



# Using Manufacturing Knowledge Earlier in the Product Lifecycle

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# This work is based, in part, on...

- **Identified research directions for using manufacturing knowledge earlier in the product life cycle**
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# The Problem

- The Defense Acquisition University<sup>1</sup> claims 60-80% of the product life cycle cost is in the acquisition, operation and support of the product
- In a sampling of 35 defense-acquisition programs<sup>2</sup>
  - Development-cost growth averages 57 percent
  - Procurement-cost growth averages 75 percent
  - Decisions dominated the growth in both
- Every decision made early in the lifecycle becomes a constraint on the remainder of the lifecycle – reduces the compliant solution space<sup>3</sup>

1. Defense Acquisition University. 2011. DoD Life Cycle Management (LCM) & Product Support Manager (PSM) Rapid Deployment Training. <http://www.dau.mil/homepage%20documents/PSM%20RDT%20%28v10%20Tailored%2014%20Jun%2011%29.pdf>.
2. Bolten, J. G., Leonard, R. S., Arena, M. V., Younossi, O., & Sollinger, J. M. (2008). Sources of Weapon System Cost Growth: Analysis of 35 Major Defense Acquisition Programs. Santa Monica CA: RAND Corporation.
3. Alejandro Salado Diez. Measuring and influencing problem complexity and its impact on system affordability during requirements elicitation for complex engineered systems. Ph.D. Dissertation, Stevens Institute of Technology, 2014.



# Background

- Design for manufacturing (DFM) receives attention in the research community
  - (Cochrane et al. 2009 ; da Silva et al. 2014 ; Garbie 2013 ; Hague, Mansour, and Saleh 2004)
  - A lack of attention among solution providers has limited the availability of industry-mature solutions
- Research identified possible solutions for using manufacturing knowledge for decision support
  - (Alizon, Shooter, and Simpson 2006 ; Guerra-Zubiaga and Young 2008; Young et al. 2005 , 2007)
  - Solutions focused solely on technology issues (e.g., ontologies and models) and do not address the system-level issues (e.g., human factors and organization culture)



# A Workshop

- Attendees: industry, academia and US government organizations – domain experts from both the design and manufacturing domains
- Objective: elicit ideas for increasing the use of MBE methods, processes and tools to enable using manufacturing knowledge earlier in the lifecycle
- Participants were asked:
  - How can manufacturing input be included as part of early system trade studies?
  - How do manufacturing requirements, constraints and decisions affect upstream processes?
  - How do manufacturing requirements, constraints and decisions affect downstream processes?



# 10 Observations

1. Rules-based manufacturing analysis focuses typically on shape, but industry must also consider in what context is the product to be used and how is the product expected to behave (i.e. function)
2. Information for design intent (why vs. how) should be captured and transferred across the life cycle
3. Models across the digital thread need to provide both machine interpretable (e.g. shape and/or PMI) and human interpretable (e.g., text and/or visualization) information
4. Current solutions use file-based interoperability, while industry needs could be served better through relationship-based interoperability
5. Industry creates custom tools when tools do not meet needs or tools do not exist



# 10 Observations, cont.

6. Significant time and resources are required to ensure technology–environment configurations are in sync and interoperable across multiple entities (organizations)
7. Standards are based on domain-specific concepts, are not always interoperable and may compete with each other
8. The need exists for information standards that derive requirements to facilitate upstream and downstream flow in the product life cycle – data format standards are not enough to accomplish the information flow.
9. Industry needs are served best from a dynamically updated enterprise knowledge base.
10. There is a desire to leverage virtual model capabilities, including both manufacturability and assembly of the product, to assess DFx (e.g. producibility, assembly, testability and/or maintainability) earlier in the product life cycle.



# Proposed Research Directions

- Dynamic knowledge bases
  - Generating knowledge bases dynamically in near-real time would address barriers: (3), (4), (6), (8), (9) and (10)
- Minimum information requirements
  - Knowing the minimum information required by the product life cycle to complete one life cycle loop would begin to address barriers: (1), (2), (3) and (7)
- Interoperability support
  - Scientific pilot projects with releasable data are needed to further gain industry confidence in MBE and address barriers (4)–(8)



# Conclusions

- Both technology and social barriers exist
- Emerging goal for many industry and academic constituents is the creation (or completion) of a more holistic, model-based, product definition
  - What does this look like?
- Job roles must change, but how?



# Newton's First Law of Parenting

A child at rest will remain  
at rest ... until you need your  
iPad back.



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# THANK YOU. QUESTIONS?

