-type: none"> <li>• Scientists, peer collaboration</li> </ul>
<b>System</b>	<ul style="list-style-type: none"> <li>• NASA Portal</li> <li>• KM for Aerospace (U.N.)</li> </ul>	<ul style="list-style-type: none"> <li>• InsideNASA</li> <li>• Research Web</li> </ul>	<ul style="list-style-type: none"> <li>• NASA Engineering Network</li> <li>• Emergency operations</li> </ul>	<ul style="list-style-type: none"> <li>• Communities</li> </ul>	<ul style="list-style-type: none"> <li>• InsideNASA 2.0</li> <li>• Collab 2.0</li> </ul>
<b>KM Infra-structure (99.95%)</b>	<ul style="list-style-type: none"> <li>• O/S</li> <li>• Applications and storage</li> <li>• Hosting (VeriCenter)</li> </ul>		<ul style="list-style-type: none"> <li>• Caching and streaming (Akamai)</li> <li>• Service desk</li> <li>• Customization support</li> </ul>		
<b>Tools</b>	<ul style="list-style-type: none"> <li>• Digital Asset Management (eTouch), Vignette, Verity, Urchin</li> </ul>	<ul style="list-style-type: none"> <li>• +SunOne, WebEx, eRoom</li> </ul>	<ul style="list-style-type: none"> <li>• +NASA Xerox (NX), Jabber (instant messaging)</li> </ul>	<ul style="list-style-type: none"> <li>• +Semantic web, W3C standards, expertise locator</li> </ul>	<ul style="list-style-type: none"> <li>• +Social networking, Web 2.0, next gen collaboration</li> </ul>



Collaborate



Communicate



Innovate

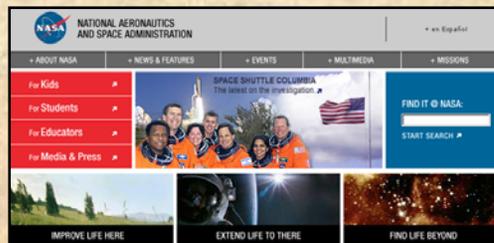


Motivate



# NASA Public Portal

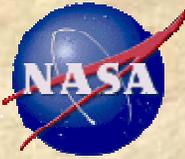
- ◆ Was designed and intended to be a dramatic, interactive interface to NASA by the public, kids, media, educators, and students
  - Create “One NASA” on the web to find content faster and easier
  - Exemplar of the President’s Management Agenda
  - Tie together NASA’s public-facing web resources
  - Inspire the next generation of explorers...as only NASA can
  - Hours after deployment, Space Shuttle Columbia tragedy would occur
- ◆ Landings of the Mars Exploration Rovers on the Red Planet became the largest online event to date
- ◆ Streaming live coverage, dynamic and distributed publishing, and automatic image upload brought fresh images within minutes of the spacecraft sending them to Earth
- ◆ <http://www.nasa.gov>



July 18, 2007

NASA KM





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Communicate



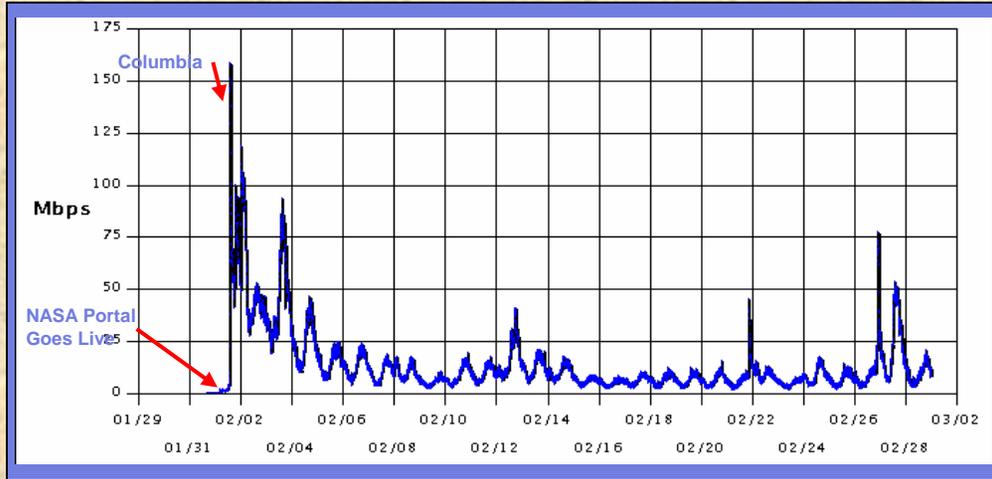
Innovate



Motivate

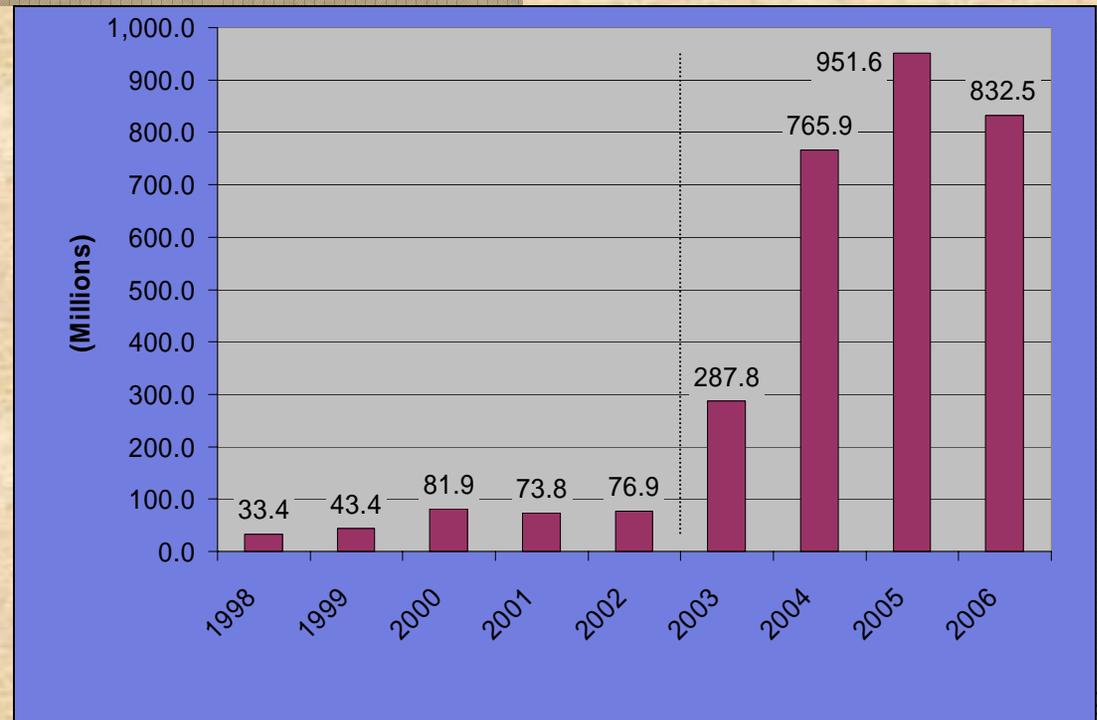


# A Snapshot of Portal Traffic

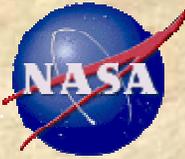


Day one: Loss of Space Shuttle Columbia

[www.nasa.gov](http://www.nasa.gov) Page Views Over Time



July 18, 2007



# Inside NASA

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## Motivate



- ◆ Intended for employees and partners
- ◆ Customizable
- ◆ Access to e-mail
- ◆ Instant messaging
- ◆ Collaborative tools
- ◆ Application integration

The screenshot shows the 'InsideNASA' website interface. At the top, it says 'NASA TV | NASA Employment' and 'Customer Support | Site Help'. Below that, there's a search bar and a navigation menu. The main content area is divided into several sections:

- Home**: Includes 'NASA Image of the Day' with a space image and 'NASA-Wide Announcements' listing events like 'Space Station Crew Landing Moved to Saturday 19-Apr-2007'.
- NASA Management Calendars**: Features a calendar for March 2007 and lists various councils like 'Council Information', '2006 Calendar', and '2007 Calendar'.
- NASA Breaking News**: Lists recent news items such as 'Media Accreditation Deadlines for Next Shuttle Mission' and 'NASA Updates Shuttle Target Launch Dates'.
- Welcome to InsideNASA**: A personal message from the NASA Administrator, Michael Griffin, regarding recent enhancements and new look.
- NASA Administrator's Q & A**: A section for questions and answers, with a recent post from Mike Griffin dated 06-Feb-2007.

At the bottom, there's a footer with the NASA logo, 'National Aeronautics and Space Administration', and contact information for the Inspector General, Equal Employment Opportunities, and other services.





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## Next Step: Creating a Learning Organization

- ◆ Integrated approach to ensuring best practices and key lessons learned are applied on missions
  - NASA Engineering Network
    - Capitalizes on best ways engineers currently work, while solving cultural and process areas that NASA for which has been criticized
    - Builds on shared infrastructure and seamlessly integrates with NASA initiatives, distributed systems, and KM infrastructure
    - Distinguished by integrating lessons and learnings that come out of engineering discussions and repositories into day-to-day engineering processes, policies, and training curriculum
    - Integrates information broadly from academia, industry, contractors, government, and NASA personnel
      - Portals to organize community and individual access to information
      - Collaborative tools expanded for secure access with our partners
      - Expertise and expert directories organized around sharing knowledge person-to-person over virtual social networks
      - Metasearch across distributed repositories
- ◆ <http://nen.nasa.gov>



### Collaborate



### Communicate



### Innovate



### Motivate



## Next Step: Creating a Learning Organization

- ◆ Establishing an integrated approach to ensure best practices and key lessons learned are accessible and applied to the whole mission life-cycle
  - NASA Engineering Network
    - Capitalizes on best ways engineers currently work, while solving cultural and process shortcomings for which NASA has been criticized
    - Builds on shared infrastructure and seamlessly integrates with NASA initiatives, distributed systems, and KM infrastructure
    - Distinguished by integrating lessons and learnings that come out of engineering discussions and repositories into day-to-day engineering processes, policies, and training curricula
    - Broadly integrates information broadly from academia, industry, contractors, government, and NASA personnel
      - Portals to organize community and individual access to information
      - Collaborative tools expanded for secure access with our partners
      - Expertise and expert directories organized around sharing knowledge person-to-person over virtual social networks
      - Metasearch capability across distributed repositories



# Communities for Collaboration

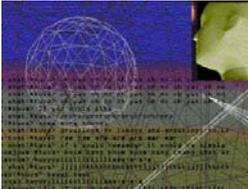
Collaborate



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Speech bubble: Saved searches and subscriptions

Speech bubble: Key lessons are integrated into the community

Speech bubble: Find information

Speech bubble: Discussions and Q&A

Speech bubble: Integration to document management

Speech bubble: Action item tracking

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION **Inside NASA** your portal to the NASA intranet

Welcome to Inside NASA

HOME | BUSINESS | EMPLOYEES | CENTERS | ENGINEERS | NEWS/COMMUNICATION | MANAGERS | LIBRARY | HELP/FEEDBACK

**INDEPENDENT TECHNICAL AUTHORITY (ITA)**

Welcome (ITA)

Welcome to the Portal for the **NASA Independent Technical Authority**. As NASA's Chief Engineer and Independent Technical Authority, I welcome your comments, suggestions, and questions. — *Rex Geveden*

Contact: [rex.geveden@nasa.gov](mailto:rex.geveden@nasa.gov)

Community Administrators: [Keri.Murphy@ipl.nasa.gov](mailto:Keri.Murphy@ipl.nasa.gov), [Greg.Williams@ipl.nasa.gov](mailto:Greg.Williams@ipl.nasa.gov)

**NASA Engineers Network (NEN)**

MY SUBSCRIPTIONS

- + Johnson Space Center
- + Manage Subscription Profiles

SEARCH QUERIES

- + LLSC Thermal Search
- + Thermal Testing
- + Columbia tile problem
- + Knowledge management

SUBMIT MY LESSONS

I want to submit my Lesson Learned

- + Submit
- + Learn More

Significant Events (ITA)

- Week of January 7, 2005
- Week of December 31, 2004
- Week of December 14, 2004
- Week of December 7, 2004

Meeting Minutes (ITA)

- January 7, 2005
- December 31, 2004 (Meeting cancelled)
- December 24, 2004
- December 17, 2004
- Meeting Minutes Archive

Engineering Quick Links

- Office of the Chief Engineer

Discussion Boards (ITA)

Forum (1-2 of 2)	Msgs	Last Post
<a href="#">Risk Management and ITA's Role</a>	2	1/5/2005 6:51 PM
<a href="#">Incorporating NESC Independent Assessments</a>	3	1/5/2005 6:49 PM

All Forums | Manage Forums

Employee Locator (X.500)

Enter a first and last name and select a NASA center. (Last name)

Last Name:

NASA Center:

Search

Key Documents (ITA) [HX Knowledge Network]

Independent Technical Authority

Location: Home > NASA Engineering Network > Independent Technical Authority Listing

Type	Title	Owner	Edited	Size
<input type="checkbox"/>	Presentations from ITA Workshop 2005-01-11 to 2005-01-13	kmurphy	01/05/05	1
<input type="checkbox"/>	Draft Strategic Plan	kmurphy	01/05/05	21K
<input type="checkbox"/>	Minutes and Notes from ITA Workshop	kmurphy	01/05/05	19K

Action Item Tracking (ITA)

2. Action Items

Location: Home > ESR&T > ASTP > 2. Action Items Listing

Type	Title	Owner	Edited	Size
<input type="checkbox"/>	AST Action Item Discussion Template	tallard	08/06/04	7K
<input type="checkbox"/>	AST Action Item Tracking Advanced Systems Technology Program Action Item Tracking	tallard	08/06/04	20K
<input type="checkbox"/>	AST Action Item Tracking Archive	tallard	08/06/04	20K

Search Engineers Knowledge Network

Enter Search Term:  + GO

Advanced Search + GO

Sort by:  Relevance

Display:  10

Datasources:  All

NOTE: Simple and Advanced Searches will deliver comprehensive results from both the Engineers Knowledge Network and the Communities of Practice Discussion Board forums threaded discussions.

Engineering Standards

- NASA Technical Standards Program
- Tech Standards Committees & Working Groups
- NASA Electronic Parts & Packaging Program (NEPP)
- Materials & Processes Technical Info System-II (MAPTIS)
- Capability Maturity Model@Integration (CMMI)
- NASA Spaceflight Hardware Workmanship Standards
- GSFC Standards Coordination
- Space Shuttle Process Control Standards
- NASA Science Office of Standards & Technology

Calendar (ITA)

Dec-Jan 2005

Su	Mo	Tu	We	Th	Fr	Sa
26	27	28	29	30	31	
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28

Click calendar dates for event details.

Upcoming Events:

- ITA Workshop, January 11-14, 2005

E-mail Lists (ITA)

- ITA Leadership Team
- ITA Discipline Experts
- ITA Support Staff

Opinion Poll (ITA)

"Is Tuesday, 9:00 a.m. a good time for the group's weekly teleconference?"

Yes

No

Submit

Previous Polls | Suggest a Poll | View Suggestions

NASA Engineering Safety Center (NESC)

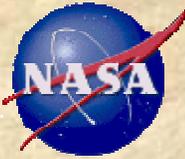
NESC's objective is to improve safety by performing in-depth independent engineering assessments, testing, and analysis to uncover technical vulnerabilities and to determine appropriate preventative and corrective actions for problems, trends or issues within NASA's programs, projects and institutions.

+ Frequently Asked Questions

General questions and requests for NESC technical reviews: [NESC@nasa.gov](mailto:NESC@nasa.gov)

Mail an anonymous technical request to:

NESC  
NASA Langley Research Center  
Mail Stop 418



# Web 2.0 Technologies

Collaborate



Communicate



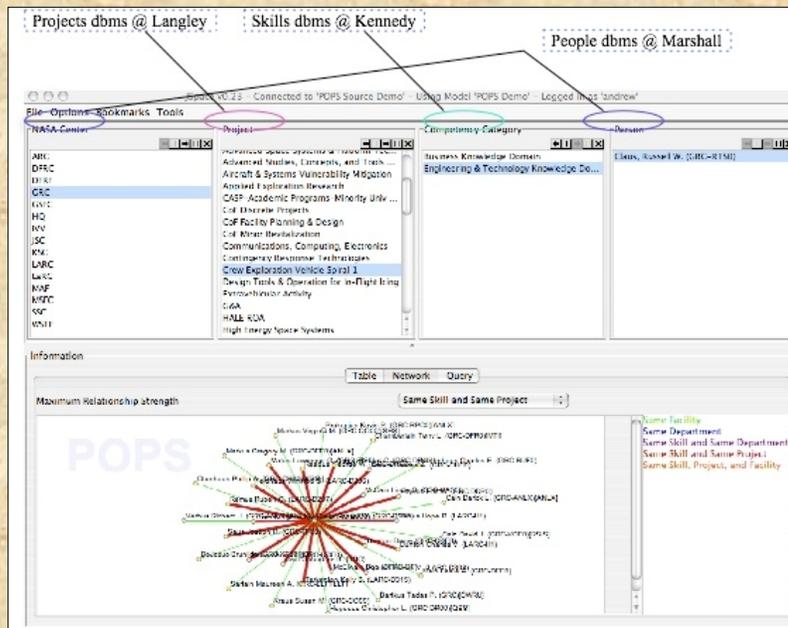
Innovate



Motivate



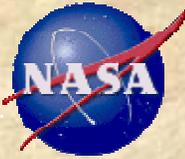
- ◆ POPS--Expertise location based on location, publications, projects, organization, and skills
  - Integrates social networks to show the searcher's relationship to the people found (U of Maryland)
  - Utilizing J-space and M-space, open source standards
  - Social network analysis and mathematical trust modeling
- ◆ And of course, wikis, blogs, and instant messaging



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NASA KM

15



Collaborate



Communicate



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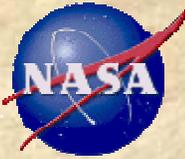


Motivate



## Web 2.0 Technologies (*continued*)

- ◆ Semantic SEEK--Searching engineering expertise and knowledge (MIT, Sir Tim Berners-Lee)
  - Semantic query, ontologies, and open source standards for dynamic integration of distributed content and *context*
  - Focusing on lunar mission data from international partners
  - RDF, OWL, SPARQL, SWOOP
- ◆ Explorer Island--Second Life immersive avatar-driven environment for collaboration and education



# Integrating Knowledge and Missions

Collaborate



Communicate



Innovate

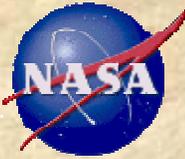


Motivate



- ◆ Integrated approach to ensuring best practices and key lessons learned are applied on missions
  - **Design:** *Principles for Flight Systems* capture key lessons learned over our history and are a required guide for managers in how to run a project; developing a learning system based on these principles for project manager certification
  - **Development:** Systems like the Technical Questions Database prompt key questions to be answered at each review to create a **virtual presence** of our experts at key reviews
    - Best questions asked at technical reviews
    - Helps to create a virtual presence when key people cannot be there
    - Over 700 questions in 42 subject areas from subject matter experts

The screenshot shows the JPL Technical Questions Database website. It features a navigation bar with 'ADMIN', 'HOW TO USE', and 'FEEDBACK' links. The main content area is divided into four sections: 'HOT QUESTIONS', 'BROWSE', 'SEARCH', and 'INPUT'. Each section has a brief description of its function. Below the main content, there are links to 'Detailed Description', 'How to Use', 'Creating Questions and TDAs', 'Related Resources', and 'About this Site'. The 'About this Site' link is highlighted.



### Collaborate



### Communicate



### Innovate



### Motivate



# NASA Engineering and Safety Center

- ◆ NESC performs independent testing, analysis, and assessments of NASA's high-risk projects to ensure safety and mission success
- ◆ NESC engages proactively to help NASA avoid future problems through
  - Independent technical assessments
  - Technical inspections, support, and advocacy
  - NESC review board and awards
  - Knowledge capture and communication
  - Mishap investigation and dissenting opinions
- ◆ Capturing, sharing, and preserving the lifetime experience and knowledge of NASA senior scientists and engineers to guide the next generation
- ◆ <http://www.nescacademy.org>





# APPEL Helps NASA Learn

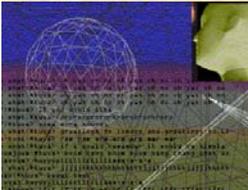
Collaborate



Communicate



Innovate

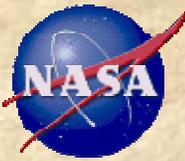


Motivate



- ◆ The Academy of Program/Project and Engineering Leadership provides leadership, advice, direction, and support for the development and learning of the NASA program/project management and engineering community

Goal	Diagnostic	Tailored Enhancements
1. <b>Teamwork</b> in a high-performance context	Team Performance Assessments	Tailored Workshops Expert Practitioners Coaching and Mentoring
2. Effective <b>Leadership</b> across the team	Individual Performance Assessments	Training Curriculum Standards and Policies Coaching and Mentoring
3. Effective Project <b>Process Utilization</b>	Process Utilization Assessments	Training Curriculum Process Tools
4. Necessary and Sufficient <b>Knowledge</b>	Knowledge Assessment and Knowledge Tools	Knowledge Forums Universities Documented Lessons Retirees



# Lessons Learning

Collaborate



Communicate



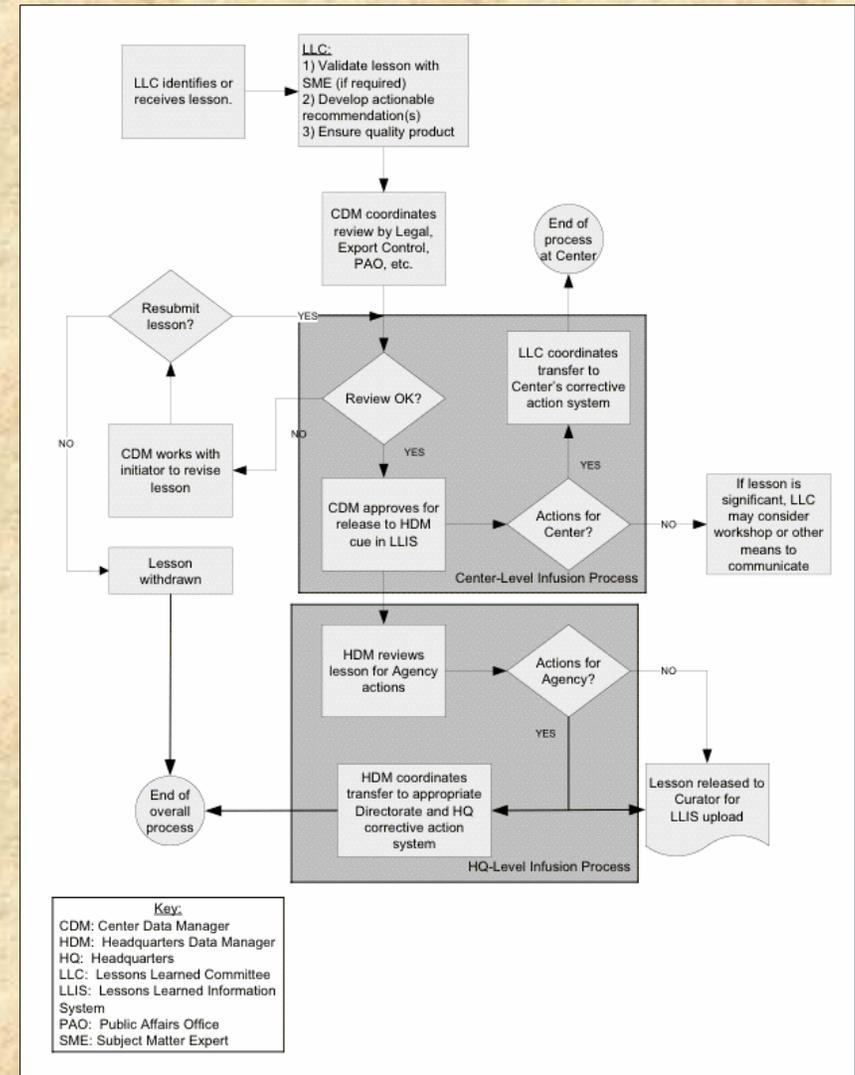
Innovate



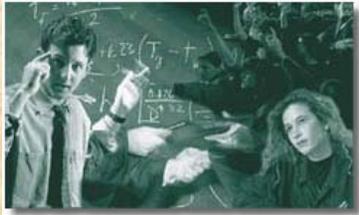
Motivate



- ◆ Integrated with the NASA Engineering Network
- ◆ Integrate lessons to policy, standards, and procedures
- ◆ Embed a “how to” capture process
  - Review lessons at major milestones, technical reviews, and other decision points
  - Determine lessons relevancy to project
  - Assess project compliance with LL recommendations



# Knowledge Management Roadmap



## Sharing Knowledge

- Adaptive knowledge infrastructure is in place
- Knowledge resources identified and shared appropriately
- Timely knowledge gets to the right person to make decisions
- Intelligent tools for authoring through archiving
- Cohesive knowledge development between NASA, its partners, and customers

## Enables sharing of essential knowledge to complete Agency tasks



- MarsNet
- Mars Exploration Rovers
- Space Interferometry Mission



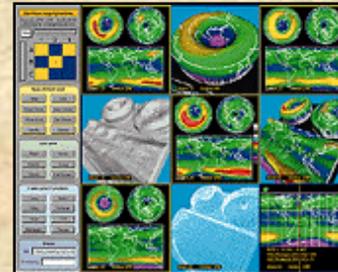
## Integrating Distributed Knowledge

- Instrument design is semi-automatic based on knowledge repositories
- Mission software auto-instantiates based on unique mission parameters
- KM principals are part of NASA culture and supported by layered COTS products
- Remote data management allows spacecraft to self-command

## Enables seamless integration of systems throughout the world and with robotic spacecraft



- Europa Lander/Submersible
- Titan Organics: Lander/Aerobot
- Neptune Orbiter/Triton Observer



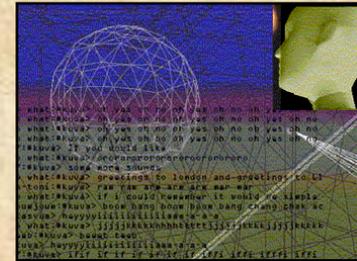
## Capturing Knowledge

- Knowledge gathered anywhere from hand-held devices using standard formats on interplanetary Internet
- Expert systems on spacecraft analyze and upload data
- Autonomous agents operate across existing sensor and telemetry products
- Industry and academia supply spacecraft parts based on collaborative designs derived from NASA's knowledge system

## Enables capture of knowledge at the point of origin, human or robotic, without invasive technology



- Mars robotic outposts
- Comet Nucleus Sample Return
- Saturn Ring Observer
- Terrestrial Planet Finder



## Modeling Expert Knowledge

- Systems model experts' patterns and behaviors to gather knowledge implicitly
- Seamless knowledge exchange with robotic explorers
- Planetary explorers contribute to their successor's design from experience and synthesis
- Knowledge systems collaborate with experts for new research

## Enables real-time capture of tacit knowledge from experts on Earth and in permanent outposts



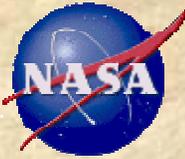
- Interstellar missions
- Permanent lunar and Martian colonies

2003

2007

2010

2025



# Thanks!

## Collaborate



## Communicate



## Innovate



## Motivate



- ◆ Many thanks to my colleagues and our partners who contributed to these ideas and to the excellent work they are doing in implementing knowledge management solutions at NASA

- ◆ If you have any additional questions, please contact me

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- ◆ More information can be found about
  - NASA's KM program: <http://km.nasa.gov>
  - NASA's portal: <http://www.nasa.gov>

