The Engineering Manual

It’s Here!

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How did we get here?

- Good Engineering?
  - Yes
- Good Documentation?
  - Sometimes
- Consistent from Project to Project?
  - No
- To repeat a DOE phrase used about 12 years ago:
  - “ islands of excellence”

Many Islands – Few Bridges!

- Information sharing
  - Largely resides within the particular island
  - What happens when the device moves to another island?
    - Little documentation, need for reverse engineering, no idea of what the decision process was => lost time.
  - Where's the drawing?
    - When multiple islands collaborate where does the documentation go?
      - This problem comes up repeatedly.
  - Teamcenter

Been there – done that!

- Don’t do it that way!
  - “Say we tried that five years ago and it just turned into a real nightmare!” (Lessons Learned)
- A simple example:
  - In my early days at the lab (back when the dinosaurs walked the earth!) I discovered some things about instrumentation on a beamline target.
    - Don’t use plastic limit switches
    - Don’t use switches that have grease inside
    - Don’t use ordinary wire with standard insulation

Fast forward

- A target on a different island was having problems.
  - The motor would not move the target
  - They didn't know the target position
- Can you guess why?
  - Folks on that island didn't hear (or read) what I had learned!
  - The grease had turned to rock and was holding the switch actuated, making the motor think it was at a limit in the direction they needed to go

So where do we go wrong?

- Not fully nailing down the requirements and specifications.
  - Can you say REVIEW?
- Not paying attention to all important elements of the design.
  - Gee, I didn't think about that happening!
- Not documenting how we came to certain decisions.
  - I know that napkin with the calculation is here somewhere.
- Not teaching the end user how to run the system and under what constraints.
- Not communicating what we learned.

The Manual's Approach

- The emphasis (and responsibility) is placed on the Lead Engineer and their Department Head.
- There is an emphasis on Review's
  - Note: not cost and schedule reviews, real design reviews.
- There is an emphasis on documentation
  - Requirements, specifications, design calculations, operations and lessons learned.
  - Central database for all design information. Teamcenter
- I heard all the groans… but wait.

What else?

- The entire manual embraces the "Graded Approach" and the formality of everything is driven by it.
- DOE did not understand the last version but with Pier's urging they offered very reasonable suggestions.
  - A critical comment that we heard was "this is an expert driven manual not a process driven manual."
  - After a follow up meeting they said it was not what they were used to seeing but no reason it could not work and work well.

Risk based graded approach

- The engineer should record, in Tables 1 and 2 below, risk assessment integer values, between 1 and 5, as follows:
- 1 – ***low risk***
- 2 – ***low to medium risk***
- 3 – ***medium risk***
- 4 – ***medium to high risk***
- 5 – ***high risk***
- Definitions of the risk levels are given below with example criteria for risk levels 1, 3 and 5. Levels 2 and 4 are implied to fall between those provided.
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- ***A – TECHNOLOGY*** – This defines the degree of technical complexity the Lead Engineer or engineering team will face in executing the project.
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- 1 –The project will use off-the-shelf technology.
- 3 – Engineers will purchase and modify off-the-shelf technology.
- 5 – The project will require the development of new technology.


Requirements & Specifications
Engineering Risk Assessment
Requirements & Specifications Review
System Design
Engineering Design Review
Procurement & Implementation
Testing & Validation
Release to Operations
Final Documentation

Some quick notes

- The manual is purposely brief, on the order of 33 pages.
- It is not for the new engineer by his or her self. It is intended to be a template for the steps that must be followed. The new engineer will have to be mentored by a more senior (a.k.a. experienced) engineer.
- There is a large appendix of examples. >200 Pages
- NOTE: we will be asking for more examples and we see the manual as being a living document. As new examples are submitted we will include them.

Status

- The Manual is here!
- The web page for the Official version and the appendices is:
- http://www.fnal.gov/directorate/documents/FNAL_Engineering_Manual.pdf
- Go check out the appendices there is some great documentation in there at:
- http://www.fnal.gov/directorate/documents/FNAL_Engineering_Manual_Appendices.pdf
- There will be a link off the Fermi At Work home page under “Policies and Forms”

Final Words

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Questions?

- “***Engineering is not merely knowing and being knowledgeable, like a walking encyclopedia; engineering is not merely analysis; engineering is not merely the possession of the capacity to get elegant solutions to non-existent engineering problems; engineering is practicing the art of the organized forcing of technological change... Engineers operate at the interface between science and society...***”
- ***Dean Gordon Brown***
- ***MIT College of Engineering***