CM and Drawing Release in a Rapid Prototyping Environment

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CM and Drawing Release

• JPL and the “JPL Way”

• Past, Present, and Future of Drawing Release

• Leveraging Tools – The Technology Catches Up!

• Integration and the Service-Oriented Approach

• Questions and Comments
Facts About the Jet Propulsion Laboratory

• Managed by the California Institute of Technology
• NASA’s lead center for robotic exploration of the solar system
  – ~$1.6B contract per year, ~ 5300 employees
  – 177 acre facility located in Pasadena, CA

– Manages worldwide Deep Space Network
  • 3 Locations - Goldstone CA, Madrid Spain, Canberra Australia
  • Spacecraft Command & Control - Recording scientific data
• 50+ years experience in spacecraft design, production and operation

JPL spacecraft have visited all planets in our solar system except Pluto!
Understanding the JPL “culture”

University Focus
- Scientific Research
  - World class Scientists in residence working with universities worldwide

Aerospace Business Focus
- State-of-the-art Engineering Design & Development
  - Spacecraft and Instruments
  - Communication and Navigation
- High Precision Production of Mechanical & Electrical Assemblies
  - In-house capability
  - Industry partners and suppliers worldwide

Other Factors
- Intelligent, creative, free thinking people
- Very visible - in the news
“Typical” Project

• JPL provides system management for a team of:
  – Project Scientists from around the world
  – Multiple JPL design teams with some in-house production
  – One or more NASA centers doing trade studies and perhaps developing instruments
  – One or more space agencies from outside the US also developing instruments
  – Industry Partners and vendors assisting with design and production of spacecraft, large assemblies, or components
Flying Prototypes

• JPL Projects are all (well, almost all) One-of-a-Kind endeavors
• No Mass Production
• No Significant Heritage from previous missions
• Fresh teams
• Very Rapid development cycles
• Finding relevant Lessons Learned, Design Information, or other previous knowledge is a challenge
• Releasing Designs must be a Rapid – but Controlled affair
Past, Present, and Future of Drawing Release
The Past

• Old Drawing Process (in order to build)
  ❖ Get all signatures on the DWG, then CM releases
  ❖ –OR –
  ❖ Create and approve an X-Revision design, build, _then_ get all signatures and release as Rev. A,
    ❖ Then provide both X and A to QA to review for final inspection

• Issues
  ❖ With Full Release, all signatures need to be gathered before build
  ❖ X Revisions can only be used prior to Initial Release
    ❖ But Most JPL drawings fly as Rev A!
  ❖ If there is an X-Revision, you need to keep it for inspection
  ❖ Most X-Revisions are never released
Current Drawing Process – How it works

X-Revision:
Rational for the Past

• Designs and Changes are done REAL TIME
• There is no history or precedence for assemblies
• Models are integrated from a variety of partners and often issues are found in the Fabrication and Assembly phase
• All the same issues you find in a normal R&D or Prototyping environment
Re-iteration of the issues

- Some drawings and designs go out for costing and fabrication without being released
- Traceability can be lost when changes occur
- The X-number scheme is unwieldy and not desired
- Sequence numbers (Versioning) is basically the same as X-revs
- Versioning poses some numbering issues (E.g.: A1, A2, A3, A, B1, B2, B) and will require custom coding on ERP and PLM systems
- The current release process is an All-Or-Nothing affair.
- There are no conditions put on the use of a drawing.
Present Day Release Process

- Discuss the benefits of the new Release Level concepts
- List of the Proposed Release Levels
- Show a practical example
- Summarize and review
Benefits of Release Levels

- Designs leaving the modeling tools are frozen
- Only full revision letters are ever referenced outside of design
- Control over the USE of the drawing is maintained
- No confusion when matching designs to Hardware
Explanation of Release Levels

What are they and How do they work?
Levels of Release

• There are THREE levels of JPL release
  – Released for **Planning**
  – Released for **Procurement or Fabrication (Build/Buy)**
  – **Final or Full Release**
• There is also a “Vendor Released” level
• There have also been other levels suggested
  – Released for Integration
  – Released for Testing
  – Released for Inspection
  – Development
• Other Concerns
  – Need to take into account Red-Lines
  – Paper Release
  – Vendor Drawings
  – ECIs (Engineering Changes to Drawings)
Release Levels

+ Designer Signature = Planning
+ CogEngineer Signature = Build/Buy
+ Design Supervisor Signature
  CM Group Signature
  Thermal Signature
  = Final
Drawing Approvals - Signatures

- Released and:
  - Approved for Planning
    - Designer or CogEngineer
    - CM
  - Approved for Build/Buy
    - CogEngineer
    - CM
  - Approved for Final Inspection
    - Specified Functional Engineers
    - CogEngineer
    - Design Supervisor
    - CM
Description of Level Usage

• Planning
  – These drawings can be used for design reviews, base-line packages, or reference designs
  – These CANNOT be used for purchase, procurement, or fabrication
    – ie. Funds cannot be committed

• Build/Buy
  – These drawings can be used to receive a quote or even begin fabrication or procurement
  – Parts released for Build/Buy can even be used in non-flight assemblies
    – These parts will NOT pass final inspection

• Final
  – These parts have passed final review or been approved by the CogEngineer
    – These are approved for all uses at JPL
Review of Benefits

- **All** drawings are now Released
  - Before they are used in Planning or Costing
  - Before Fabrication or Procurement
  - Whenever they leave the design environment (TC Engineering)

- All designs that leave the modeling tools are frozen

- Only full revision letters are ever referenced outside of the design – Ends numbering scheme issue

- Control over the **USE** of the drawing is maintained

- No confusion when matching designs to Hardware
Issues with Release Level Concept

- Shift in the culture at JPL
- Release letters may reach Y or even AA, AB, etc
Use in Industry

• Large or slower moving Aerospace companies tend to use Full Revisions
• Some (ex: Hamilton-Sunstrand) use X-Revisions, but they always release drawings before integration
• Rapid development companies like HP use release levels or Full release on all designs
Summary and Conclusion

• This presentation is a simple overview
• The concept is sound and proven in industry
• It involves minimum intrusion into JPL’s actual practices, BUT
• It involves a change in the JPL cultural concept of Release
1) Call CM or use PDMS to reserve a drawing number.
Building to a Drawing

2) Capture the drawing:
   - Scan the drawing if necessary.
   - Upload the drawing file.
3) Sign-off the drawing:
   - Electronically
   - On the paper drawing itself
Building to a Drawing

- If you need to expedite the drawing:
  - Leave the signed drawing with CM
  - E-mail the drawing to CM and include a note that it is approved and okay to build
Revision Process
1) Call CM to reserve a revision letter.
2) Capture the revised drawing:
   - Scan the revised drawing if possible
   - Upload the revised drawing file
3) Sign-off the revised drawing:
   - Electronically
   - On the paper revised drawing itself
Redline Process – How it works

You may do a redline if the redlines are:

- Legible
- Signed
- Dated

Make sure to reserve a revision letter from CM.
Redline Process

- ECI information (was-is) is captured when a new revision letter is issued
- Redlines may be done electronically on the drawing PDF
- Redlines may be marked on the physical drawing
- ECIs May Substitute for a Red-Line
Take-Aways
Drawing Summary

- Drawings must be released prior to Build or Buy
- Sketches (Cat-E drawings) must also be released
- Models can be released as Cat-E drawings
- Drawing numbers are issued by CM or PDMS
- Drawings can be released with one signature & CM
- Released Drawings are authorized for specific purposes:
  - Planning
  - Build/Buy
  - Final Inspection
- All Drawing information will now be captured electronically
- CM is there to assist you
Revision Summary

- Revision letters come from CM or PDMS
- Revisions get signed and released just like Drawings
- Redlines can be released
Drawing Release – The Future

• Full Integration with Design and Modeling Tools
• Model-Based Release and Red-lining
• Capture design changes that happen in Assembly or off-site
• Electronic Mark-up and capture
• Eventual goal is to have NO red-lines or ECIs!
Long Term Vision

- COTS, state-of-the-Practice, efficient, evolvable, and cost-effective
- Scalable to all levels/disciplines
- Make collaborative, distributed engineering easy, routine, and effective
- Seamlessly connect tools to each other (and to previous phases of the design) to assure necessary coordination among functions
- Workflow based to assure that proper processes are followed
- Permit rapid development of high-quality designs
- Configuration control is easy and continuous
- Connects to business system and ERP to support best business practices, earned-value management, etc.
New Interface

Main Page

Drawing Tool

DRI Tool
The Technology Catches Up

Innovations in UI Design

&

The SOA Solution
Innovation Objectives

Establish a Common Engineering Environment/Platform

• Deploy a common environment for supporting engineering based upon a commercially available suite centered on a “product data management system” (PDMS)
  • Workflow based mechanism for capturing, storing, and relating all of the system engineering products to assure proper coordination and control
  • Proposed changes are identified throughout the system, the defined change approval process is invoked and managed, official documents and drawings are properly updated, cognizant engineers and managers are notified, etc.
  • Links to computer-aided engineering and design systems assure that the results of the changed requirement can be easily and correctly assessed
  • Workflow-based system easily configured to specific needs and processes of any project
  • Links to most commonly used system engineering tools, such as requirements repositories, document and information management systems, design tools, failure reporting systems, and enables data to be passed among them
  • Provides for remote concurrent engineering with built-in ITAR safeguards
  • Incorporates capabilities which accommodate team-based interactions, such as action item tracking and notification, task list maintenance and coordination, calendaring, messaging, etc.
  
• Represents a potential “sea change” for the working-level engineer
New Features

NO MORE POP UP Windows!!!
New Features

Want the URL to a Drawing Record??

<table>
<thead>
<tr>
<th>Item Number</th>
<th>Relationship</th>
<th>Edit Record</th>
<th>Don't Delete Record</th>
</tr>
</thead>
<tbody>
<tr>
<td>10270073,A,1</td>
<td>Has Part</td>
<td>Modify</td>
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# of new parts to this drawing

Add | Add | Delete


http://pdmtestwss.jpl.nasa.gov/_layouts/Community1/0/PropertiesAction.aspx?objd=pdmtestjpl--pdmtestwss-gWV&recordType=Drawing

2005/11/10-20:31:01:130

super user

Drawing Source: TecEnt
New Features

Want to bookmark an important Drawing??
New Features

Original process

Release Package Wizard

Want to add Drawings on to a Release Package?
New Features

New Process

Want to add Drawings on to a Release Package?
### Multiple Drawing Modification

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<tr>
<th>Type</th>
<th>Number</th>
<th>Revision</th>
<th>Title</th>
<th>Status</th>
<th>File</th>
<th>Project</th>
<th>CogE</th>
<th>Release Date</th>
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<tbody>
<tr>
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<td>10270410 A</td>
<td>A</td>
<td>SHARON STILL TESTING</td>
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**Cognizant Engineer**

**Designer**

**Title**
PDMS in 2005

Development

Project Requests

Drawings
Documents
DRs
Waivers
AIDS
CDRLs
Budget Lien

API Layer
Processes and Security
Sherpa
Oracle
Support

Enterprise (Process & Security)
Community
Oracle
SQL

Other Systems

Project Requests

Models
Viz
Collaboration
Meetings

SPIDER

Oracle

PDMS in 2005

API Layer
Processes and Security
Sherpa
Oracle
Support

Enterprise (Process & Security)
Community
Oracle
SQL

Other Systems

Drawings
Documents
DRs
Waivers
AIDS
CDRLs
Budget Lien

API Layer
Processes and Security
Sherpa
Oracle
Support

Enterprise (Process & Security)
Community
Oracle
SQL

Other Systems
Implementation Lessons Learned

• Re-engineer processes - involving direct user groups
  – Build an integrated architecture and framework from the beginning
  – Develop top-down strategy for common processes (and tools)

• Key technical staff committed to support the project for its duration
  – Copilot with consultants but train your own staff

• Philosophy: Stay with COTS - Minimize customization

• Early development of a pilot system with demos to all
  – PowerPoint charts are ineffective – everyone wants a demo
  – Use “real – project” data to show how it works -It helps to train your staff
  – Senior management is more willing to fund a working pilot
  – Collaborative demos from Vendor and Partner locations build interest in the new system

• Phase implementation
  – Manage the shock of change - take small steps – don’t over promise
  – Advertise, Advertise, Advertise
Next Steps

• **Mechanical Design Process**
  – Complete TC Engineering/Enterprise interface
  – Enhance the TC Integrator connector to move as-built from ERP to PDMS for as-designed/as-built comparisons
  – Expand process for models only (no drawing)
  – Expand design connection to contractors

• **Electrical Design Process**
  – Develop a seamless “Design to ERP” process
  – Expand ERP to include electrical fabrication
  – Expand PDMS with part-family management of electrical parts
  – Mechatronics

• **Link to Windchill for ESMD programs**
Thank You
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