

# Knowledge Management @ NASA/JPL


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*4 Oct 57 - Sputnik*  
*1 Oct 57 - NASA \$100mm Jet Propulsion Lab C.I.T.*  
*25 May 1961 - Manned mission*  
*1970 - US moon. \$ 5 Bn. Apollo.*

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## Context

- Downsizing through attrition and buyouts had resulted in an imbalance in NASA skill sets
- In 2002, 40% of the workforce eligible for retirement  
*2006 50%*
- Budgets were reduced, but mission parameters increased
  - Workforce stretched to meet targets
  - Multiple mission failures
- In 2000, US Congress recommends KM to reduce risk of failure

*IT*  
*Apollo. → Knowledge.*  
*Knowledge Management*

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## The Dilemma


- Legacy KM tools were IT-based systems
  - Internet-based databases and portals easy to pitch & obtain funds (\$200k to \$500K)
  - No avenue for mentorship or training/sharing of tacit knowledge
- Continue with IT-based systems?
  - Senior managers comfortable ✓
  - Systems in place
- ✓ Change the knowledge-sharing culture at NASA?
  - Higher budget requirement (\$2Mn to \$5Mn) with no guarantee on ROI
  - NASA was \$4Bn overbudget on International Space Station

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## Lessons from the Past

- Apollo Missions
  1. Performance
  2. Schedule
  3. Cost
- Shuttle Program
  - Cost control
  - Resisted technology advancement
  - Commercial business practices
  - Private contractor oversight

*Handwritten notes:* Moon. 9 years. Race with USSR. - funds - manpower. Skylab. Apollo-Soyuz. Viking. Voyager. 1977. Space station. Base on Moon. Nixon. Vietnam. cheap. test time. tender. subsurface.




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## Lessons from the Past

- Shuttle flight was declared operational under duress
  - Annual launch schedule of 24 flights by 1990
- Jan 1986, Shuttle Challenger exploded.
  - All seven crew members died.
  - Failure of O-Ring
- Hubble launched with defects in 1990.
  - Could have been prevented

*Handwritten notes:* April 1981 Columbia. 32 - 4 flights.




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## Faster, Better, Cheaper

- Goldin era – 1992 to \_\_\_\_\_
  - Reduced workforce by 28%
  - Outsourced operations with a freeze on hiring.
  - Moved towards smaller and less expensive projects
    - Reduce the risk of failure
    - Increase creativity and diversity
    - More successful projects to regain confidence and public support
- **Faster:** Mars projects every 26 months
- **Better:** Open to interpretation
- **Cheaper:** Projects scrapped if off-budget by 15%

*Handwritten notes:* bigger. heavy payloads. smaller. \$Bn → \$Mn. Cassini. multiple projects.



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## Faster, Better, Cheaper


- 1997 - \$260 Mn Mars Pathfinder – success
  - Overconfidence in team
  - Managed by JPL



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## Result of Success


- From 1992 to 2000, out of 16 FBC missions, six failed
  - Due to FBC, projects at JPL jumped 10x *lead.*
  - Forced to onboard junior, inexperienced staff in senior positions
  - 80 to 90 workweeks became the norm
  - "Dot-gone syndrome" *IT industry*
    - missions, papers, patents, conferences.
  - Lack of oversight by Senior Experienced members *managerial*
- Shortchanging the Future *reviews testing*
- Using (Ignoring) the Past *senior*



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## KM Initiative


- 40-member team led by Holm setup in Jan 2000
  - Strategic plan & implementation *KM @ NASA JPL*
- Cultural change required
  - The NASA centres competed for resources – privatized knowledge
  - Transfer knowledge across missions & generations - missions last for over 50 years
  - Transfer knowledge across national boundaries – political ramifications
  - Curate knowledge on the web – develop next gen engineers



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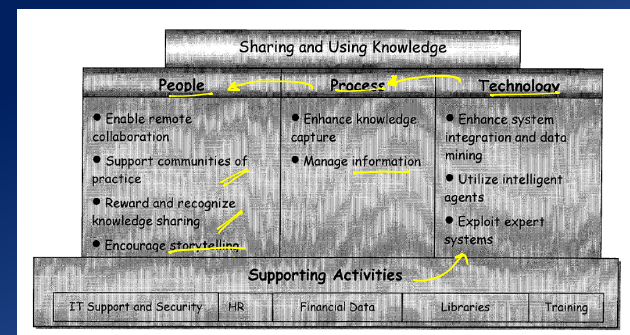
## KM Cornerstones

- "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 NASA and its partners"
- Major stakeholders
  - Congress – Controls budget *←*
  - Taxpayers – Failures and technical tragedies affect PR & Congress
- The knowledge architecture addresses:
  - Services
  - Processes
  - Systems



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## KM Cornerstones



The diagram illustrates the Knowledge Management Framework as a multi-layered structure. At the top is a box labeled "Sharing and Using Knowledge". Below this is a central box divided into three columns: "People", "Process", and "Technology".

- People:**
  - Enable remote collaboration
  - Support communities of practice
  - Reward and recognize knowledge sharing
  - Encourage storytelling
- Process:**
  - Enhance knowledge capture
  - Manage information
- Technology:**
  - Enhance system integration and data mining
  - Utilize intelligent agents
  - Exploit expert systems


At the bottom is a box labeled "Supporting Activities" which includes: IT Support and Security, HR, Financial Data, Libraries, and Training. Arrows indicate interactions between the central components and the supporting activities.



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## KM Cornerstones

- Process of making relevant information available quickly and easily for people to use productively
  - Helping people capture key knowledge for reuse (creating a knowledge-sharing culture)
  - Helping people work together to develop knowledge (individual & group support)
  - Helping people organize and catalogue knowledge
  - Helping people distribute and find knowledge
  - Infrastructure to make this work




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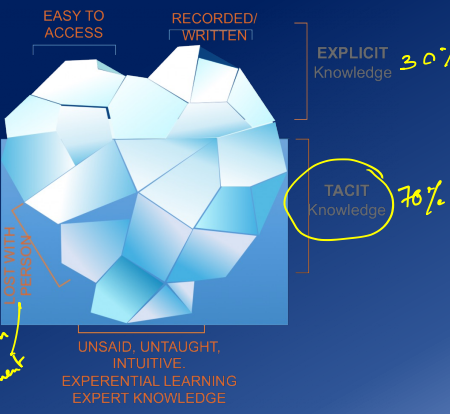
## Types of knowledge

- Explicit knowledge and tacit knowledge are the two major types of knowledge that firms can observe when seeking to achieve competitive advantage
  - An individual develops tacit knowledge by action and experience
  - Tacit knowledge is implicit in nature and operates on a subconscious level within each individual, making it very difficult to articulate and disseminate across the organization
  - Explicit knowledge represents information that can be articulated, documented, formalized, and therefore systematically shared

*IT based systems: 10K 20K*



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The diagram shows an iceberg with two parts. The top part, representing explicit knowledge, is labeled 'EASY TO ACCESS' and 'RECORDED/WRITTEN'. The bottom part, representing tacit knowledge, is labeled 'DIFFICULT TO ACCESS' and 'LOST WITH PERSON'. The top part is labeled 'EXPLICIT Knowledge 30%' and the bottom part is labeled 'TACIT Knowledge 70%'. The bottom part is also described as 'UNSAID, UNTAUGHT, INTUITIVE, EXPERIENTIAL LEARNING, EXPERT KNOWLEDGE'. A handwritten note 'Attention Requirement' points to the bottom part.


## Types of knowledge

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## Types of knowledge

*RBV → VRIO*

- Because all organizational knowledge originates as tacit knowledge at some point and because tacit knowledge is most inimitable and immobile, KBV recognizes tacit knowledge as the primary strategic resource of the firm.



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## Capturing Knowledge

- Helping people articulate knowledge that can be easily shared and reused
  - Supporting people in moving tacit knowledge to explicit knowledge

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## KM Initiative

- The Lessons Learned Information Systems (LLIS)
  - Encourage storytelling and recognize people for sharing knowledge; sharing of success and failures
  - Irrelevant entries; fear of acknowledging failure
- Web-based portal
  - Providing access to experts through integrated directories
- Academy of Program and Project Leadership (APPL)
  - Training & mentorship – classes, team-targeted training, just-in-time online learning, community of practice

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## Capturing Knowledge

- Standards** (<http://step.jpl.nasa.gov>)
  - Advocates and adopts standards for core metadata, name spaces, and engineering models (STEP)
- Documentation and Data Management**
  - Goal is to support the entire lifecycle of project information
  - Currently provides Project Libraries (Xerox's DocuShare software) to 6500 users and 75 organisations
  - Moving to an electronic archive and integrated authoring environment
- Knowledge Navigation**
  - Using portals, taxonomies, and enhanced searching to help gather information for individuals and communities
- Knowledge Capture Studies**
  - Investigating how teams create, capture, and share knowledge
- Expert Connections**
  - Helps to find people with the answers, includes profiles of ~1100 technical experts

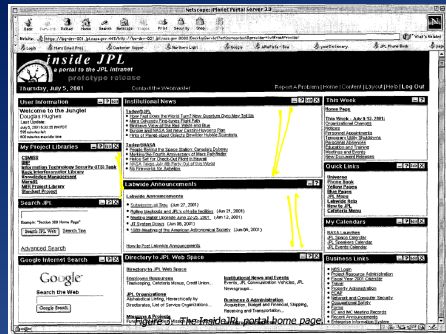
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## IS Architecture

"What do you want to do?" "Who are you?" "How do you want it?"

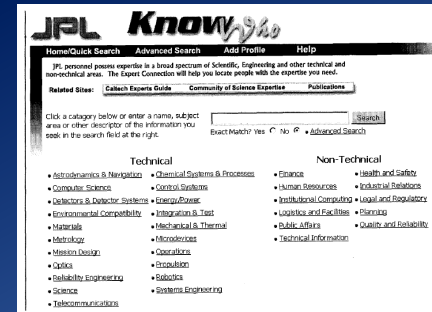
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# Knowledge Navigation



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# Expert Connection



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# Capturing Knowledge



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# Lessons Learned

- Enlist, encourage, empower (baptize the evangelists)
- Develop solutions, services, and rewards
  - Deliver specific solutions to specific customers
  - Build KM into the way people already do their jobs
  - Understand that cultural acceptance is key
  - Make services operational (including funding and metrics)
  - Reward knowledge sharers through promotions, recognition, and time to learn and share
  - Recognize and celebrate contributions of the KM team and others
- Keep the alliances strong
- Balance long-term desires (capturing knowledge) with local requirements (specific solutions to a problem)
- Don't try to solve the whole problem-just start somewhere and solve part of the problem

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## Lessons Learned

- **KM and Business Drivers**
  - When selecting a KM solution to implement, it needs to be tied to the core issues and business drivers for that firm
  - KM solutions are not "one-size-fits-all" and need to be tailored for each organization
- **Stock and Flow**
  - Knowledge is sticky...
  - Without processes (and a system) it wont flow
  - Knowledge depreciates with time




Handwritten notes: "Stock" with a left-pointing arrow and "Flow" with a right-pointing arrow.

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## Lessons Learned


- **The need to manage knowledge**
- **Because we have to:**
  - Cost savings and growth to deal with competition
  - Create differentiation based on knowledge
  - Work faster and agile to keep up with change
- **Because we can:**
  - Rise of IT/communication technology
  - Mature, proven strategies to motivate behaviour change
  - Better understanding of how to make knowledge flow



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## Lessons Learned

- **Objectives of Knowledge Management**
  - Mitigate enterprise risk by protecting critical knowledge
  - Increasing operational efficiencies by making knowledge accessible and encouraging its reuse
  - Support employee learning and development
  - Use product, process, customer or market information to improve offerings and better serve customers.



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## Lessons Learned

- **Knowledge Management Approaches**
- **Process approach:** attempts to organize knowledge (explicit) through formalized controls, processes and technologies
  - Content management for text/video
  - After action review or lessons learned processes
  - Transfer of best practices
- **Practice approach:** focuses on building the social environment necessary to facilitate the sharing of knowledge (tacit)
  - Communities of practice
  - Enterprise social networking
  - Knowledge retention and transfer
  - Virtual collaboration



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## Lessons Learned

- **Knowledge Management Enablers**
- Knowledge is embedded and carried through multiple entities including
  - Organizational culture and identity
  - Policies
  - Routines
  - Documents & systems
  - Employees



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R B V

## Knowledge Based View



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## Building on RBV

- Building upon RBV, the knowledge-based view of the firm highlights the strategic importance of a specific type of resource, knowledge
- Whereas RBV treats a wide variety of resource types in a generic fashion, KBV recognises that knowledge is maintained by individuals, not by organizations, and can take the form of either tacit or explicit knowledge



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## Assumptions of KBV

- Knowledge-based resources hold the most strategic significance in firms.
- Production activities and processes in firms involve knowledge application.
- Individuals rather than organizations are responsible for creating, holding, and sharing knowledge.



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## Assumptions of KBV

- The incapability of markets to coordinate specialized knowledge necessitated the existence of firms, with management playing the coordination roles within the firms.
- Knowledge-based resources are characterized by difficulty of imitation and social complexities.
- Knowledge draws strategic significance from its appreciative value as opposed to other traditional factors of production, which depreciate.



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# Thank You

Questions?

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