Knowledge

Risk

People

Building the Goddard Learning Organization

Dr. Edward W. Rogers
Office of Mission Success
November 1, 2005

Knowledge Management Office at GSFC

- Ed Rogers, BS - Ohio State; MIB - Univ. S. Carolina, Ph.D. - Cornell
- Consultant, International Relief Projects, Professor of Business
- Started at NASA in May 2003
  - Task Challenge
    - Understand and describe the KM and learning organization problems in an actionable way
    - Develop a coherent and coordinated approach to help make GSFC a better learning organization
    - Develop and implement practices that can be readily adopted across the center to improve our learning and knowledge management
      - Help smart people work together for mission success
      - Creating, sharing and applying our best collective knowledge
  - First Priorities
    - Understand NASA and Goddard
    - Gain credibility for the KM function
    - Develop a plan that people understand and support

Not a Learning Organization

"Shuttle management declined to have the crew inspect the Orbiter for damage, declined to request on-orbit imaging, and ultimately discounted the possibility of a burn-through."

"The Board views the failure to do so as an illustration of the lack of institutional memory in the Space Shuttle Program that supports the Board's claim… that NASA is not functioning as a learning organization."

CAIB Report (2003) Section 6.1, Page 127

Unintended Consequences

"NASA's culture of bureaucratic accountability emphasized chain of command, procedure, following the rules, and going by the book. While rules and procedures were essential for coordination, they had an unintended but negative effect. Allegiance to hierarchy and procedure had replaced deference to NASA engineers' technical expertise."

CAIB Report Vol 1, Section 8.5, Page 200

Accepting Risk

"When a program agrees to spend less money or accelerate a schedule beyond what the engineers and program managers think is reasonable, a small amount of overall risk is added. These little pieces of risk add up until managers are no longer aware of the total program risk, and are, in fact, gambling."

CAIB Report Vol 1, Section 6.2, Page 139

Blocked Communication

"The organizational structure and hierarchy blocked effective communication of technical problems. Signals were overlooked, people were silenced, and useful information and dissenting views on technical issues did not surface at higher levels. What was communicated to parts of the organization was that O-ring erosion and foam debris were not problems."

CAIB Report Vol 1, Section 8.5, Page 201

Lacks Checks & Balances

"The Board concludes that NASA's current organization does not provide effective checks and balances, does not have an independent safety program, and has not demonstrated the characteristics of a learning organization."

CAIB Report Vol 1, Synopsis, Page 12

Not Functioning as a Learning Organization?

- The Organization accepts unintended consequences

  Changes in classification of foam anomalies improved schedule but were detrimental to safety.

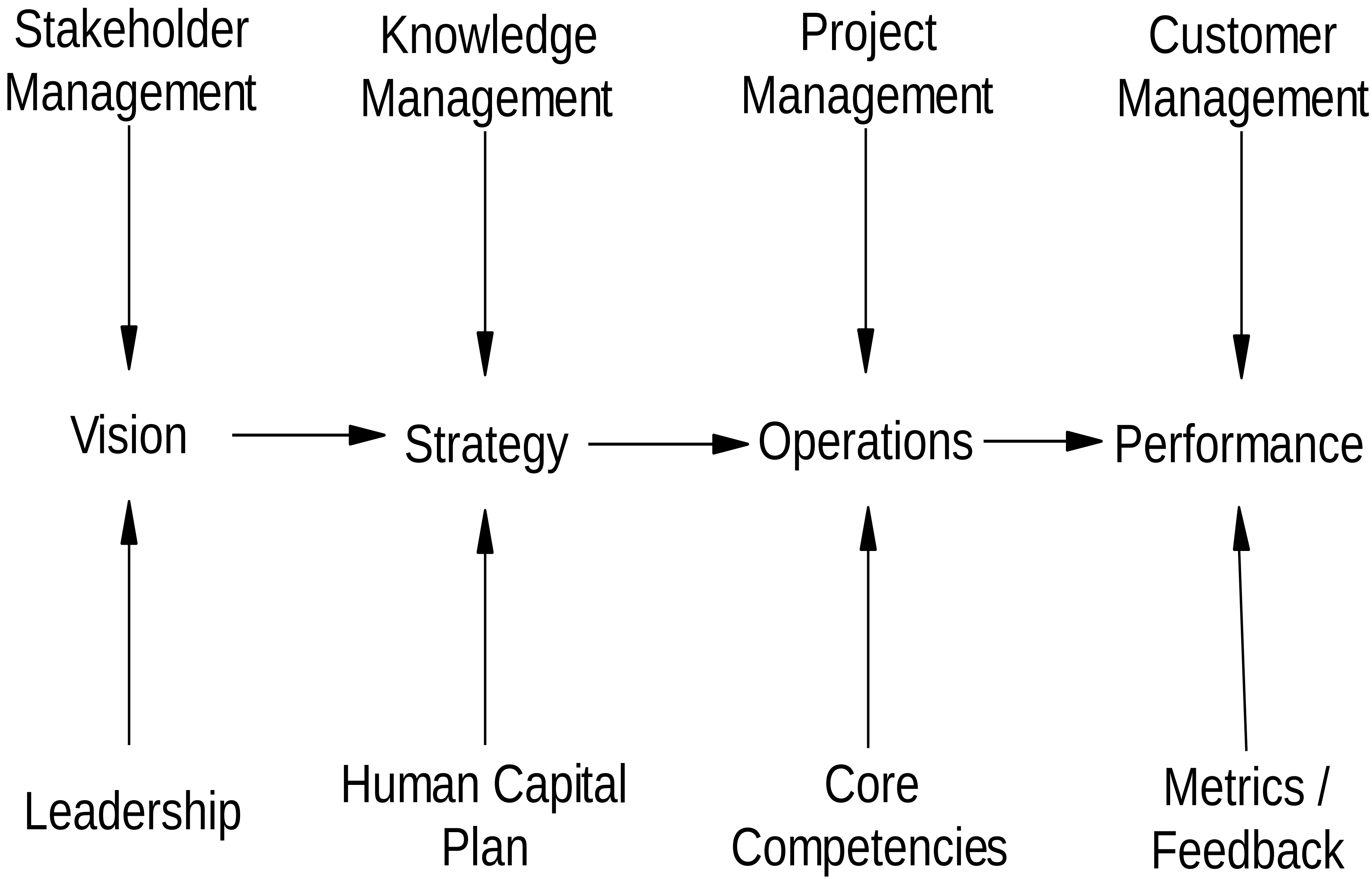
- The Organization stumbles over itself

  Engineering opinion was controlled by stifling demand for rule adherence to the point where no images were obtained of the orbiter.

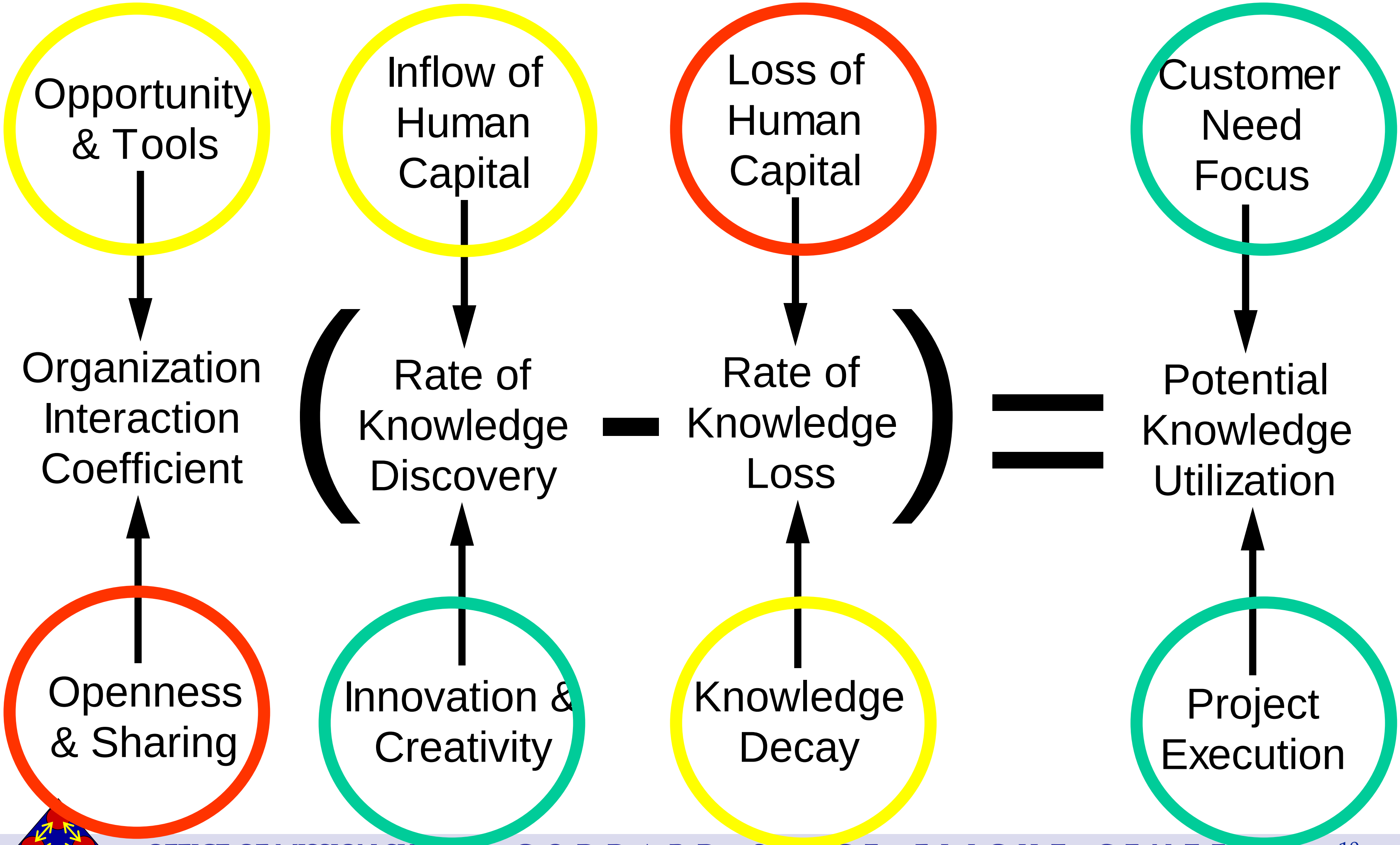
- The Organization lacks capability for error correction

  Safety organization failed to operate as an error correction mechanism.

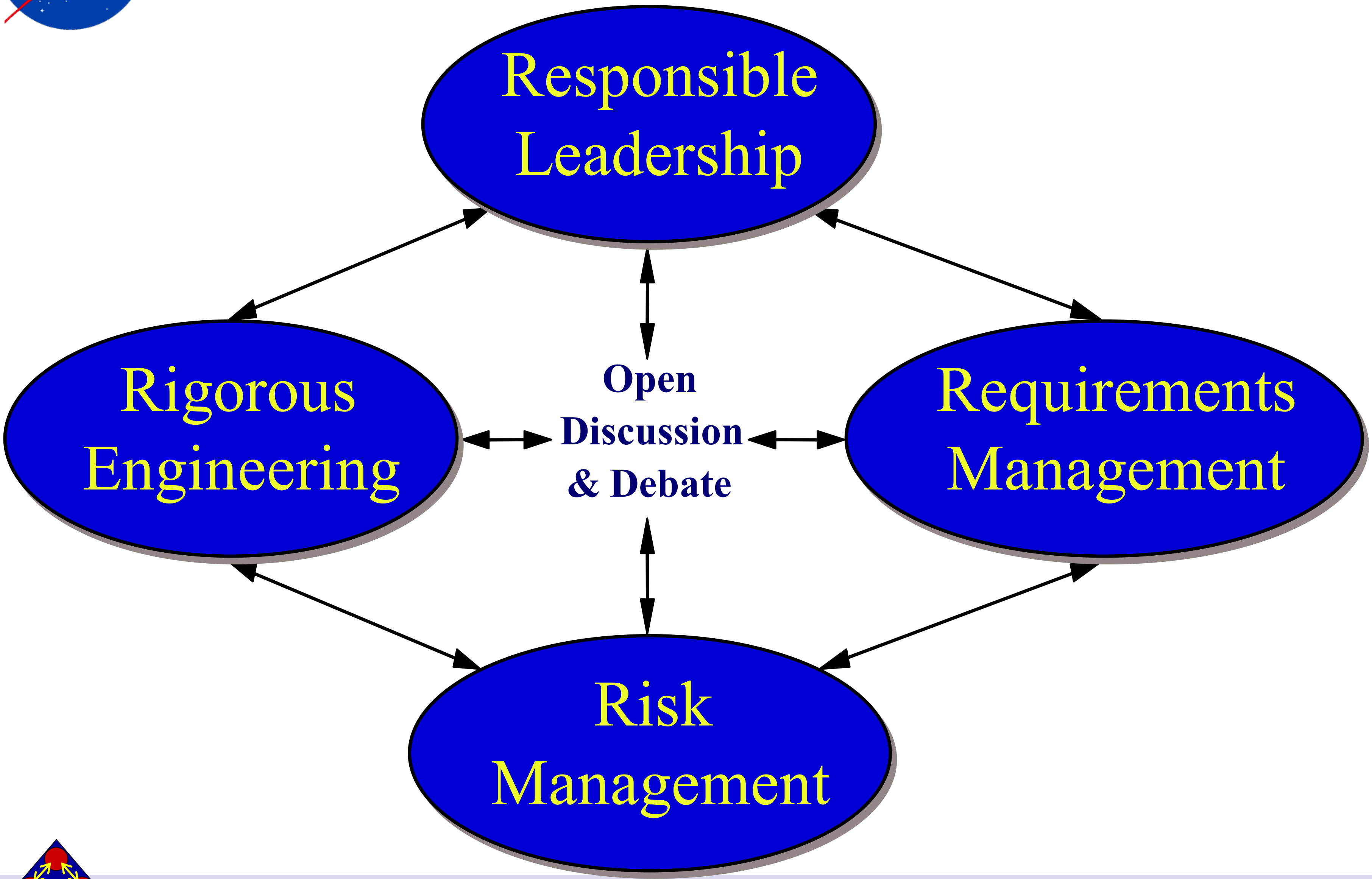
Where Does KM Fit in the Big Scheme?



The Knowledge Production Function



How We Accomplished So Much

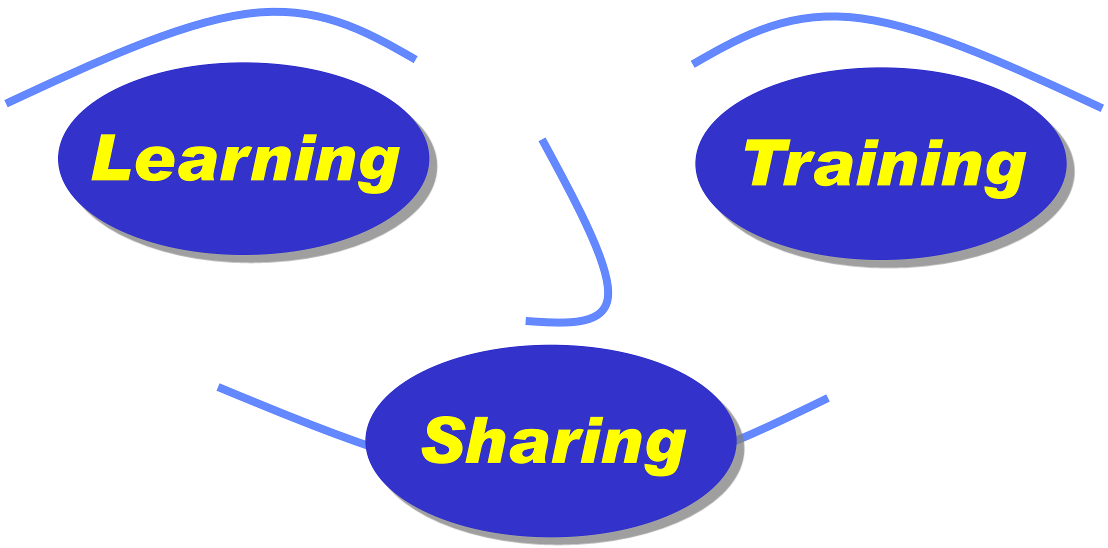


The KM Problem at the Project Level

- Not Reliable
  1. Designer dependent outcomes (team make up determines team outcome as much as team function or structure)
  2. Organizational communication processes introduce risk to system (redundancy, reliability delusions, stress points)
  3. Knowledge loops are longer than operational throughput cycle time (knowledge is not timely in application)
- Not Sustainable
  1. Social networks are decaying faster than they are being reproduced
  2. Knowledge sharing legacy systems are not built around today's workplace structures
  3. Mentors have a time-space gap with Mentees for effectively sharing knowledge

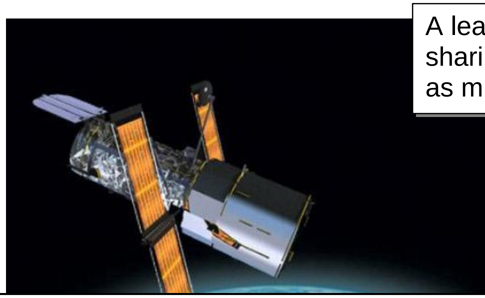
Knowledge Management Office in 170

"Enhances Center performance as a learning organization through leadership of the knowledge management function including lessons learned, knowledge sharing and training initiatives."



Goddard's Learning Plan

Building the Goddard Learning Organization:
A strategic plan for managing our collective knowledge and changing our culture to help GSFC function more like a learning organization



A learning organization facilitates the sharing of knowledge among people as much as among systems.

The Challenge to Change

The Need for a Plan to Manage Knowledge and Build a Learning Organization at NASA has been highlighted in a number of official documents. This Plan for GSFC is

"The Goddard Plan is designed to overcome the previous Agency focus on IT as a KM driver with its over-emphasis on ***capturing knowledge from workers*** for the organization and instead focuses on facilitating ***knowledge sharing among workers***."

p5 of draft Goddard Learning Plan

Future Goddard projects should never accept risk or experience failure because the organization did not apply its own best knowledge.

Goddard must not sit by expecting our successes of the past to carry us through the times ahead.

[1] *Strategic Plan for Knowledge Management*, NASA Knowledge Management Team, April 2, 2002 (unsigned draft document) available on the NASA KM website at: http://www.km.nasa.gov/home/index.html

Goals of Learning Plan

1. Build a Learning Organizational Culture
2. Manage Knowledge Assets Efficiently
3. Facilitate Effective Knowledge Application

Learning Practices

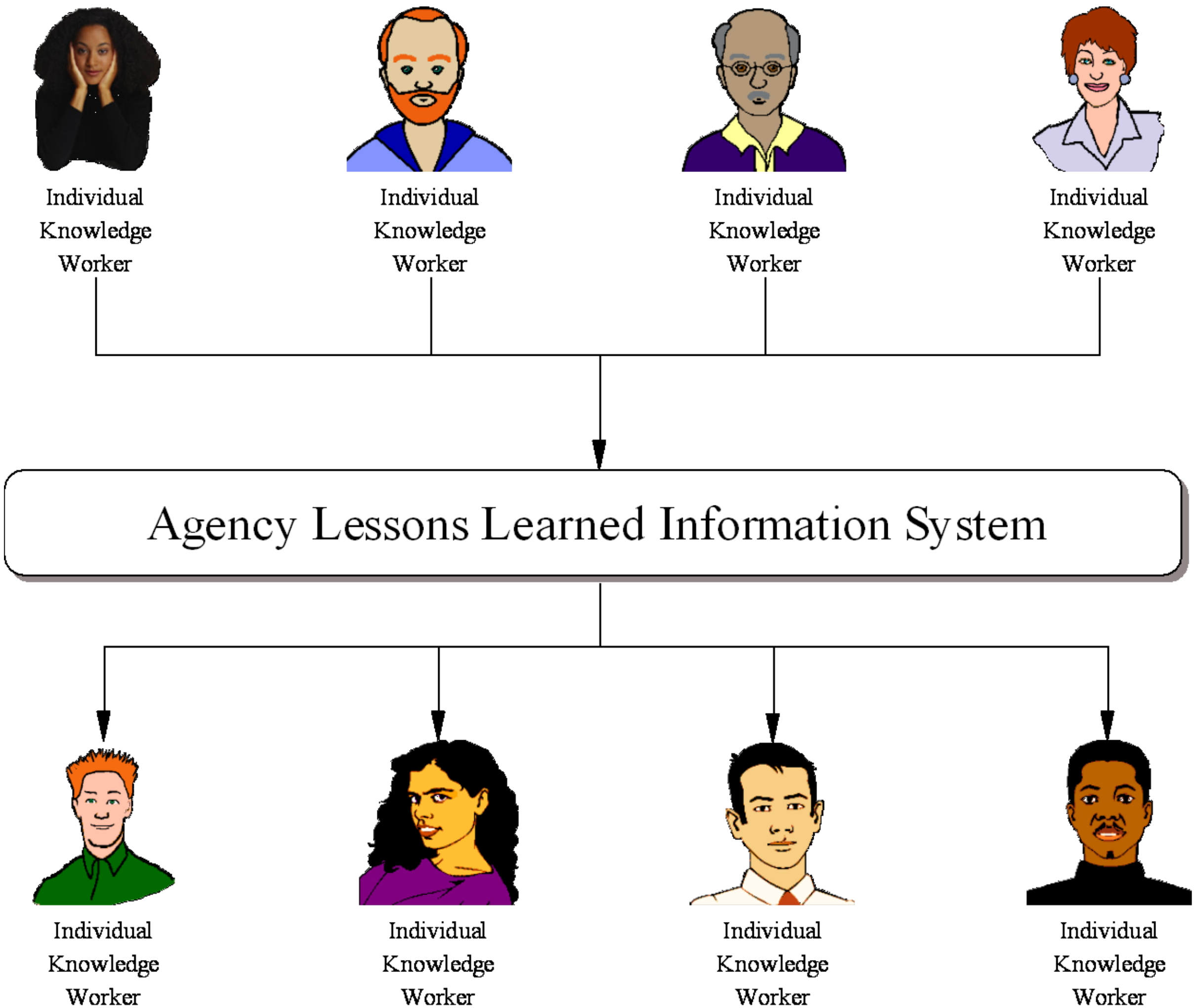
1. Pause and Learn
2. Sharing Workshops
3. Case Studies
4. Lessons Learned
5. Training & Development
6. Design Rules

Open Loop Lessons Learned

Typical IT Tools Driven Approach

Capture is the Key Word

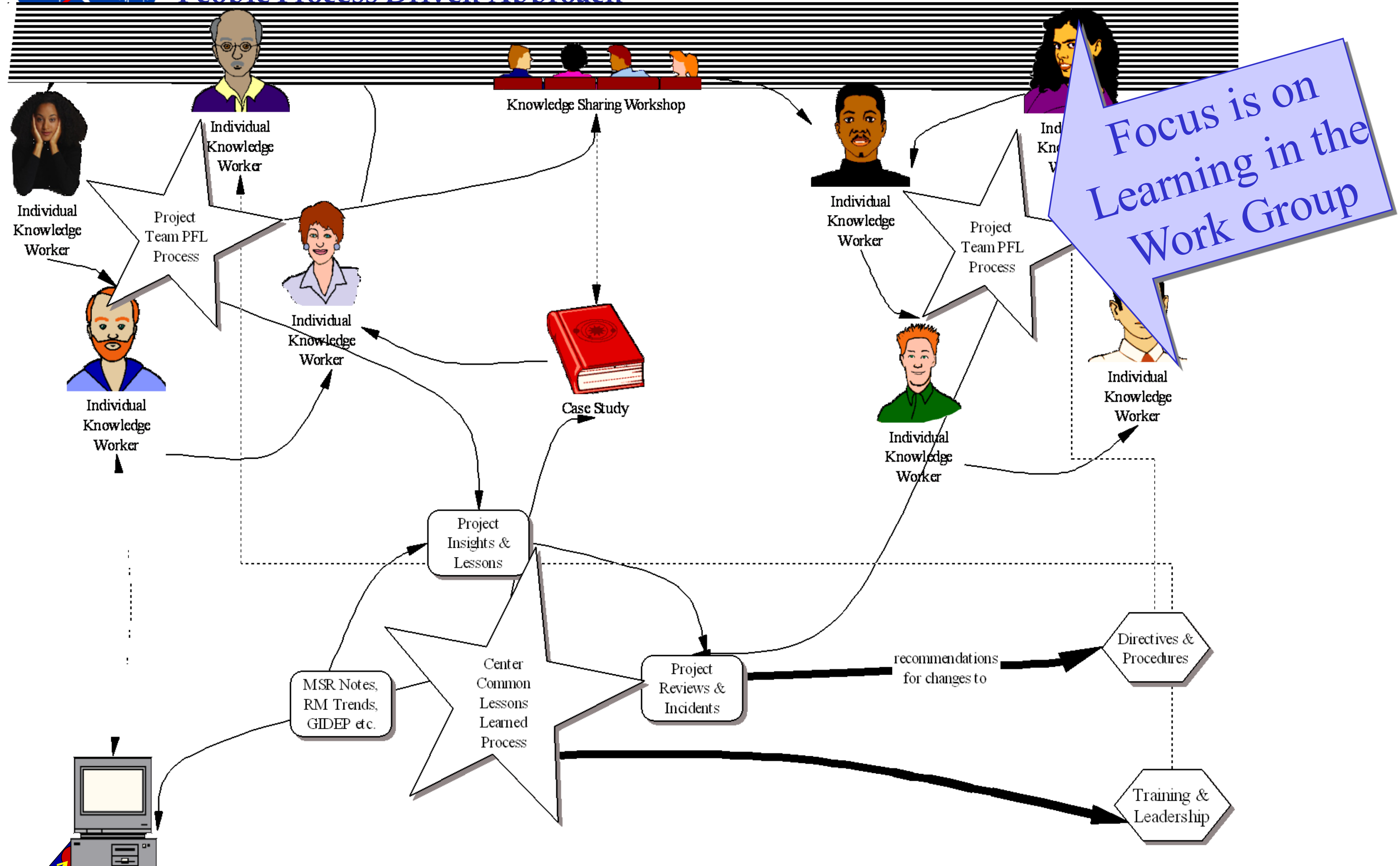
Focus is on Deploying the LL Tool Set



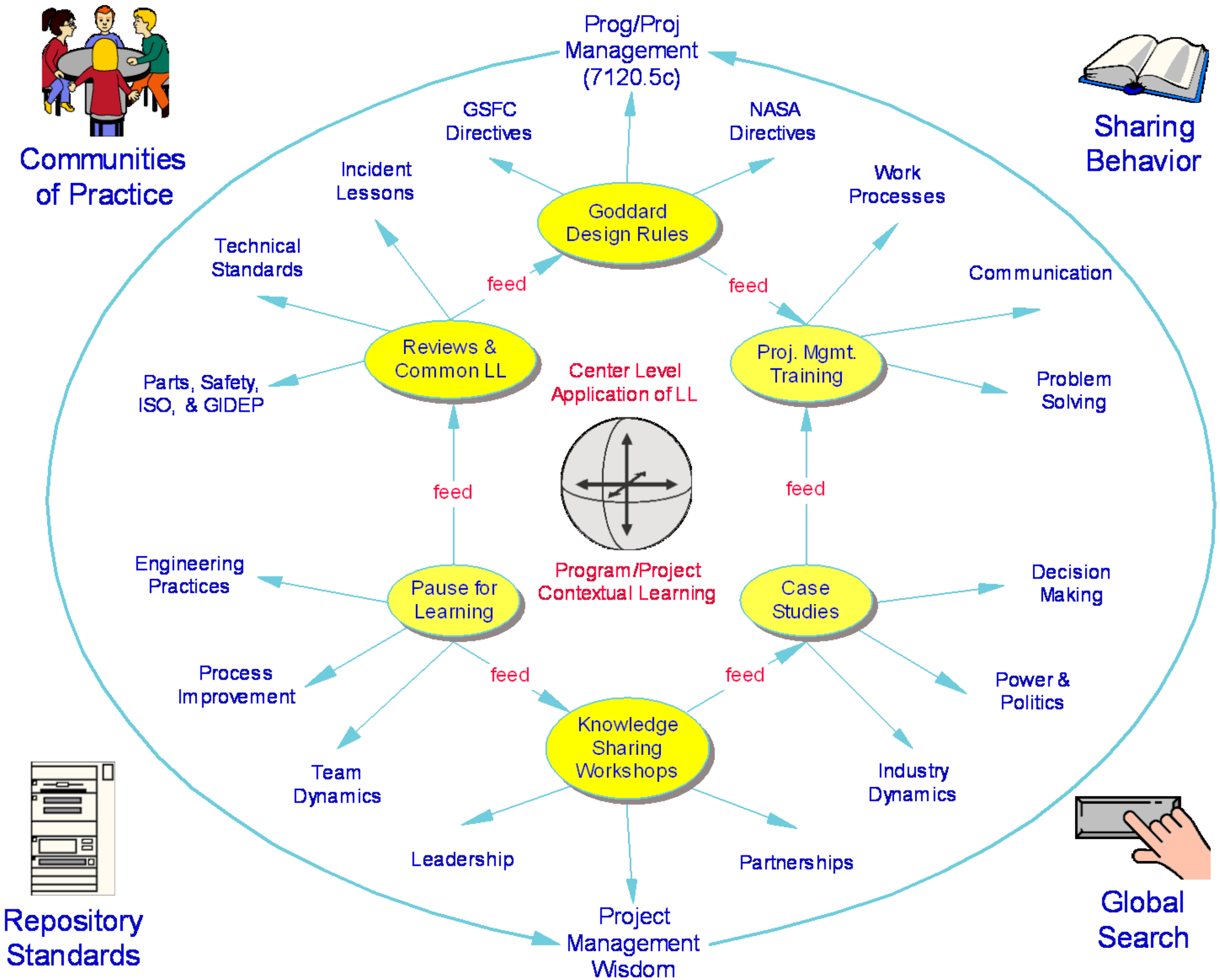
Local Loop Learning Process

People Process Driven Approach

Share is the Key Word



Goddard KM Architecture



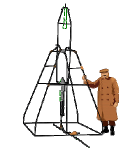
Goddard's Six Key Learning Practices

The Need to Pause, Reflect, and Learn

- Lessons Learned are nothing more than a collection of our reflections on our experiences: If we don't stop and reflect: we generally don't learn much.
  - Reflection helps us overcome near-miss-bias (NMB)
  - Must learn from what we did right
  - The time to learn is right after the experience
- Conducted a year long pilot adapting the After Action Review Concept to NASA
  - Held numerous facilitated sessions
  - Worked with project teams to debrief, collect insights & share
- Produced a white paper on the Pause & Learn Concept
- Available from www.missionsuccess.gsfc.nasa.gov

Pause And Learn Sessions (PAL)

- Produced a white paper describing how we will adapt the process for use inside NASA.
- Obtained some seed money to train facilitators
- Piloted with several projects
  - GOES/POES
  - ST-5
  - SWIFT
- Rolling out to other projects
  - JWST
- Showing how process is:
  - Immediately useful to the team
  - Helps complete other requirements for LL
- Established process for holding center wide sharing within 60 days post-launch for every mission



WHITE PAPER

Pause And Learn:

Adapting the Army After Action Review Process to the NASA Project World at the Goddard Space Flight Center

Developed at the

NASA Goddard Space Flight Center
Knowledge Management Office

by
Dr. Edward W. Rogers

May 20, 2004
Revised May 10, 2005

Knowledge Sharing Workshops

Sharing

Date	Topic	Target Audience	Panel Members	#
12/2/03	Jerry Madden's Proj Mgmt Principles	Project Managers	M.Davis	74
2/6/04	WIRE Case Study	Project Mgrs & Subsys Leads	J. Watzin D. Everett J. Hrastar	30
3/16/04	TIMED Case Study	Project Managers	J. Wolfe G. Colon B.Campbell	25
4/27/04	VCL Case Study	Project Mgrs & Systems Engrs	P. Sabelhaus R. Dubayah	35
6/15/04	Code T LL Workshop	Program and Project Mgrs	Barrowman Hraster Powers McCarthy Rogers	5
7/15/04	ICESAT GLAS	Project Mgrs & Systems Engrs	J. Abshire, E. Ketcham C. Krebs	35
9/22/04	Hitchhiker Lessons	Project Mgrs & Safety Eng	G. Daelemans M.Wright J. Harper	22
10/26/04	NOAA-N Prime Mishap	Project Mgrs & Safety Engineers	C. Scolese	75
12/9/04	TDRSS Case Study	Project Mgrs & System Engrs	R. Jenkins Ed Lowe	20
3/22-23/05	Project Mgmt Challenge Conference	Project Mgrs & System Engrs	VCL, STEREO, SSPPO, CREAM, NOAA N'	100 +
4/7/05	CONTOUR	Project Mgrs & System Engrs	With APL and GSFC Ed Reynolds Tom Mangus	75+
7/14/05	ESDIS Case Study	Project Mgrs & Science Leads	D. Perkins R. Obenschain J. Dalton C. Scolese	60
8/03/05	CREAM / EQUUS II	Project Mgrs & System Engrs	Jeff Reddish, John Hickman	25

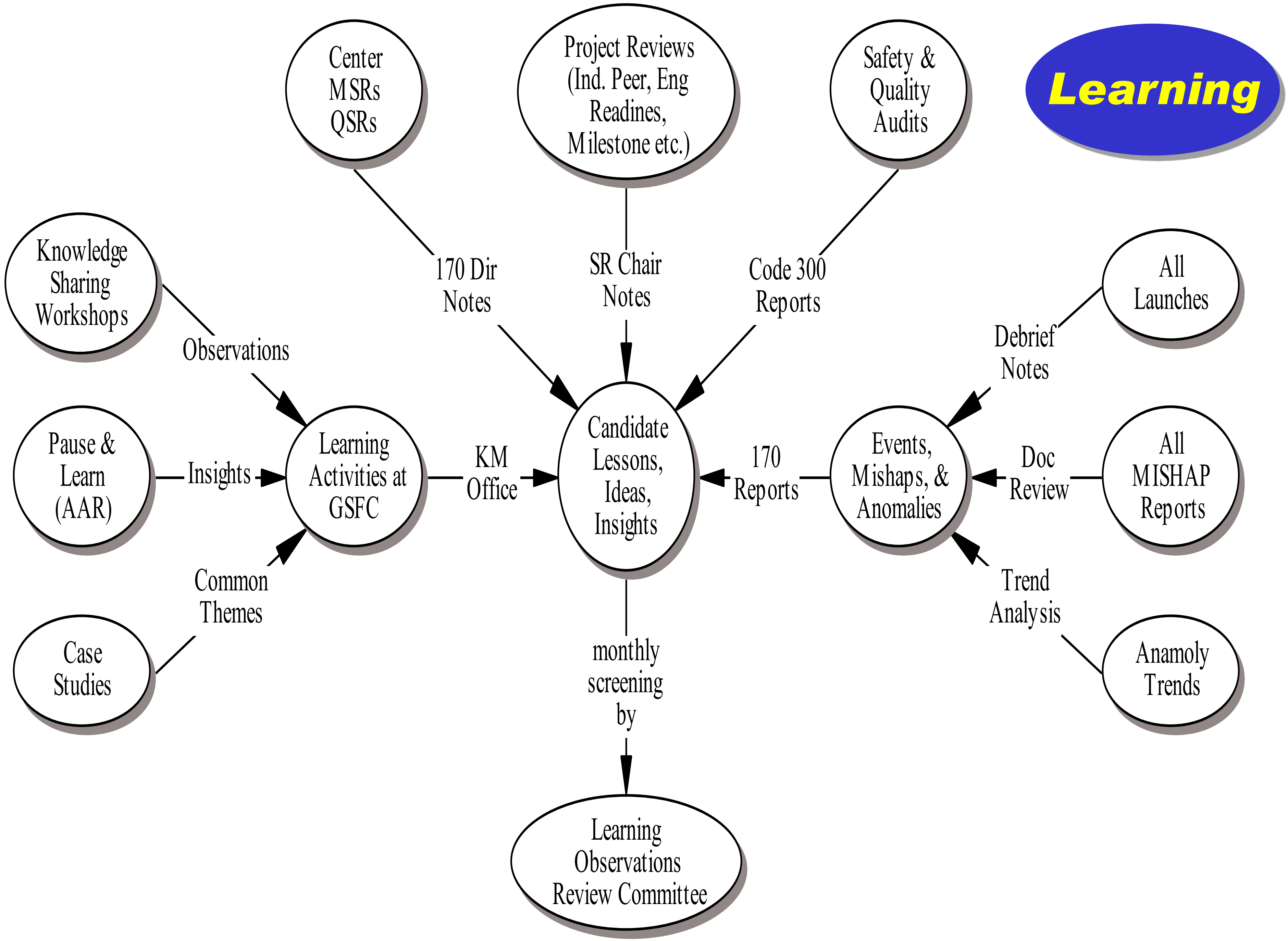
Case Studies

PROJECT	TYPE of CASE	Use To Date	Planned Use
NOAA N prime	Teaching Case	Discussion by Proj. Mgr done at PMChallenge Conference March 05; KSW held 11/04	RTMS Workshop
VCL	Case & Teaching Case	Used at KSW 4/04 Used at PMChallenge Conference March 05	RTMS Workshop
TIMED	Teaching Case	Used at KSW 3/04	RTMS Workshop
CREAM	Teaching Case	Used at PMChallenge Conference March 05	Planned for WFF 07/05
GENESIS	Teaching Case	Used at PMChallenge Conference March 05 Used at ST-5 Project PAL Session	RTMS Workshop
SSPPO	Teaching Case	Used at KSW 9/04 Used at PMChallenge Conference March 05	TBD
TDRSS	Teaching Case	Used at KSW 12/04	TBD
Comanche	Teaching Case	Used at PMChallenge Conference March 05	TBD
Columbia Rescue	Teaching Case	Not yet used	TBD
STEREO	Teaching Case	Used at PMChallenge Conference March 05	RTMS Workshop
AC-67	Teaching Case	Used at TMT (in 04 and 05)	TMT 06
MAP	Reference CD	Used as example for CRT Presentation 3/05	KSW Sum 05
EOSDIS	Case Study	KSW scheduled for July 14, 2005	KSW July 05
SWIFT	Case Study	Not yet released	KSW Fall 05
Calipso	Case Study	Not yet released	KSW Spr 06
ICESat/GLAS	Case Study	Not yet released; KSW held 7/04	RTMS Workshop

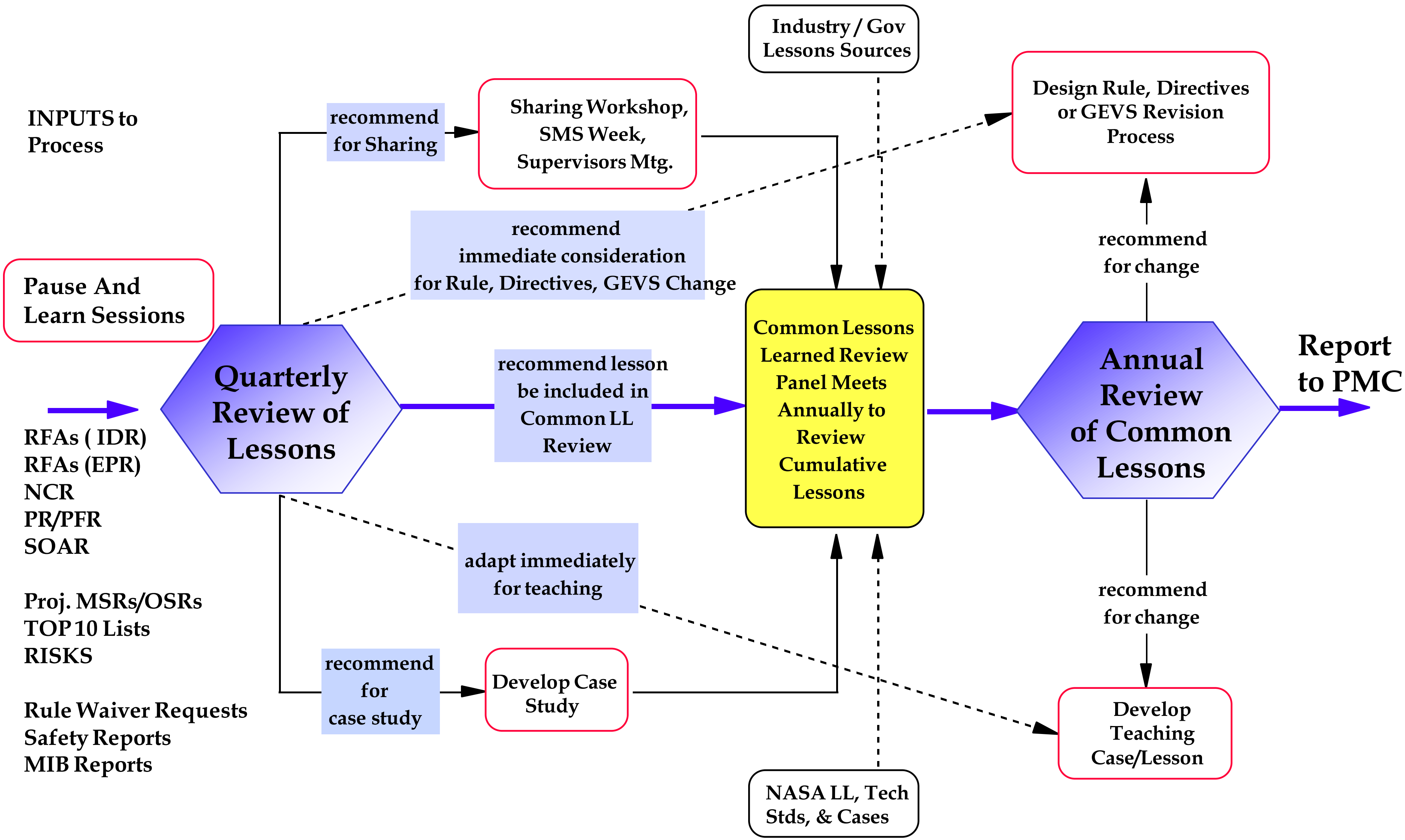
How Can We Learn From This?

Goddard Learns from NOAA N-PRIME

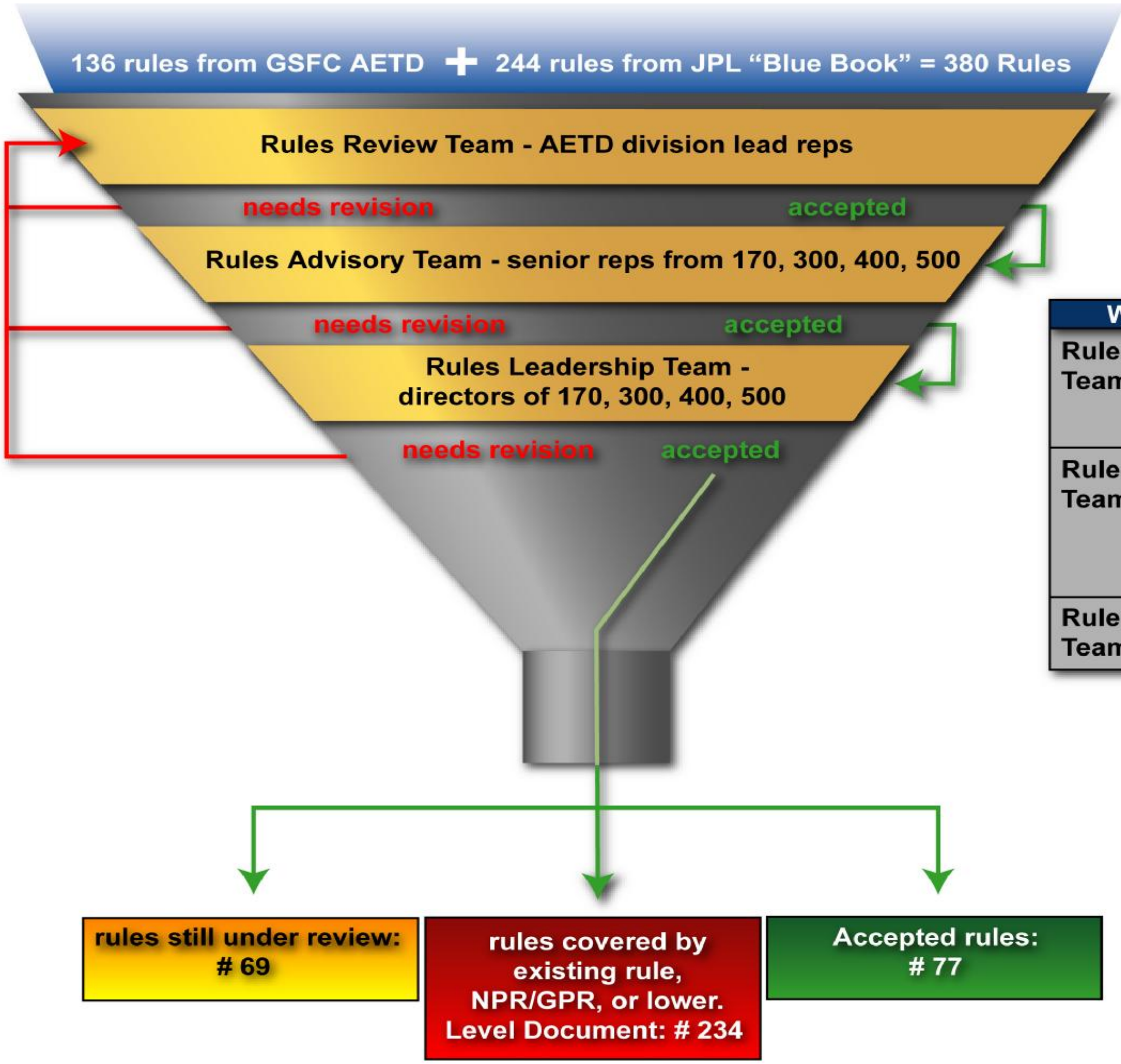
Sept. 6, 2003	Mishap Occurs in Sunnyvale, CA
Sept. 13, 2004	MIB Report Completed
Oct. 26, 2004	GSFC Center Wide Knowledge Sharing Workshop
November 2004	CAP and Implementation Report Done by Project
December 2004	Draft Lessons Learned Done by Project
December 2004	LL Included in Center Common LL Review
January 2005	Project LL Reviewed by Center KM Architect
February 2005	ASK Magazine Article by Marty Davis, Program Manager
February 2005	Draft Case Study ready for insertion into training
March 2005	Team Debrief Pause and Learn Session
March 2005	***Case Study*** on team response at PMChallenge Conference
June 2005	NOAA N Launch Successful: Team Reflects on Lessons
July 2005	NOAA N Team Shares LL in Center Wide Workshop


Learning
Center MSRs QSRs
Project Reviews (Ind. Peer, Eng Readines, Milestone etc.)
Safety & Quality Audits
Knowledge Sharing Workshops
170 Dir Notes
SR Chair Notes
Code 300 Reports
All Launches
Debrief Notes
Observations
Pause & Learn (AAR)
Insights
Learning Activities at GSFC
KM Office
Candidate Lessons, Ideas, Insights
170 Reports
Events, Mishaps, & Anomalies
Doc Review
All MISHAP Reports
Common Themes
Trend Analysis
Case Studies
monthly screening by
Anamoly Trends
Learning Observations Review Committee

Common Lessons Learned Process



GOLD Rule Book Development Process



WHO	WHAT
Rules Review Team	• technical expertise • direct experience
Rules Advisory Team	• coherence of rule set • gap identification
Rules Leadership Team	• Center-wide perspective


Goddard Space Flight Center

Rules for the Design, Development, Verification, and Operation of Flight Systems

GSFC – STD – 1000
Baseline Release
December 10, 2004

SMART Search Capability

(under design)

A search on the term “FPGA” will yield:

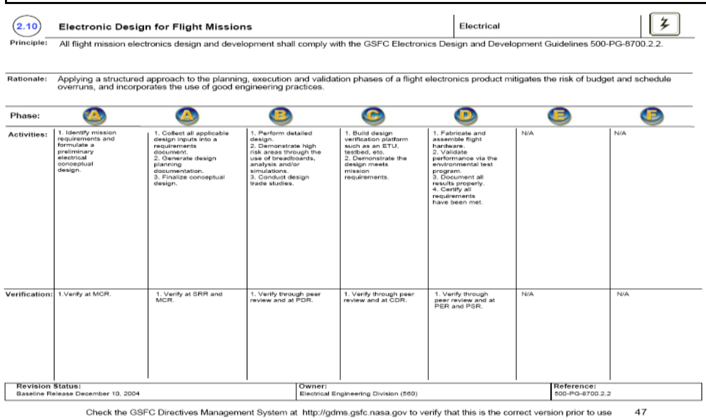
GODDARD SPACE FLIGHT CENTER

+ NASA Homepage
+ NASA en Español

SEARCH

FPGA

GOLD Rule 2.10 – Electronic Design	Link to specific NASA LLIS data	Link to specific MIL-STD



2.10 Electronic Design for Flight Missions — Electrical

Principle: All flight mission electronics design and development shall comply with the GSFC Electronics Design and Development Guidelines 500-PG-8700.2.2.

Rationale: Applying a structured approach to the planning, execution and validation phases of a flight electronics product mitigates the risk of budget and schedule overruns, and incorporates the use of good engineering practices.

Revision Status: Baseline Release December 10, 2004 — Owner: Electrical Engineering Division (560) — Reference: 500-PG-8700.2.2

Check the GSFC Directives Management System at http://gdms.gsfc.nasa.gov to verify that this is the correct version prior to use — 47

NASA Public Lessons Learned System (PLLS) Database - Mozilla Firefox

NASA Public Lessons Learned System (PLLS) Database

PLLS Database Entry: 0637

Lesson Info

- Lesson Number: 0637
- Lesson Date: 21-oct-1998
- Submitting Organization: HQ
- Submitted by: Michael E. Card

Subject/Title/Topic(s):

Wide-Field Infrared Explorer (WIRE) Mishap Investigation Board

Description of Driving Event:

The Wide-Field Infrared Explorer Mission objective was to conduct a deep infrared, extra galactic science survey. The Wide-Field Infrared Explorer was launched on March 4, 1999, and was observed to be initially tumbling at a rate higher than expected during its initial pass over the Poker Flat, Alaska, ground station. After significant recovery efforts, WIRE was declared a loss on March 8, 1999.

Lesson(s) Learned:

The WIRE Mishap Review Board has determined that the telescope instrument cover was ejected earlier than planned and at approximately the time the WIRE pyro electronics box was first powered on. The instrument's solid hydrogen cryogen supply started to sublimate faster than planned, causing the spacecraft to spin up to a rate of sixty revolutions per minute over the twelve hours following the opening of the secondary cryogen vent. Without any solid hydrogen remaining, the instrument could not perform its observations.

The root cause of the WIRE mission loss is a digital logic design error in the instrument pyro electronics box. The

The documentation and process conversion measures necessary to comply with this revision shall be completed by 31 December 2004.

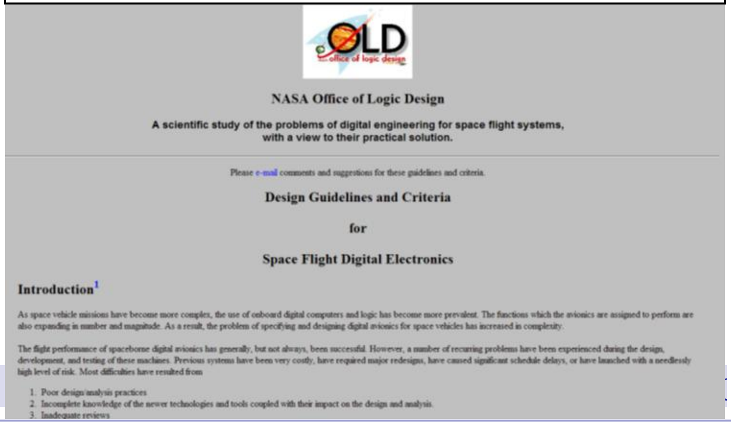
INCH - POUND

MIL-STD-883F
18 JUNE 2004
SUPERSEDING
MIL-STD-883E
31 DECEMBER 1996

DEPARTMENT OF DEFENSE
TEST METHOD STANDARD
MICROCIRCUITS

AMSC N/A — FSC 5962

Link to klabs.org page on FPGA design	Link to JPL Blue Book FPGA rules	Link to relevant case study



NASA Office of Logic Design

A scientific study of the problems of digital engineering for space flight systems, with a view to their practical solution.

Please e-mail comments and suggestions for these guidelines and criteria.

Design Guidelines and Criteria

for

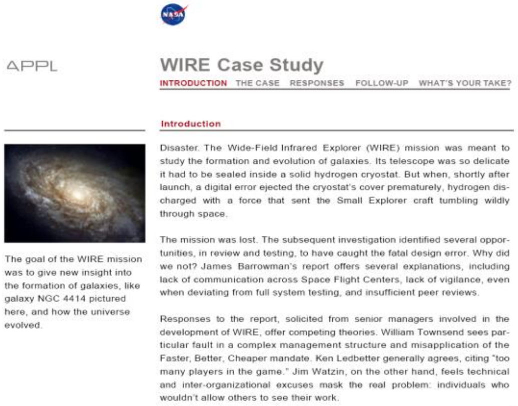
Space Flight Digital Electronics

Introduction[1]

4.12.10.2. *ASIC/FPGA synchronous designs* - The synchronous design of ASIC or FPGA shall be verified, as a minimum by post-route timing analyses using a place and route tool and test vector simulation with timing checkers performed at the primitive level. Timing of boundary conditions (pin-outs) shall be constrained for place, route, and test vector simulation.

4.12.10.3 *ASIC performance characterization* - Functional tests shall be performed with simultaneous digital, analog and mixed signal circuitry to assess interactions, as well as, separate tests on each portion of the ASIC.

4.12.10.4 *Use of behavioral models* - ASIC design shall develop behavioral and hardware description models to capture implementation of system design specifications and evaluate performance.



APPL

WIRE Case Study

INTRODUCTION THE CASE RESPONSES FOLLOW-UP WHAT'S YOUR TAKE?

Introduction

Disaster. The Wide-Field Infrared Explorer (WIRE) mission was meant to study the formation and evolution of galaxies. Its telescope was so delicate it had to be sealed inside a solid hydrogen cryostat. But when, shortly after launch, a digital error ejected the cryostat's cover prematurely, hydrogen discharged with a force that sent the Small Explorer craft tumbling wildly through space.

The mission was lost. The subsequent investigation identified several opportunities, in review and testing, to have caught the fatal design error. Why did we not? James Barrowman's report offers several explanations, including lack of communication across Space Flight Centers, lack of vigilance, even when deviating from full system testing, and insufficient peer reviews.

Responses to the report, solicited from senior managers involved in the development of WIRE, offer competing theories. William Townsend sees particular fault in a complex management structure and misapplication of the Faster, Better, Cheaper mandate. Ken Ledbetter generally agrees, citing "too many players in the game." Jim Watzin, on the other hand, feels technical and inter-organizational excuses mask the real problem: individuals who wouldn't allow others to see their work.

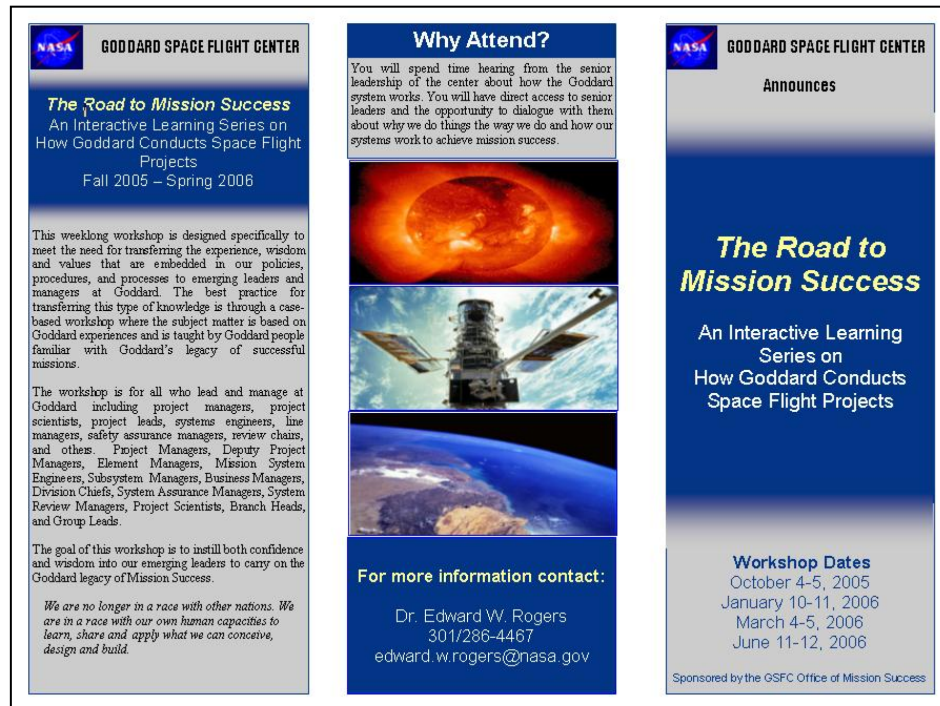
The goal of the WIRE mission was to give new insight into the formation of galaxies, like galaxy NGC 4414 pictured here, and how the universe evolved.

The Road to Mission Success

Training

Workshop Series Objectives

1. **Engage in dialogue with senior management on “Mission Success: The Way Goddard Does Business”**
2. **Articulate a clear and consistent statement of the rules, processes, and values that contribute to Goddard’s success with flight missions**
3. **Identify the array of support mechanisms in place at Goddard**
4. **Expand and empower the cadre of existing and potential leaders and managers within Goddard**



GODDARD SPACE FLIGHT CENTER

The Road to Mission Success
An Interactive Learning Series on
How Goddard Conducts Space Flight Projects
Fall 2005 – Spring 2006

This weeklong workshop is designed specifically to meet the need for transferring the experience, wisdom and values that are embedded in our policies, procedures, and processes to emerging leaders and managers at Goddard. The best practice for transferring this type of knowledge is through a case-based workshop where the subject matter is based on Goddard experiences and is taught by Goddard people familiar with Goddard’s legacy of successful missions.

The workshop is for all who lead and manage at Goddard including project managers, project scientists, project leads, systems engineers, line managers, safety assurance managers, review chairs, and others. Project Managers, Deputy Project Managers, Element Managers, Mission System Engineers, Subsystem Managers, Business Managers, Division Chiefs, System Assurance Managers, System Review Managers, Project Scientists, Branch Heads, and Group Leads.

The goal of this workshop is to instill both confidence and wisdom into our emerging leaders to carry on the Goddard legacy of Mission Success.

We are no longer in a race with other nations. We are in a race with our own human capacities to learn, share and apply what we can conceive, design and build.

Why Attend?

You will spend time hearing from the senior leadership of the center about how the Goddard system works. You will have direct access to senior leaders and the opportunity to dialogue with them about why we do things the way we do and how our systems work to achieve mission success.

For more information contact:

Dr. Edward W. Rogers
301/286-4467
edward.w.rogers@nasa.gov

GODDARD SPACE FLIGHT CENTER

Announces

The Road to Mission Success

An Interactive Learning Series on
How Goddard Conducts Space Flight Projects

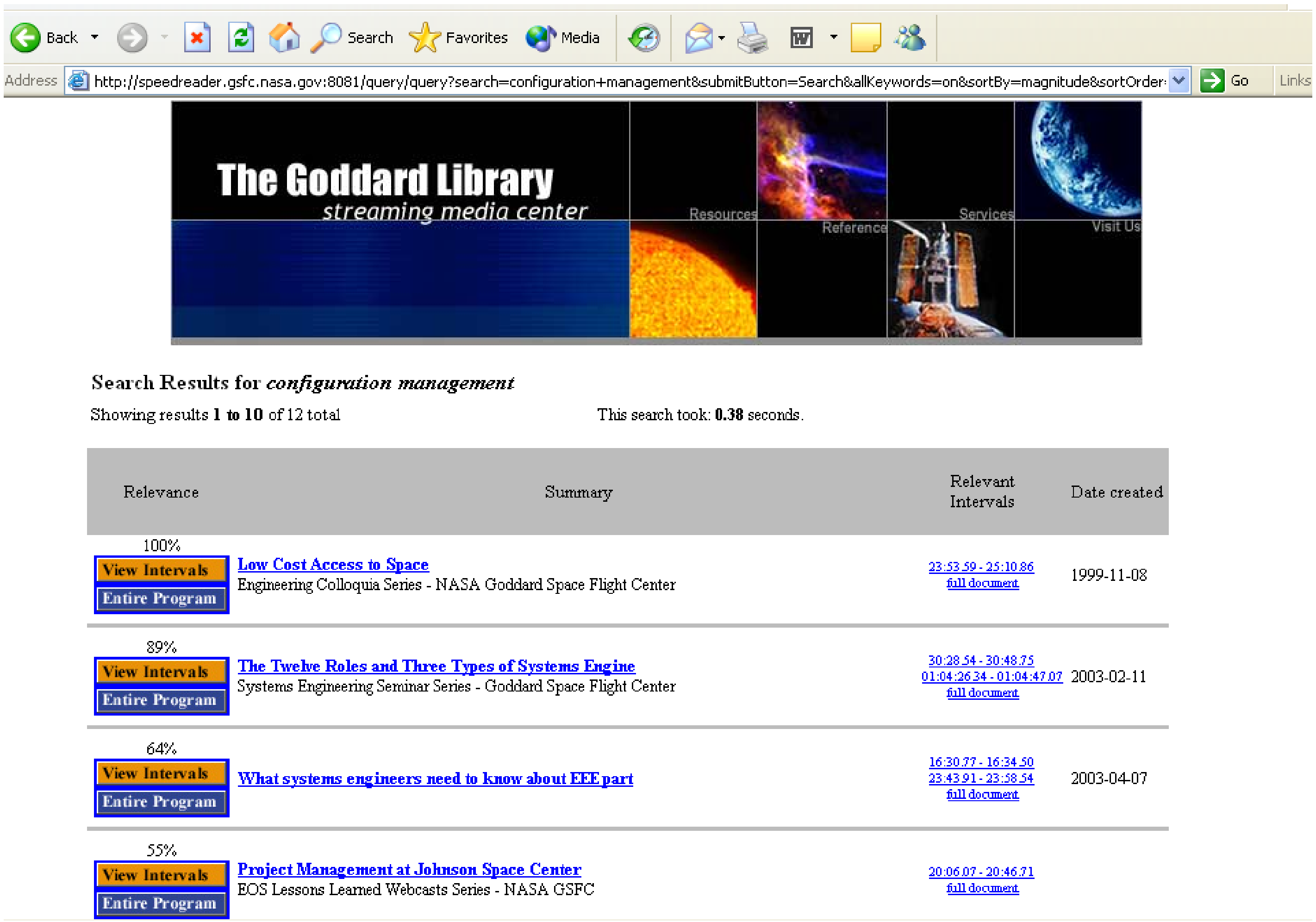
Workshop Dates
October 4-5, 2005
January 10-11, 2006
March 4-5, 2006
June 11-12, 2006

Sponsored by the GSFC Office of Mission Success

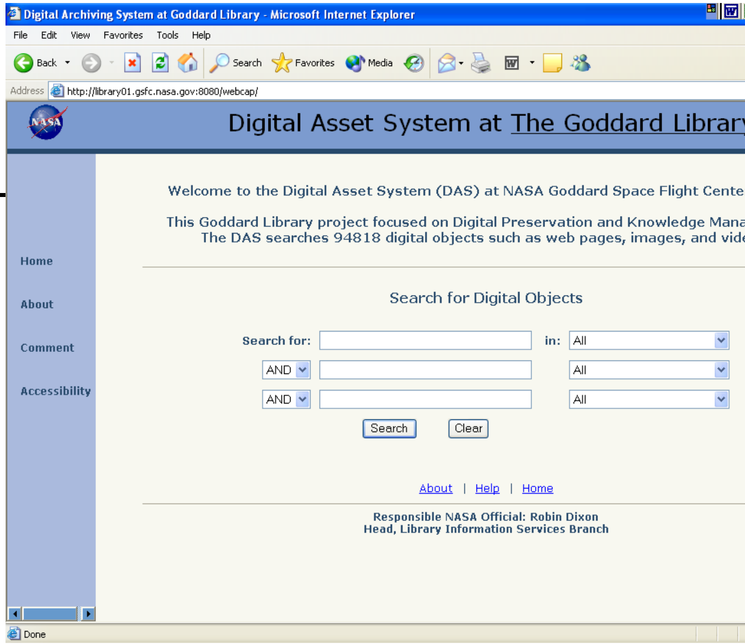
KM Support Efforts Underway at GSFC

- Digital Asset System
- Video Clip Retrieval (Streamsage)
- How to Get it Guide (Reference Searching)
- Semantic Search Pilot with INXIGHT
- Document Repository Standards Development
- Project Document Preservation
- Anomaly Trending Analysis
- Community Portal Development (Use PBMA as much as Possible)
- Center-Wide Document Management

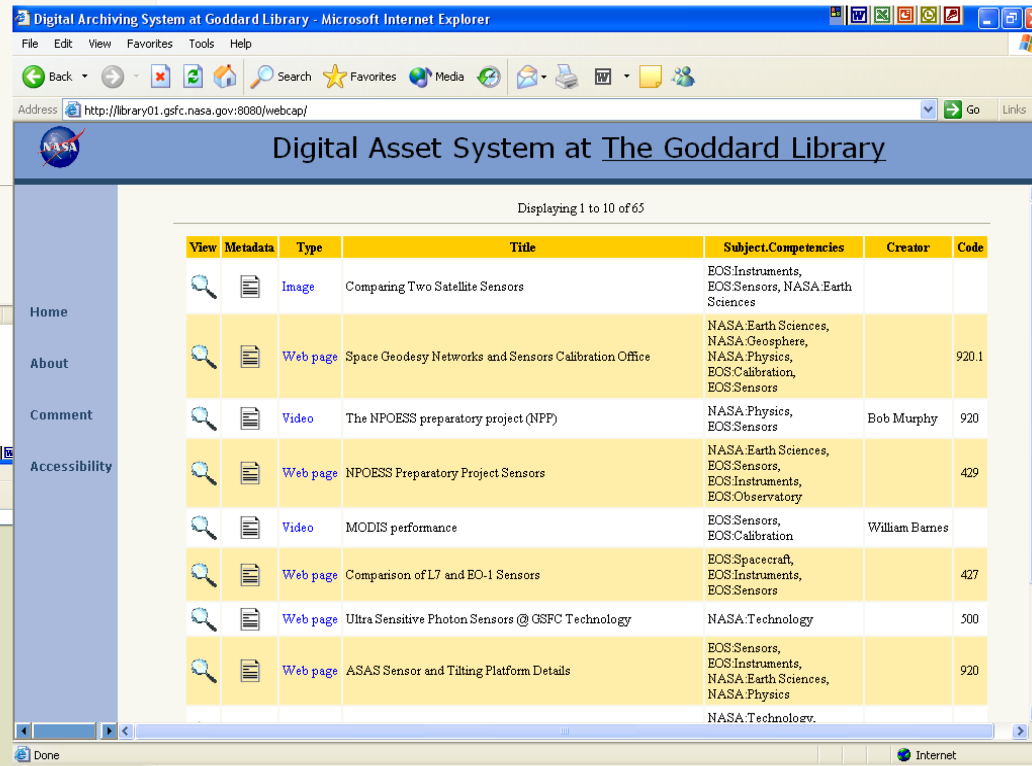
Video Query Results



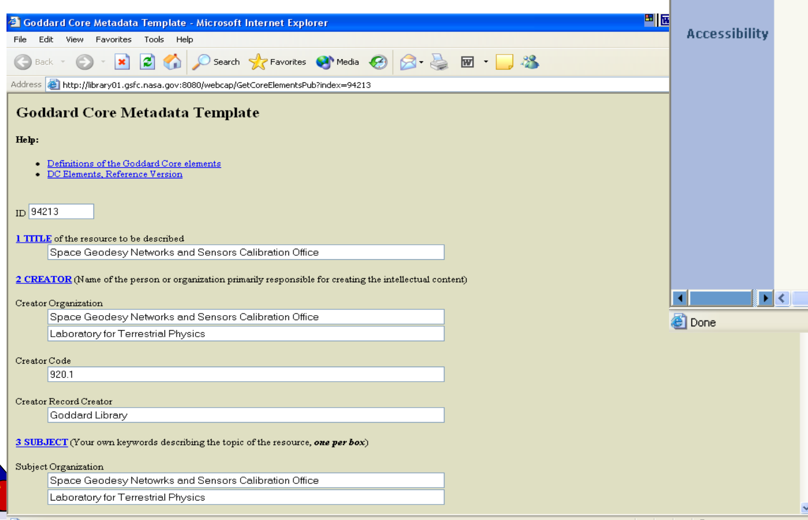
DAS Search Interface



DAS Results Page



DAS Metadata Record



information@work

Lessons Building Learning in the Army

1. The knowledge of the Army profession resides primarily in the minds of its members.
2. Connecting members allows the knowledge of the profession to flow from those who know to those who need to know, from those with specific experience to those who need that experience right now.
3. ***Person-to-person connections and conversation allow context and trust to emerge and additional knowledge to flow***.
4. Relationships, trust, and a sense of professional community are critical factors that set the conditions for effective connections and convesations.

From Company Command by Nancy Dixon, et.al. (2005). Center for Advancement of Leader Development and Organizational Learning. p21.

Navy Knowledge Management Strategy

"Knowledge Management in the DON is a centralized vision executed through decentralized implementation."

"…encourage commands to implement KM programs, structures, pilots, and methodologies as part of process improvement efforts."

"The emphasis should be on KM's applicability to decision superiority, improved organizational performance, and individual task accomplishment."

"One of the basic tenets of KM is that ***it can be accomplished without the use of sophisticated IT systems***. However, technology is an enabler…"

Knowledge Management Strategy Memo DON Oct. 20, 2005

Why Knowledge Sharing Efforts Fail

1. Knowledge management efforts mostly emphasize technology and the transfer of codified knowledge,
2. Knowledge management tends to treat knowledge as a tangible thing, as a stock or quantity, and therefore separates knowledge as something from the use of that thing,
3. Formal systems can't easily store or transfer tacit knowledge,
4. ***The people responsible for transferring and implementing knowledge management frequently don't understand the actual work being documented***,
5. Knowledge management tends to focus on specific practices and ignore the importance of philosophy.

From The Knowing-Doing Gap: How smart companies turn knowledge into action by Jeffrey Pfeffer and Robert Sutton. (1999). Harvard Business School Press. Page 22.

Lessons Learned About Lessons Learned

"A second generation KM Architecture must show how learning will occur across the organization to produce a continuous knowledge supply, not just how current knowledge will be efficiently harvested with no thought to replenishment. Sustainment must be part of the design if the results are to last longer than the current version of KM software deployed. All three phases of the knowledge life cycle must be supported: knowledge production, knowledge diffusion and knowledge use. ***As smart as a KM system may be, it will never be smart enough to fool the people expected to use it***."

McElroy, M.W. (1999). Double-Loop Knowledge Management, MacroInnovation Inc. Available from www.macroinnovation.com