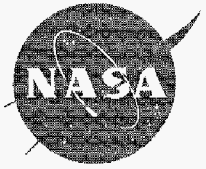

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Lessons Learned in Design Knowledge Capture (DKC)

JPL IT Forum

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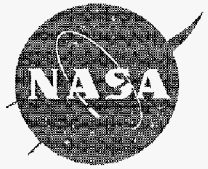

What is DKC?

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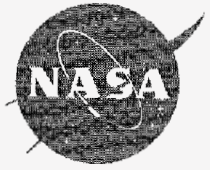
Making the ancillary information and factors that influence design decisions explicit, shareable, and understandable (long) after the decision was made. This can include:

- Components of the design: options, derived requirements, assumptions, guesses, information sources, conflicts, supporting and contradictory evidence, open issues, evaluation criteria, uncertainty, etc.
- Components of the design process: Conflicts, assessment of difficulty in reaching the decision, uncertainty, risk, roles & responsibilities, commitments
- Contextual factors: initiating event, drivers, when, where, by whom, tools & services employed



Why doesn't DKC happen?

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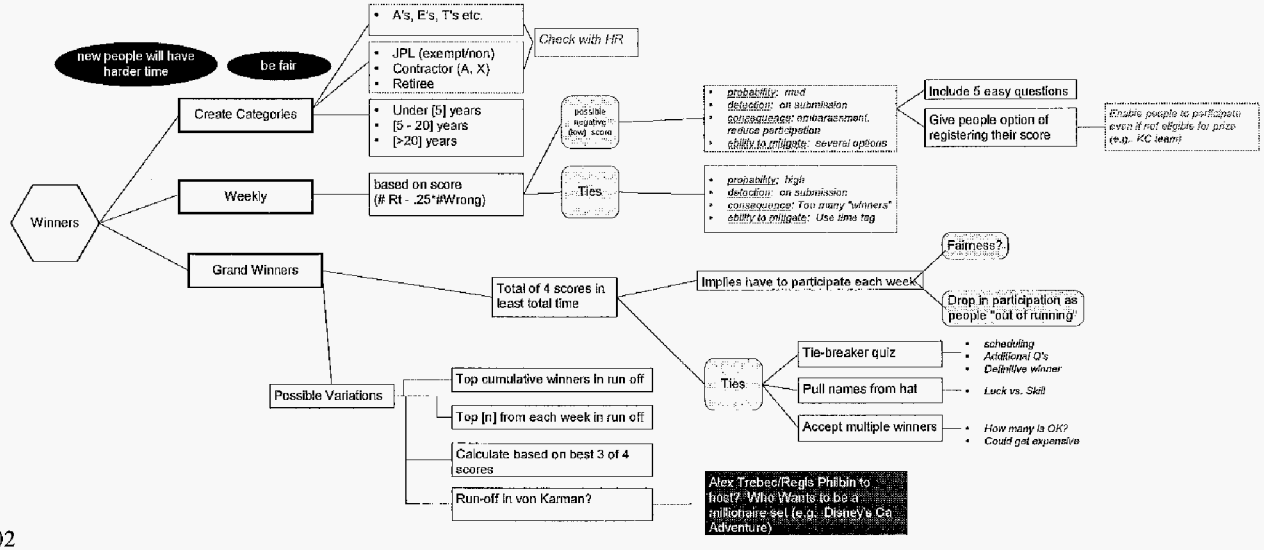
- Priority focus on getting the job done (vs. documenting it)
  - Important info in dialogue that never makes it into the documents
  - Participating vs. facilitating or documenting
- Teams have cognitive limitations
  - Limited recall, ability to construct retrospective sequences
  - Bias toward what's of immediate importance and personal relevance
- Some information is hard to capture
  - Ambiguous, partially formed, controversial information
  - Assumed shared references or "givens"

Sample DKC Products

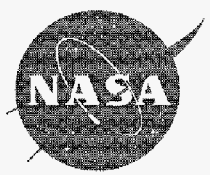
- Meeting Summaries, Action Items, To-Do Lists, Commitments, Rec/Dels
- Annotated Requirements
- Feed-forward Information, Reminders
- Decision Map: Graphical representation of components of decision/process and relationships between them



What we've learned (cont.)

1. Design Knowledge Capture products are valuable to the project team

- Facilitate work
  - Reduce "falling through the cracks"
- Project continuity
  - Make decisions once/Reduce "reconstruction" of decisions
  - Bringing new people up to speed
  - Bridging down times
- Mission assurance & Risk management
  - Document assumptions, information sources
  - Ripple effects when assumptions violated
- Identifying opportunities
  - When technologies or constraints change



What we've learned (cont.)

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2. It is extremely difficult to both actively participate and attempt to capture the decision process

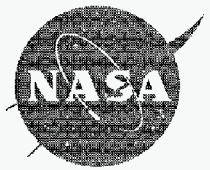
- Greater degrees of cross-functional-ness increase the difficulty of DKC
  - Need background and skills in multiple vocabularies, understanding significance across multiple disciplines, identifying interactions
- What gets captured is heavily influenced by what the participant focuses on
  - Other important information ignored

What we've learned (cont.)

3. Some products are easier to capture than others
   - Action items, Rec-Del, To-Do Lists, Commitments
     - Easily discernable verbal cues exist for these items
     - A "Trained Listener" can improve capture by a **factor of six**
     - Products can be created in realtime and used at end of a meeting or work session
   - Information Sources
     - Files or other materials created by team members referenced during sessions – easy follow-up to get file name, url, or upload document
     - External references are harder to track

What we've learned (cont.)

4. Good facilitation practices enhance what can be captured
   - Incorporating verbal cues into dialogue
     - E.g., "I will take an **Action** to ...." or "The **need date** is ..."
   - Identifying and summarizing key discussion points
   - Specifically requesting enough info to locate internal or external references
   - Creating a shared "parking lot" of issues for future discussion
   - "Labeling" the conversation
   - Providing opportunity for team members to annotate the record(s) of the session



What we've learned (cont.)

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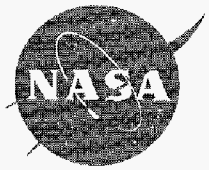
5. Decision maps extremely difficult to create in real time
   - ...unless willing to disrupt the natural flow of the discussion
   - Otherwise:
     - Discussion isn't linear
     - Latency between when a particular thread begins and when it's recognized
     - The items and relationships between them emerge throughout the discussion
     - It's difficult to correctly label content as it's being generated
     - Amount and speed of discussion beyond most people's ability to type, write, or manually record
     - Significant cross-talk, multiple conversations



What we've learned (cont.)

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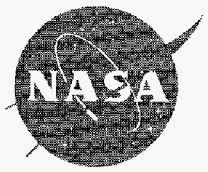
6. Decision maps are valuable even if created off-line

- Experienced success using decision maps to support on-going team activity
  - Team lead generated initial map following early team sessions, based on personal notes, recall
  - Review and update in subsequent meetings
  - Results from off-line activities spliced into overall map
  - Some things still slip through cracks – but what is captured is considered valuable



What we've learned (cont.)

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7. Technology to do automated, realtime, fly-on-the-wall capture not available

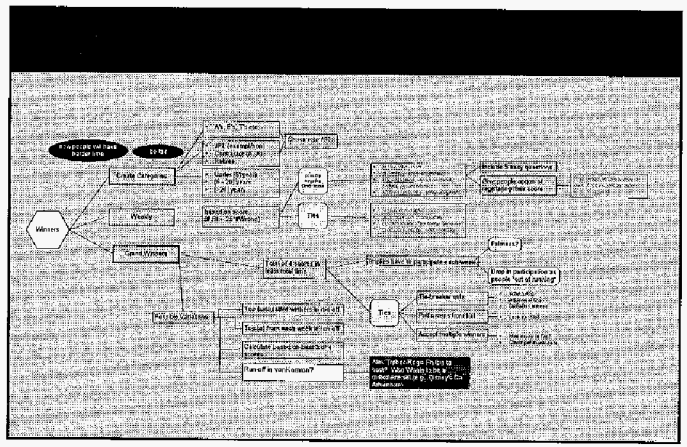
- Voice-to-text
  - Limited to what a conscientious note-taker, with possible audio recording support, can capture
- Text coding or analysis
  - However, emerging technology can be applied to assist manual processing
- Packaging and delivery
  - Limited to products defined and formatted a priori
  - Delivery options limited to subscription, pull, or rudimentary push (e.g., via agents)

What we've learned (cont.)

8. Several factors could turn DKC benefits into liabilities (for the project team)

- Overload
  - Managing the volume of new material captured
- Premature commitment
  - Due to psychological impact of seeing "draft" materials in product format
  - Anchoring effects
- Post-project audit liability
  - Should have known
  - Should have attended to
- Increased visibility into internal team activities

Long Term Vision

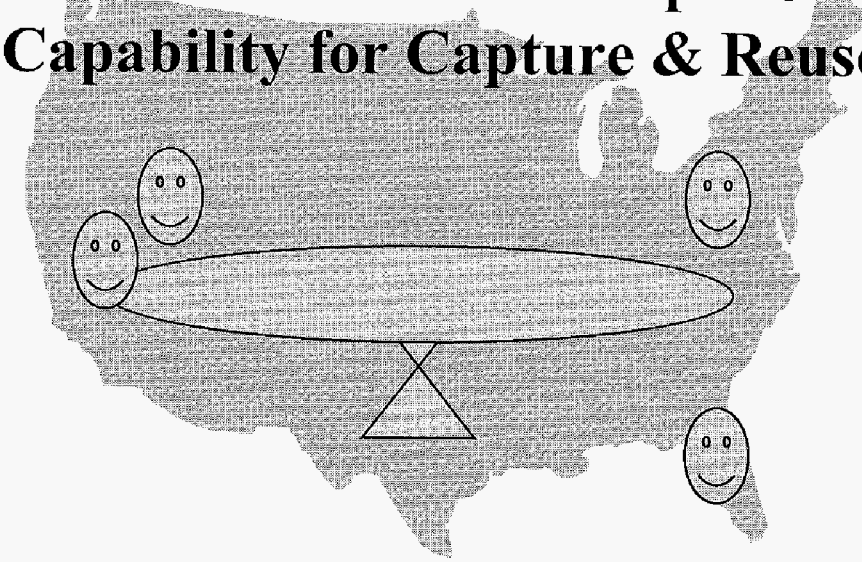


- Complete test plan
- Develop upscreening process for rad hard parts
- Sanity check subsystem design
- Logistics for peer review

- Readiness of technology
- Availability of parts from vendors
- Getting time in test chamber
- Replacing PEM
- Return to Flight

Real time – Unobtrusive – Cheap – On Demand Capability for Capture & Reuse

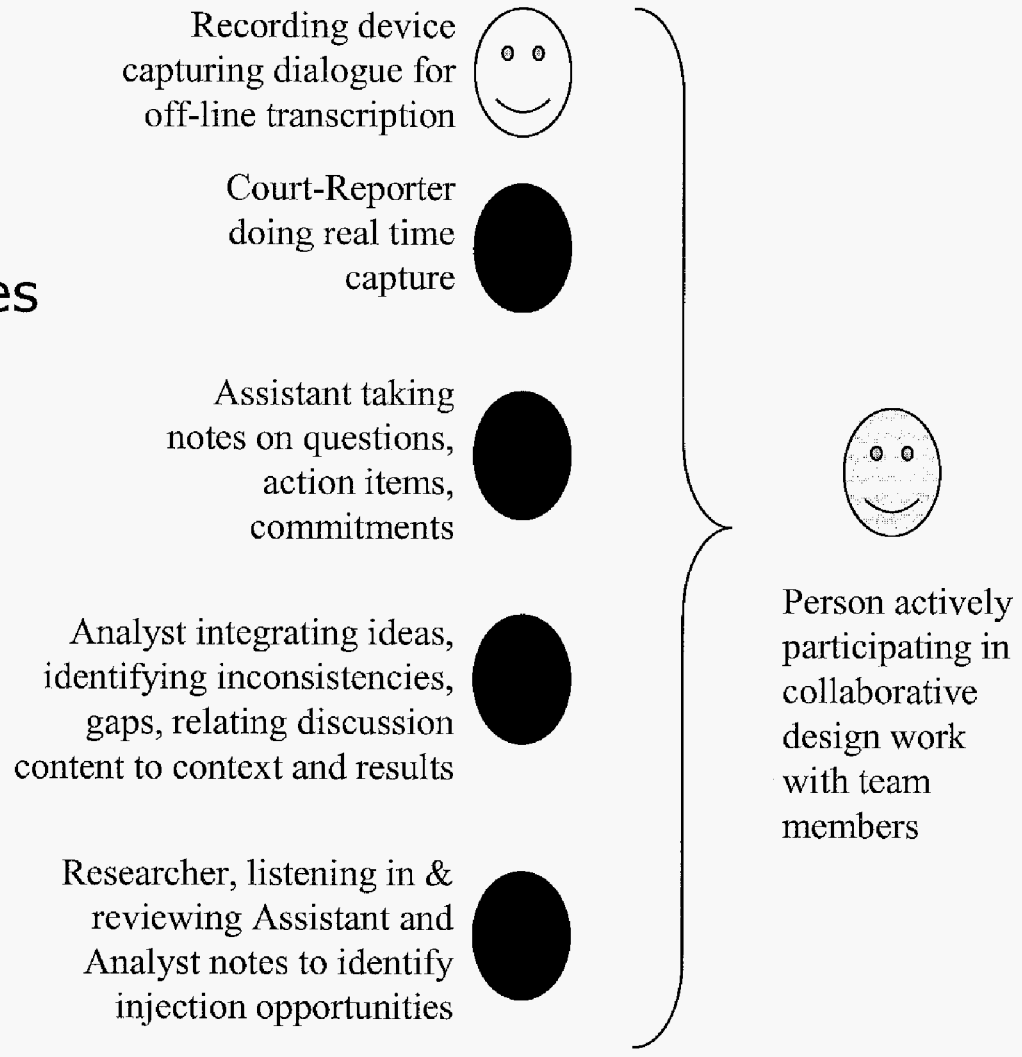
- E: IEEE paper on rad hard upscreening
- A: Environmental test facility available when needed
- A: Thermal profile = -140C to 25C
- A: Total dose req same as MER

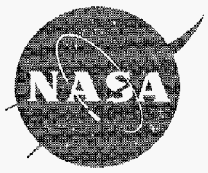


- Lesson Learned #1234
- Widgets-R-Us eCatalog
  - RSC100345 5V
  - RSC10034F 15V
- Mars Envir Doc
- Environmental Test Fac.
- TQDB
- etc

Near-Term Reality

- Evolution Issues
  - Cost
  - Filling the roles (willing and able)
  - Real-time capabilities
  - Performance
  - Trust
- Incremental improvements through
  - Technology
  - Method
  - Behavior
  - Product definition
  - Service base





In closing

- Developing new products, tools, and delivery methods for DKC
  - Being tested using data gathered from actual JPL proposal team
- Shifted focus
  - From evolution to automated, realtime capability
  - To what can be implemented in the near term
    - Product templates and methods
    - Training
    - Support tools