



A screenshot of the NASA website homepage. The top left features the NASA logo and the text "NATIONAL AERONAUTICS AND SPACE ADMINISTRATION". To the right, there is a link for "+ en Español". Below this is a navigation bar with links for "+ ABOUT NASA", "+ NEWS & FEATURES", "+ EVENTS", "+ MULTIMEDIA", and "+ MISSIONS". The main content area includes a red sidebar with links for "For Kids", "For Students", "For Educators", and "For Media & Press". The central banner features a photo of the Space Shuttle Columbia crew with the text "SPACE SHUTTLE COLUMBIA" and "The latest on the investigation." To the right is a search bar with the text "FIND IT @ NASA:" and "START SEARCH". Below the banner are three smaller images with captions: "IMPROVE LIFE HERE", "EXTEND LIFE TO THERE", and "FIND LIFE BEYOND".

Effective Techniques for Capturing, Creating, and Management Knowledge at NASA

Jeanne Holm
Chief Knowledge Architect
NASA Knowledge Management Team
Jet Propulsion Laboratory, California Institute of Technology

7 November 2005



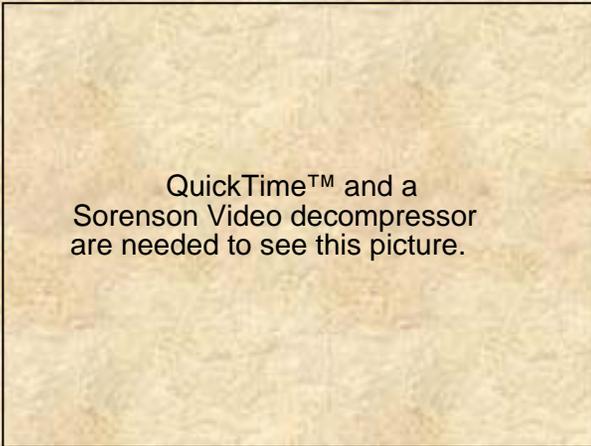
Creating an Opportunity

Collaborate



- ◆ *Knowledge management activities provide the chance to look across an organization, regardless of boundaries, and find opportunities to make a difference...*

Communicate



Innovate



NASA's Knowledge Management goal

Motivate



Knowledge management is getting the right information to the right people at the right time, and helping people create knowledge and share *and act upon information in ways that will measurably improve the performance of an organization and its partners*



Why Is KM Critical to NASA?

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Motivate



- ◆ We are constantly challenged to document and integrate our lessons to effectively manage the risk involved in space exploration and human space flight
- ◆ By its nature, NASA's employees have specialized knowledge
- ◆ The workforce in the Agency is aging
- ◆ Our goal is to share knowledge with each other and with the public
- ◆ To ensure safe flight, we must respond to the issues raised by the Columbia Accident Investigation Board
- ◆ *The Administration will adopt information technology systems to capture some of the knowledge and skills of retiring employees. Knowledge management systems are just one part of an effective strategy that will help generate, capture, and disseminate knowledge and information that is relevant to the organization's mission.*



President's Management Agenda



KM Critical Success Factors

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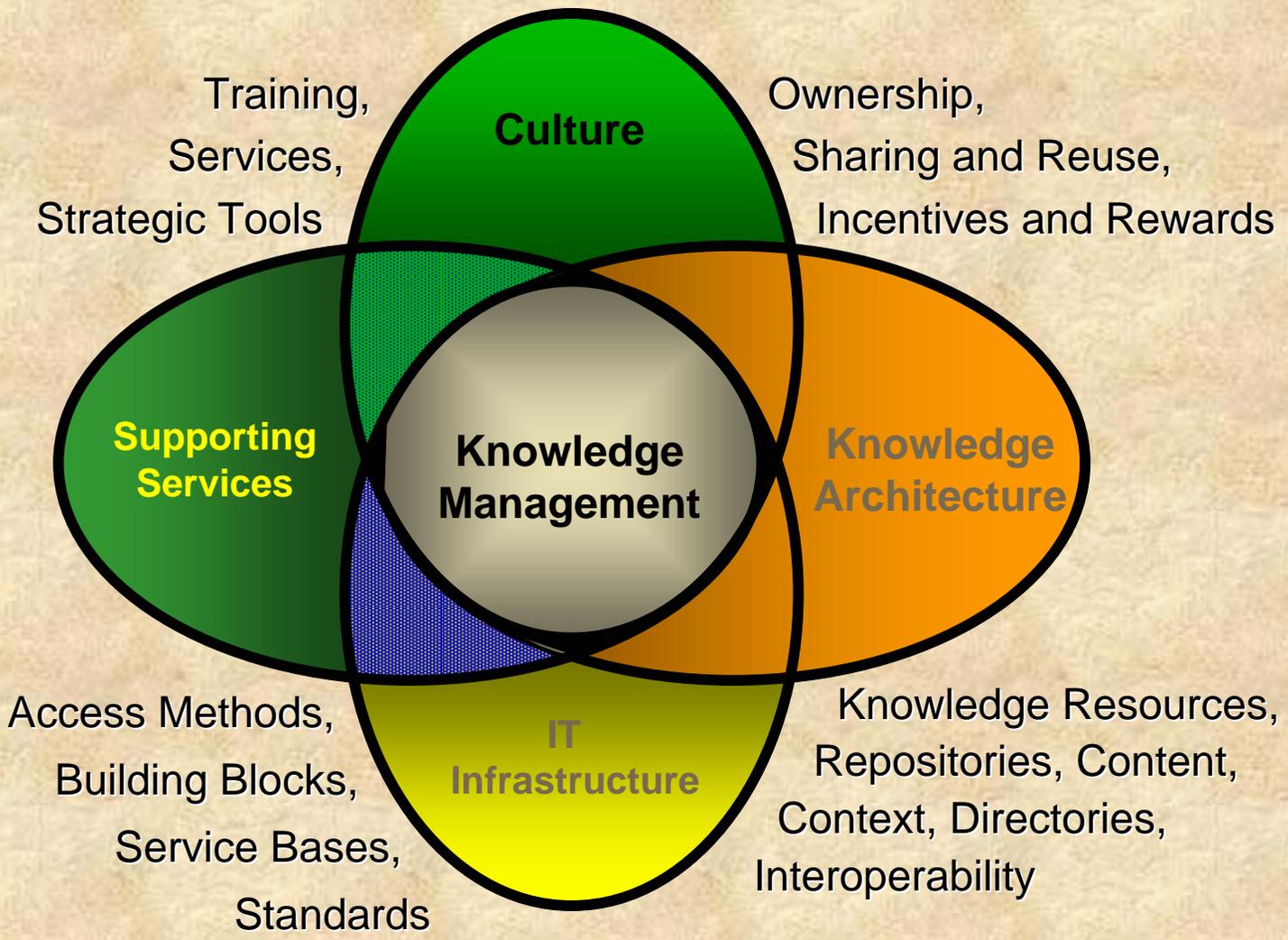
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Building a KM Team

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- ◆ We find good solutions, fill the gaps, and build a federation of resources to support our missions and research communities
 - Supports and enables other initiatives by advocating best practices, promoting good solutions, and building infrastructure and applications to bridge distributed systems
 - Infuse new ideas or needed technology
- ◆ NASA's Knowledge Management Team is chartered by
 - Chief Information Officer (putting the rules into the tools)
 - Co-sponsored by the Chief Engineer and close partnerships with Human Resources
 - To ensure the tools support the engineering processes and to affect cultural change through recognition and education
- ◆ Team members are from across the Agency, ranging from system architects to authors to anthropologists
- ◆ Actively share and benchmark with other Agencies, the National laboratory community, and academia



Key Areas for NASA's KM Strategy

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Sustain NASA's knowledge across missions and generations

Identify and capture the information that exists across the Agency



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Help people find, organize, and share the knowledge we already have

Efficiently manage NASA's knowledge resources

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◆ Increase collaboration and to facilitate knowledge creation and sharing

- Develop techniques and tools to enable teams and communities to collaborate across the barriers of time and space



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Framework for KM at NASA

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Sharing and Using Knowledge

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

Supporting Activities

Education and Training	IT Infrastructure	Human Resources	Security
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KM Team Activities

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	2000	2001	2002	2003	2004	2005
	<ul style="list-style-type: none"> • CIO forms Team • Focus groups and interviews • Benchmarking 	<ul style="list-style-type: none"> • Strategic Plan • Portal study • Lessons learned prototype 	<ul style="list-style-type: none"> • NASA Portal development • Collaboration study 	<ul style="list-style-type: none"> • NASA Portal deployed • Inside NASA pilot • Collaboration pilot 	<ul style="list-style-type: none"> • NASA Portal provides 17.5B pieces of information • Collaborative tools deployed 	<ul style="list-style-type: none"> • Deep Impact event breaks Internet records: 50 Mbps • NASA Engineering Network creates Agency-wide communities of practice
		<ul style="list-style-type: none"> • Competia Best Practice in KM 	<ul style="list-style-type: none"> • APQC Best Practice for Using KM to Drive Innovation 	<ul style="list-style-type: none"> • International Champion for KM • Two Webby awards for best Government site • Fastest Site Response Time in Government • #2 Customer Satisfaction in Government Sites 	<ul style="list-style-type: none"> • Chair International Working Group for Aerospace • Chair, Knowledge Retention and Human Capital for US Government 	<ul style="list-style-type: none"> • eGov best practice • NASA Exceptional Service Award



KM Systems

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	2003	2004	2005
Customers	<ul style="list-style-type: none"> •Public 	<ul style="list-style-type: none"> •NASA personnel •Peers 	<ul style="list-style-type: none"> •Engineers •Projects and teams
Stakeholders	<ul style="list-style-type: none"> •CIO •Public Affairs •Education •Training 	<ul style="list-style-type: none"> •CIO 	<ul style="list-style-type: none"> •Engineers •Mission Directorates
System	<ul style="list-style-type: none"> •NASA Portal 	<ul style="list-style-type: none"> •Inside NASA •Research Web 	<ul style="list-style-type: none"> •NASA Engineering Network (Communities) •Collaboration
KM Infrastructure (99.995% up time)	<ul style="list-style-type: none"> •O/S •Applications •Hosting (VeriCenter) •Storage 		<ul style="list-style-type: none"> •Caching (Speedera) •Streaming •Service desk •Customization support
Tools	<ul style="list-style-type: none"> •Digital Asset Management (eTouch), Vignette, Verity, Urchin 	<ul style="list-style-type: none"> •+SunOne, WebEx, eRoom 	<ul style="list-style-type: none"> •+NASA Xerox (NX)



Making Progress on Knowledge Sharing

Collaborate



- ◆ Providing **training and mentoring**
 - Academy of Program and Project Leadership hosts targeted training, just-in-time learning, and a community for managers
 - <http://appl.nasa.gov>

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- ◆ Encouraging **storytelling**
 - Knowledge Sharing Initiative (storytelling) provides forums for people to share stories and publishes the best of those
 - http://appl.nasa.gov/knowledge/knowledge_home.htm

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- ◆ **Recognizing people** for sharing knowledge
 - Changing our incentives to encourage knowledge sharing
- ◆ Enhancing our ability to **capture** knowledge and **expertise**
 - Rearchitecting **our learning** system to integrate key engineering expertise, information, experts, and lessons throughout the Agency and with our partners to encourage sharing of successes and failures
 - <http://llis.nasa.gov>

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- ◆ **Collaborative environments** for missions
 - Creating access to tools and training for virtual teams
 - Utilizing real-time sharing through WebEx, shared workspaces through NX and instant messaging through Jabber



The NASA Public Portal

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- ◆ 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 NASA 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
- ◆ We selected the following partners to help us create the NASA portal
 - eTouch Systems Corporation as the prime technologists for content management and implementation
 - Critical Mass as the designers and AT&T and Sprint for hosting



When Disaster Strikes...

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- ◆ Our known challenges included
 - An evolving architecture, with a 4-week deadline for deployment
 - Deploying a portal that provided
 - Quick and easy navigation for our many audiences
 - A simple-to-use, highly capable content management solution
 - Interactive design and flash modules
 - Content migration from top NASA sites
 - Industrial strength hosting solution to handle ~140,000 hits per day

- ◆ Our unknown challenge
 - Hours after deployment, the Space Shuttle Columbia tragedy would occur
 - We needed to redesign the Portal immediately and support outreach to the public on what had happened to the crew and shuttle



When Success is Out of This World!

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- ◆ 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
- ◆ Expanded content brings information to NASA's six key audiences
- ◆ Rich, interactive media at the home page helps people see NASA's message and understand our discoveries

NASA NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

+ Text Only Site
+ Non-Flash Version
+ en Español
+ Contact NASA

FIND IT @ NASA : GO

+ Advanced Search

+ ABOUT NASA + NEWS & EVENTS + MULTIMEDIA + MISSIONS + MY NASA + WORK FOR NASA

+ For Kids
+ For Students
+ For Educators
+ For Media & Press
+ For Researchers
+ For Industry
+ For Employees

SPIRIT AND ONE YEAR ON MARS OPPORTUNITY

+ LIFE ON EARTH + HUMANS IN SPACE + EXPLORING THE UNIVERSE

<p>01.13.05 Tsunami: Before and After + Read More + Space Station Photos + Satellite Reveals New Details</p>	<p>01.12.05 A 'Moving Van' for Space + Read More</p>	<p>01.13.05 Huggens At Titan Friday + Read More + More Cassini Images</p>
<p>01.11.05 Satellite Follows Heavy California Rains + Read More + View Animation</p>	<p>01.11.05 Return to Flight Elements in Place + Read More + From Sea to Space</p>	<p>01.13.05 One Year Later: Vision Coming Into Focus + Read More + Flash Feature</p>
<p>01.10.05 No Bones About It: NASA Looks at T. Rex Skull + Read More</p>	<p>01.07.05 STS-114 Crew Checks Out Hardware + View Video</p>	<p>01.12.05 Deep Impact Lifts Off for Comet Encounter + View Site</p>



A Snapshot of 2004 Portal Traffic

Collaborate



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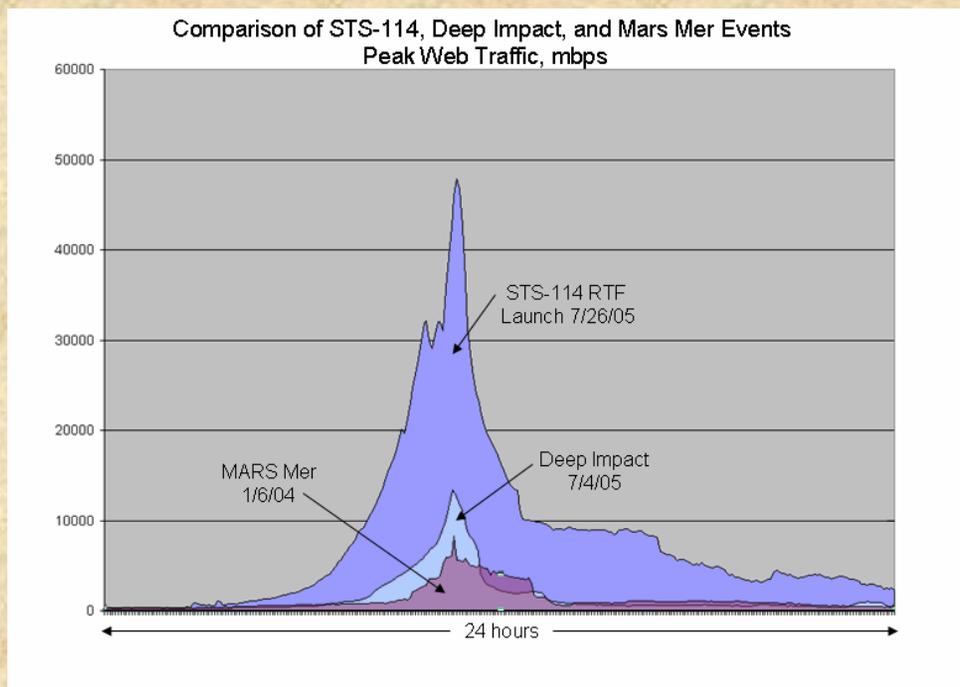
Innovate



Motivate



- ◆ Web site hits in 2004: 17.5 *billion* (already at 16B for 2005)
- ◆ Page views: 1.75 *billion*
- ◆ Visitors: 140 million
- ◆ Total information transferred: 300 terabytes
- ◆ Large spikes of traffic
 - Traffic in first 5 days of the Portal equaled the traffic for the previous six months
 - Mars Rover interest in 10 days in 2004 exceeded entire previous year
 - Deep Impact interest in 2005 set new records: >7 times 2004 event interest





Next Step: Creating a Learning Organization

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- ◆ 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



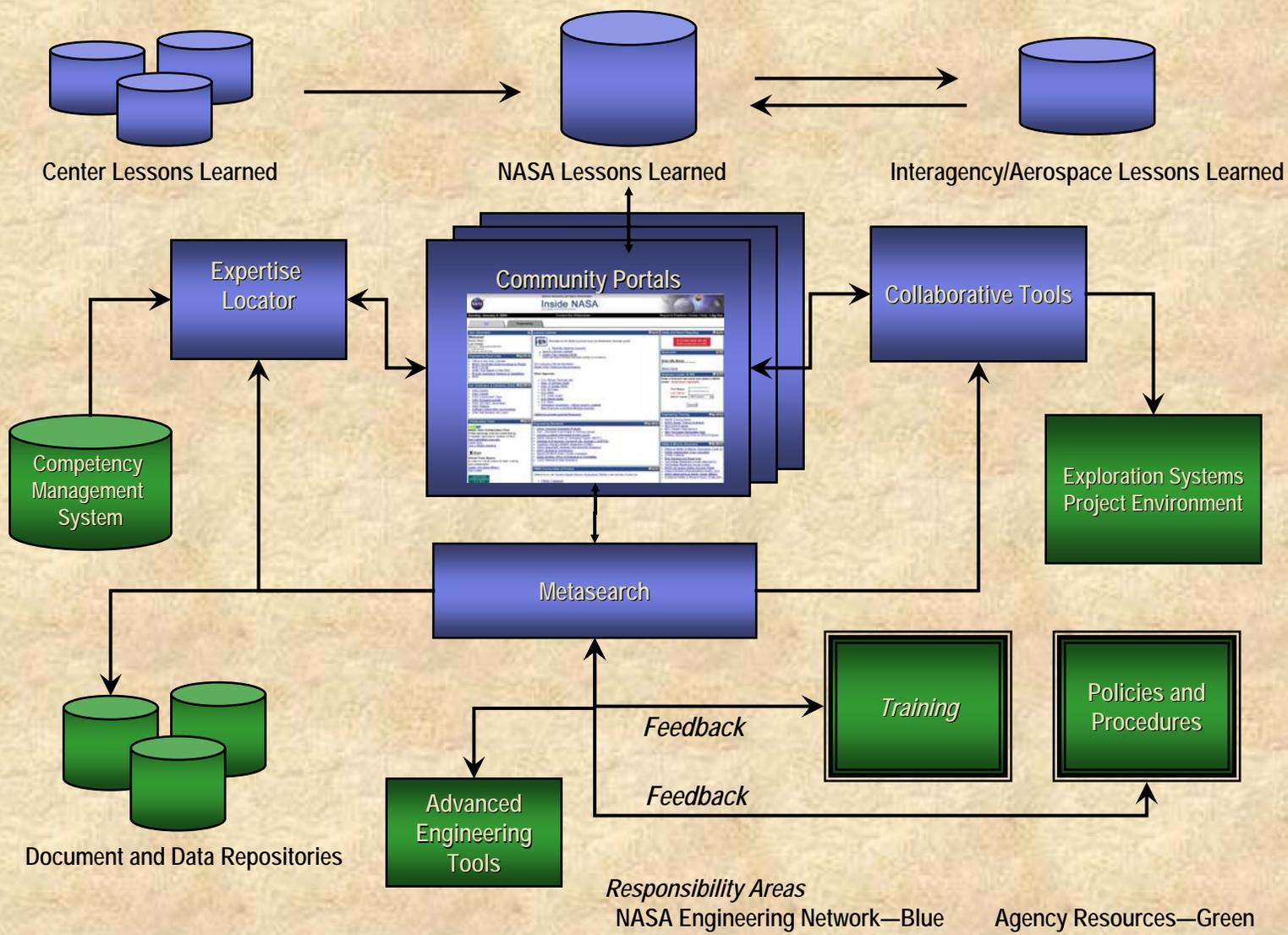
Learning Process Occurs Behind All Components: Embed learnings into tools and communities

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Accessing and Gathering Lessons Learned

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Built on same infrastructure as NASA's public Portal

The screenshot shows the NASA Lessons Learned Knowledge Network (LLKN) website. At the top left is the NASA logo and the text "LESSONS LEARNED KNOWLEDGE NETWORK". To the right is a search bar with "FIND IT @ LLKN" and a "+ ADVANCED SEARCH" link. Below the header are navigation tabs: "+ ABOUT LLKN", "+ MY LLKN", "+ COMMUNITIES", and "+ EXPERT LOCATIONS".

On the left side, there is a "Find Lesson Learned By" section with a list of filters: "+ NASA CENTERS", "+ NASA ENTERPRISE", "+ CROSS CUTTING PROCESSES", "+ TOPICS", "+ BY YEAR", and "+ BY COLLECTION".

The main content area features a large banner image of a control room with the text "APPLYING PAST KNOWLEDGE FOR CURRENT AND FUTURE MISSION SUCCESS" and "LESSONS LEARNED KNOWLEDGE NETWORK". To the right of the banner is a "SATURN" observation campaign link.

Below the banner is a welcome message: "Welcome to the new Lessons Learned Knowledge Network. This online knowledge management system brings you NASA's official lessons learned as well as a variety of online knowledge management tools for discovering NASA's vast engineering resources."

There is a "LATEST LESSONS LEARNED" section with two entries:

- 03/11/2004 - ATCS , PVATCS , 12-Aug-01 - 14KB**
ISS Problem Report: 1 Page of Prepared on 12- APR- 2004 3538 Level: 2 PR Status: 0 ECD: Closure Signatures 0 / 4 Concurrences 0 / 2 PPD: 3 Manufacturer's Name: Manufacturer's Cage Code: Waiver/...
[+ Read More](#)
Creator: Marisela Crowe
NASA Organization: ISS-MER
Collection: PRACA
- 03/11/2004 - ECLSS , RUSSIAN SEGMENT , 15-Oct-03 - 13KB**
8,041,000 Nonconforming Part Number: TBD Part Serial/ Lot Number: ECLSS - ENVIRONMENTAL CONTROL AND LIFE SUPPORT RUSSIAN SEGMENT - RUSSIAN SEGMENT ISS Subsystem Name: SM - Service Module (SM)...
[+ Read More](#)
Creator: Marisela Crowe
NASA Organization: ISS-MER
Collection: PRACA

At the bottom, another entry is partially visible: "03/11/2004 - ATCS , IATCS , 25-Feb-04 - 20KB".

On the right side, there is a "LOG IN TO MY LLKN" section with "Username:" and "Password:" fields, a "+ SIGN IN" button, and a "WHY REGISTER?" section with "Take a tour" link, "Site Map", and "Privacy Policy" links.

Lessons are solicited from academia, industry, and global partners



Communities for Collaboration

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Speech bubble: Saved searches and subscriptions

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 Login | Register

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*

[+ Read Biography](#)

Contact: rex.geveden@nasa.gov

Community Administrators:
Keri.Murphy@nasa.gov
Greg.Williams@nasa.gov

Discussion Boards (ITA)

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

All Forums | Manage Forums

Employee Locator (X.500)

Enter a first and last name

First Name:

Last Name:

NASA Center:

NASA Engineers Network (NEN)

MY SUBSCRIPTIONS

+ Johnson Space Center

+ Manage Subscription Profiles

SEARCH QUERIES

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

[more >>>](#)

SUBMIT MY LESSONS

I want to submit my Lesson Learned.

+ Submit
 + Learn More

Key Documents (ITA) [NX Knowledge Network]

Search: In This Collection

Independent Technical Authority

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

Select All | Clear | Edit Selected... | Go

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

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](#)

NASA Engineers Network (NEN)

MY SUBSCRIPTIONS

+ Johnson Space Center

+ Manage Subscription Profiles

SEARCH QUERIES

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

[more >>>](#)

SUBMIT MY LESSONS

I want to submit my Lesson Learned.

+ Submit
 + Learn More

Action Item Tracking (ITA)

2. Action Items

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

Select All | Clear | Edit Selected... | Go

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

E-mail Lists (ITA)

- [ITA Leader's Info 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
 No Comment

[Previous Polls](#) | [I suggest a Poll](#) | [View Suggestions](#)

Significant Events (ITA)

- [Week of January 7, 2005](#)
- [Week of December 31, 2004](#)
- [Week of December 24, 2004](#)
- [Week of December 17, 2004](#)
- [Significant Events Archive](#)

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](#)

Search Engineers Knowledge Network

Enter Search Term:

Sort by:

Display:

Datasource:

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](#)
- [CSFC Standards Coordination](#)
- [Space Shuttle Process Control Standards](#)
- [NASA Science Office of Standards & Technology](#)

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

Mail an **anonymous technical request** to:

NESC
 NASA Langley Research Center
 Mail Stop 118



Looking Ahead

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- ◆ We are working on a variety of new initiatives that are still being formulated, including
 - Agency-wide knowledge architecture
 - Update structured approach to integrating distributed content systems
 - Accelerating learning
 - Integrated approach to e-learning and support to the project managers
 - NASA Engineering Network
 - 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
 - Semantic web technologies for enhanced search and expertise location
 - Managing knowledge for aerospace and government
 - International Astronautics and Aeronautics (IAA) Working Group on KM for Aerospace
 - Federal KM Working Group--Knowledge and Human Capital Retention

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

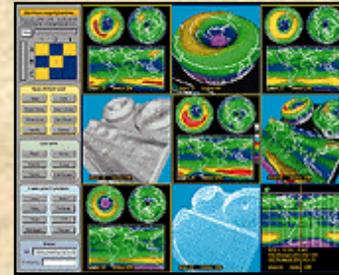


Integrating Distributed Knowledge

- 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

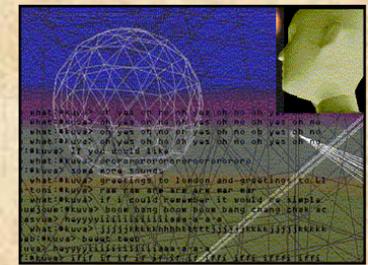


Capturing Knowledge

- Knowledge gathered anyplace 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

Enables sharing of essential knowledge to complete Agency tasks

- MarsNet
- Mars Exploration Rovers
- Space Interferometry Mission

2003

2007

2010

2025



Thanks!

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- ◆ 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
Jeanne Holm, NASA/JPL
4800 Oak Grove Drive, Mail Stop 202-204, Pasadena, CA 91109
Jeanne.Holm@jpl.nasa.gov (818) 354-8282
- ◆ More information can be found about
 - NASA's KM program: <http://km.nasa.gov>
 - NASA's portal: <http://www.nasa.gov>

