Helping NASA Preserve its Legacy

Lessons Learned in Capturing Human Knowledge:
Cultural Issues, Knowledge Capture, & the Spiral Framework

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Lessons Learned in Capturing Human Knowledge

- Cultural Issues
- Knowledge Capture
- Spiral Framework

NASA-Specific Cultural Considerations in KM

- Valuable knowledge is often tacit
- "We know more than we can tell"
  - Difficult to codify and capture
  - TFs and TDTs often underestimate their own talent

Robert Kichak: Bringing Out the Best in Others
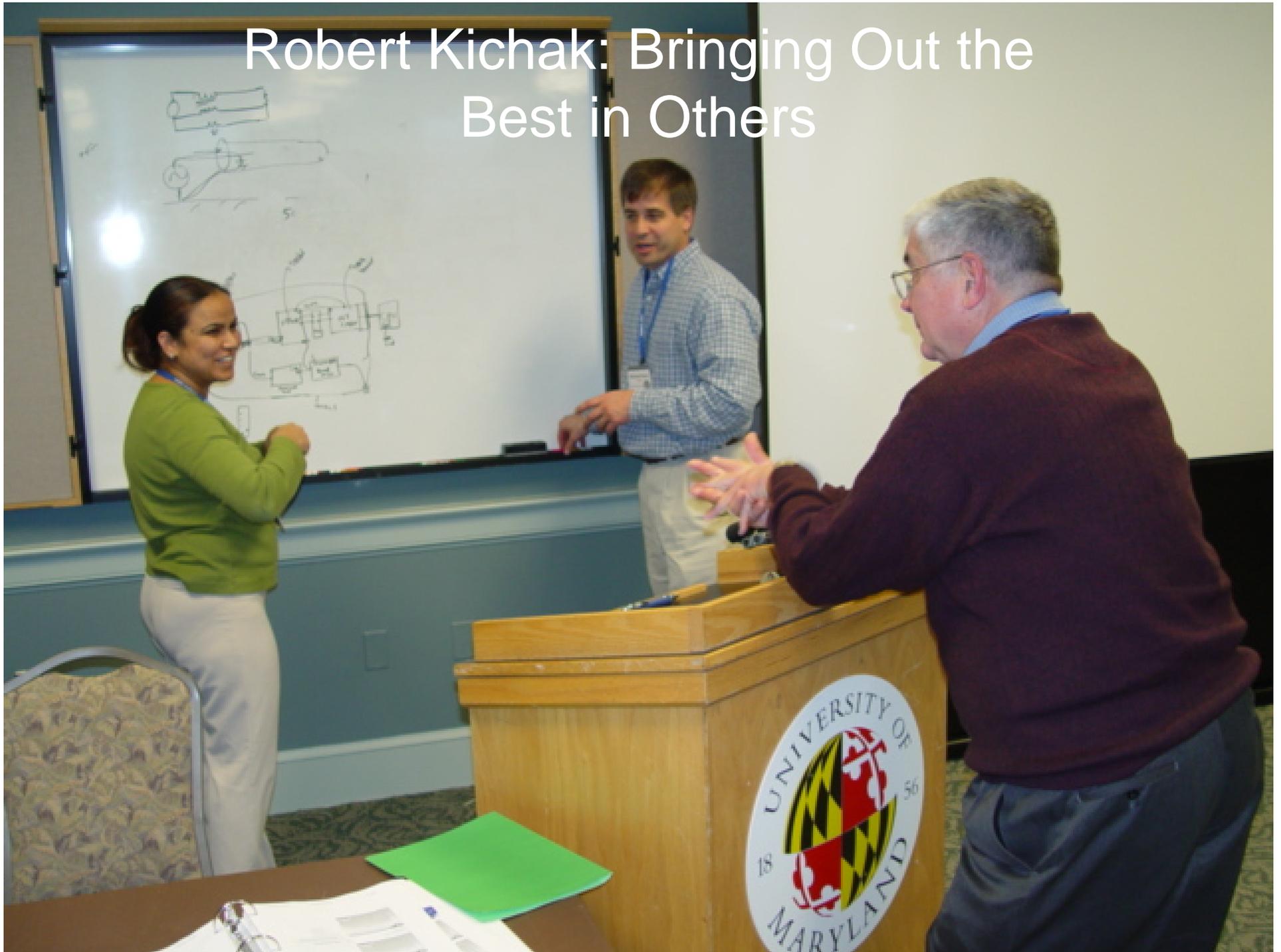
Hank Rotter: Sharing Tacit Knowledge

Every TF Presents a Unique Set of Challenges

- Negotiate different solutions for objectives, availability, number of staff to be interviewed, precourse materials, etc.

- Employ flexibility & scheduling adjustments

Identifying How Cultural Issues Enable Success at NASA

Techniques to Identify Cultural Issues

- Augmenting staff with SMEs who:
  - Are familiar with culture, inside & out
  - Have assisted in ID'ing clues to cultural elements
  - Generate follow-up questions that help extract tacit knowledge
- Enforcing a value judgment: What is most important for a new engineer to know?

Knowledge Extraction: Techniques

- Capture key content in short time
- Convey to TFs the value of stories
- Train KC staff to ID and capture tacit knowledge
- Determine role of videotaping
- Help TFs take knowledge extraction seriously
- Determine what is most important to be shared
- Make information available to highest number of users
- Determine frequency of review of draft materials
- ID and protect ITAR materials

Steps in the KC Process

- Initial briefing to TFs by Academy management
- ID SMEs for individual discipline
- Conduct individual daily interviews
- Provide questions to TF and staff
- Conduct multi-day data gathering sessions
- Conduct follow-up interviews
- Transcribe & edit interviews
- Digitize & upload interviews to website
- Analyze transcripts vis-a-vis program objectives
- Develop content outline for platform course

Knowledge Capture

- Lessons Learned in KC
- Challenges of Knowledge Extraction
- Virtual Academy
- Sources of Knowledge
- Lessons Learned in KM

Lessons Learned in Knowledge Extraction

- Using videotape helps TFs & TDTs take effort seriously
- Provide questions to TFs beforehand & explain tacit vs. explicit knowledge
- Schedule TF's time in advance
- Ask for copies of documents, prototypes, models, etc.
- TF should identify all ITAR content

Meeting the Challenges of Knowledge Extraction

- **The NESC Academy has met its goals of**
  - 1. Developing a curriculum that enables engineers/scientists to pass on knowledge
  - 2. Developing "Virtual Academy"

- **Four products were developed:**
  - 1. Website resource database & forum
  - 2. Classroom-delivered, technology-enhanced curriculum
  - 3. Self-paced, web-based precourse
  - 4. Self-paced,web-based delivery of the course

NESC Academy: "Virtually" Like Any Other University

- Consistent branding in materials and course deliveries
- Services include
  - Application processing
  - Online course registration
  - Classroom (& online) course delivery
  - Student selection & admissions notification
  - Library
  - Curriculum
  - Transportation
  - Food Services

Common KM Core: Whose Knowledge Do We Gather & Other Considerations

NESC management chose original group of scientists & engineers

- **Timing is important**
  - Retiring workforce
  - Maximum window for interviewing is 2 years
- **Focus is on TF, but he or she usually has a support team numbering from 3-15**

Improving KM through Lessons Learned

- **Project focuses on 2 kinds of lessons learned**
  - Implementing lessons learned by staff to improve KM
  - Identifying & sharing lessons learned by TFs & TDTs

Improving KM through
Lessons Learned (Cont)

- **The team makes recommendations following each course delivery. Examples:**
  - Adoption of precourse package as standard practice
  - Determining graphics plan during analysis phase
- **TFs emphasize importance of sharing information**
- **Lessons learned may have no value for Shuttle or ISS, may be valuable in future long missions outside Earth's atmosphere**

A Successful KM Approach

- **KM approach has been successful since inception of Academy in 2005**

- **Success supported by:**
  - Multi-level evaluation results
  - Anecdotal interviews with students
 - Objective 3rd party evaluation

Using a Spiral Framework to Understand KM Elements

- The knowledge spiral (Nonaka model,1995) illustrates how tacit & explicit knowledge interact
- Function is to create knowledge within an organization

Nonaka Model (adapted)
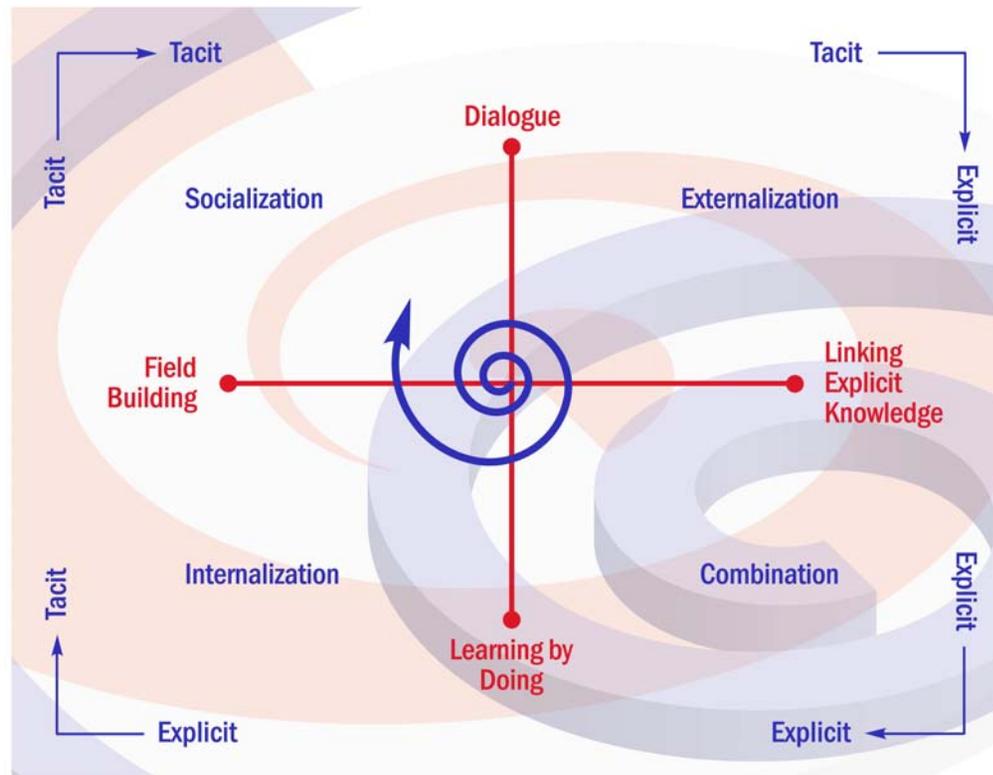
Four Patterns of the Spiral Framework

- Socialization (tacit to tacit)
- Externalization (tacit to explicit)
- Combination (explicit to explicit)
- Internalization (explicit to tacit)

Socialization (Tacit to Tacit)

- KM interviews & courses delivered on campuses epitomize socialization pattern
- First, tacit knowledge must be gained thru observation, imitation, practice. Examples:
  - Students enjoy interaction with NASA scientists/engineers & appreciate their passion
  - Students learn from one another. Feedback from TFs enhances their understanding of existing knowledge
  - Information transferred between TFs and graphic artists result in capturing a record of incidents for the very first time

Externalization (Tacit to Explicit)

- Adopted as methodology for NESC Academy
- Happens when tacit knowledge becomes explicit. Examples:
  - TFs share stories with IDs & SMEs which are recorded
  - Content is turned into print media & online courses. May be 1st time TFs ideas appear in print
  - Media elements communicate to students in many ways & are captured in online database

Combination (Explicit to Explicit)

- Combines discrete pieces of explicit knowledge to form new explicit knowledge. Examples:
  - Explicit knowledge from classroom delivery is basis for online delivery
  - Technology shines in the combination pattern. Students encounter knowledge captured via extensive Academy website that includes graphics, diagrams, photos, transcripts, charts & videos—beyond that which was delivered in classroom

Internalization (Explicit to Tacit)

- Occurs when explicit knowledge becomes intuitive knowledge, or tacit knowledge. Examples:
  - Students recognize that valuable lessons can be learned from the past
  - They realize that a discipline must interact with their own
  - Communities of practice start the sharing process by passing knowledge on to others, tacit to tacit

Comments from Students

- "The information and insight that I was able to gain from these instructors is really valuable to a young engineer about to start his career. I would like to thank everyone involved in helping this program run. This program is an excellent tool that can be used to train and teach future engineers about what engineering really is and how one approaches engineering problems." We can definitely see that socialization and externalization has occurred.

- "Offer this course more! Knowledge/experience learned here *has* to be passed on to those developing the CLV/CEV!" This comment seems to indicate that some internalization has or is occurring as the student has mulled over the CLV/CEV relationship to the lessons learned from the past.

Comments from Students (Cont.)

- "The lessons learned in several areas were very useful in gaining insight into potential problems when devising a system," wrote a student from the Satellite Attitude Control Systems course. Is this an indication of the combination pattern? It appears that the explicit knowledge gained will be provided through some vehicle to others in designing a new system.

Summary

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