Integrating Manufacturability into Fuze Design
How to blow the competition away
(above results not typical, individual results may vary)
• INTRODUCTION
  – The Fuze Development Center
• Common pitfalls in development
• Two design approaches
• Integrating manufacturability
  – Key concepts
• Infrastructure examples
• Summary
Fuze Development Center Mission: Accelerate New technology to the Field
• You know your project is in trouble when:
  – Cost, schedule and performance are equally weighted.
  – The plan to meet the schedule requirement assumes none of the planned risk factors are ever encountered.
  – Requirements change but cost and schedule do not.
  – Your successful concept demonstration leads management to believe they have a product.
  – The formula \((2 \times \text{Manpower} = \frac{1}{2} \text{Schedule})\) is applied.
• Common pitfalls that impact schedule & cost
  – Using concept development for product development
    • Misleading results
    • Schedule and cost overruns
    • Dead end projects
  – Insufficient documentation during development
    • Results cannot be reproduced
    • Lost progress / wasted money
  – Uncontrolled materials used in development
    • Results cannot be reproduced
    • Misleading results
– Uncontrolled development processes/methodology
  • Diminishes teamwork
  • Duplication of effort
  • Lack of focus

– Lack of teamwork
  • Results cannot be reproduced independently
  • Duplication of effort
  • Schedule delays

– Absence of configuration controls during development
  • Results cannot be reproduced
  • Schedule delays
  • Cost overruns (Rework)
• Lets get something straight !!!
  – Experimentation (A few of a kind)
    • Focus on answering questions (is it useful?, how does it work?)
    • Ideal for exploring new or unknown technology
    • Documentation nonexistent or incorrect due to uncontrolled changes
    • Limited or no direct product transition (product potential only)
    • Foundation for a new competency
    • Often mislabeled as prototyping
  – Prototype (The first of many)
    • Focus on fielding a new capability
    • Results reproducible by an independent party
    • Easily transitions to production
    • Foundation for spiral development / product improvement
Integrating Manufacturability
Two approaches to development

Concept Prototyping
A model for experimentation and development

Government

Entry → Design → Test → Results → Hardware

Private Industry

Contract → Design → Mfg Data → Manufacture → Test → Results → Hardware → Exit

Legend:
- Process Block
- Database
- Hardware Object
- Data object (electronic method)
- Document (human method)
Integrating Manufacturability
Two approaches to development

Integrated Producibility
An integrated model for experimentation and product development

- Design
- Test
- Results
- Technology Database
- Hardware
- Mfg Data
- Manufacture
- Entry
- Exit

Government
Private Industry

Legend

Author: Stephen Redington
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Integrating manufacturability in development

- Focus on the product more than the part
  - Products can be delivered, parts cannot
- Focus on documentation up front
  - Assume nothing, specify everything
  - Is there enough detail for someone else to fabricate the design
- Stay under control
  - Follow a design process
  - Enforce a mechanism for identifying prototype configurations
- Promote teamwork
  - Minimize schedule delays
  - Share and incorporate specialized knowledge
This is extra work. Why Bother?

**Benefits**
- Less rework down the road
- Shorter time to field
- Lower overall cost
- Improved uniformity / consistency of performance

**Key concepts for success**
- Information Identification
- A Self Documenting Design Process
- A Self Explanatory Design Process
- Feedback Controls
- Design for Reuse / Prevent rework
- Manufacturing Awareness
Integrating Manufacturability

Key Concepts

• Information Identity is Key to Producibility
  – Identify information first, then create it
    • Enables product level documentation up front
    • Don’t create information, then identify it (indicates lack of planning)
  – Promotes teamwork / Enables information sharing
  – Mechanism depends on enterprise philosophy
    • Stupid numbers
      – Imply no information about the item / No classification errors
      – Simple rule to create / No exceptions to deal with
      – Requires an IT system to be useful
    • Smart numbers
      – Embed information about the item / Subject to human error
      – Must follow rules to create / Exceptions create problems
      – May or may not require an IT system to be useful
• **Self Documenting Design Process**
  
  – Shared common templates are key
    - Establish drawing format pages for all CAD tools
    - Establish common fabrication notes for all applicable technologies
    - Use your ID system to manage
  
  – Integrate the design process with your ID system
    - Make getting an ID number the first step in design
    - Promote configuration control up front
  
  – Leverage IT to make it work
    - Avoid human factor road blocks
      - Generate your ID numbers automatically
    - Automate repetitive tasks
• Self Explanatory Design Process
  – Consider human factors to minimize error
    • Minimize misinterpretation of design information where possible
    • Eliminate superfluous / irrelevant information
    • Accurate schematic representation of all elements in assembly
    • Physical location on schematic implies physical grouping on a PCB although no rules exist in reality
  – Group all appropriate information together
    • One archive per item to be fabricated
    • Natural enforcement of configuration
  – Review designs like your seeing them for the first time
    • Is it clear and easy to understand
    • Is it complete
• Enable feedback control in development
  – Capture and retain cost information where possible
    • Enable design to cost
    • Use as a metric (not actual cost) due to volatile nature
    • Use to quickly focus attention to “big ticket” items driving cost
  – Inventory information
    • Avoid designing in new parts / maximize reuse
    • Reduce schedule and cost at development time
  – Tracking and monitoring
    • Manage product development by managing its physical (tangible) parts rather than work breakdown on the project schedule
    • Track metrics that are easily quantifiable (tangible)
    • Avoid metrics that involve time (process over schedule)
• Design for reuse / Prevent rework
  – Design history is the core competency of the enterprise
    • Provide a foundation for repeat work
    • Provide a foundation for new work
    • Success or failure is irrelevant, either result builds knowledge
  – Centrally locate Information
    • CAD tools share common libraries
    • CAD information is the foundation for the next iteration
    • Make historical data accessible
  – Correct erroneous information immediately
    • Think of the next design error you will be preventing
Increase Manufacturing Awareness

- What can be made versus what can be drawn
  - What can done by machine / What needs to be done by hand
  - When are tooling holes needed and how are they used
  - What is a reference datum
    - How are they used
    - Where should they be located

- What kind of machines are applicable / available
  - How do the machines work
  - Where do they get their reference
  - What kind of tolerances are they capable of

- What kind of tools are applicable / available
  - How are the tools used
Integrating Manufacturability Infrastructure

How to go from here......

To here
A universal ID numbering system
- Select the best compromise of number intelligence

Example of an Information identification scheme used by the FDC

Note:
Only 6 classes cover everything

This presentation is
FDC # 0602-00013
- Self Documenting Process

User gets an ID number from Web application

Web application sets up all appropriate file folders and CAD templates
Integrating Manufacturability

FDC Infrastructure Examples

• Self Explanatory Process

What CAD generates

What is really needed

Look from the recipient point of view
• Feedback control example (cost & inventory)

(Inv > 0 ; $ > 0)
Researched and used

(Inv = 0 ; $ > 0)
Researched and not used

(Inv = 0 ; $ = 0)
Not researched and not used

(Inv > 0 ; $ = 0)
Not researched but Used (not shown)
• Pay as much attention to little problems as you would the big problems
  – Unlike experimentation, one unsolved little problem will kill a product just the same as one big problem.
  – Solving little problems early can help you solve big problems latter.

• It’s easier said than done
  – Everyone agrees that integrating manufacturability up front is a good thing. How many actually do it?
    • Expect resistance on both sides: engineering and management
  – Infrastructure and Management support are essential.
Questions

**Fuze Development Center**

US Army RDECOM ARDEC Fuze Division
Picatinny Arsenal, NJ

Stephen Redington, PE
973-724-2127