

U.S. Army Research, Development and Engineering Command



# Integrating Manufacturability into Fuze Design



### TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

#### Fuze Development Center

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Integrating Manufacturability into Fuze Design





# How to blow the competition away

(above results not typical, individual results may vary)





Integrating Manufacturability into Fuze Design



- INTRODUCTION
  - The Fuze Development Center
- Common pitfalls in development
- Two design approaches
- Integrating manufacturability
  - Key concepts
- Infrastructure examples
- Summary





The Fuze Development Center Picatinny NJ, Building 1530





### Fuze Development Center Mission: Accelerate New technology to the Field







Integrating Manufacturability Common Pitfalls



- 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 x Manpower =  $\frac{1}{2}$  Schedule) is applied.





Integrating Manufacturability Avoiding trouble



- 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





Integrating Manufacturability Common Pitfalls



### 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)





Integrating Manufacturability Two approaches to development



- 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







Integrating Manufacturability Two approaches to development



### **Integrated Producibility**

An integrated model for experimentation and product development









- 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







# • 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 verses 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



# Infrastructure



### To here







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



Example of an Information identification scheme used by the FDC







# Self Documenting Process









## • Self Explanatory Process

Look from the recipient point of view

| File Edit View What CAD  |   |
|--|---|
| G Back · C<br>Address D Y:\LLb generates                       |   |
| Folders  | Name 🔺  |
|  | Gerber Gerber Gosma, Rev0_spin_Air_Gun_uC.apr.apr 105mm_Rev0_spin_Air_Gun_uC.DRL.DRL 105mm_Rev0_spin_Air_Gun_uC.DRL.DRL 105mm_Rev0_spin_Air_Gun_uC.EXTREP 105mm_Rev0_spin_Air_Gun_uC.GBU.GBU 105mm_Rev0_spin_Air_Gun_uC.GBV.GBD 105mm_Rev0_spin_Air_Gun_uC.GBV.GBD 105mm_Rev0_spin_Air_Gun_uC.GBV.GBS 105mm_Rev0_spin_Air_Gun_uC.GBV.GBS 105mm_Rev0_spin_Air_Gun_uC.GBV.GBS 105mm_Rev0_spin_Air_Gun_uC.GBV.GBS 105mm_Rev0_spin_Air_Gun_uC.GBV.GBS 105mm_Rev0_spin_Air_Gun_uC.GBV.GBS 105mm_Rev0_spin_Air_Gun_uC.GM1.GM1 105mm_Rev0_spin_Air_Gun_uC.GM1.GM1 105mm_Rev0_spin_Air_Gun_uC.GM1.GM1 105mm_Rev0_spin_Air_Gun_uC.GM1.GM1 105mm_Rev0_spin_Air_Gun_uC.GT0.GT0 405mm_Rev0_spin_Air_Gun_uC.GT0.GT0 105mm_Rev0_spin_Air_Gun_uC.GT0.GT0 105mm_Rev0_spin_Air_Gun_UC.GT0 |
| re 🔳   | 105mm_Rev0_spin_Air_dun_uc.pur.pur  |
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#### Makedm Baidrige National Quality Award 2007 Award Recipient





Feedback control example (cost & inventory)









- 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.
- Its 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.





Integrating Manufacturability



# Questions

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