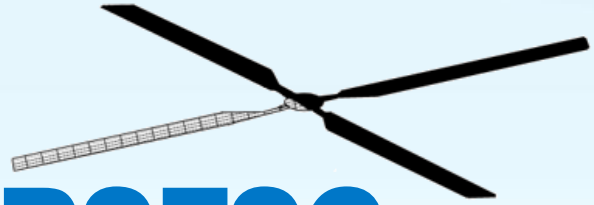

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MBSE Programs at UAH and Other Thoughts

Presented at the

MBSE and Software System Safety Workshop

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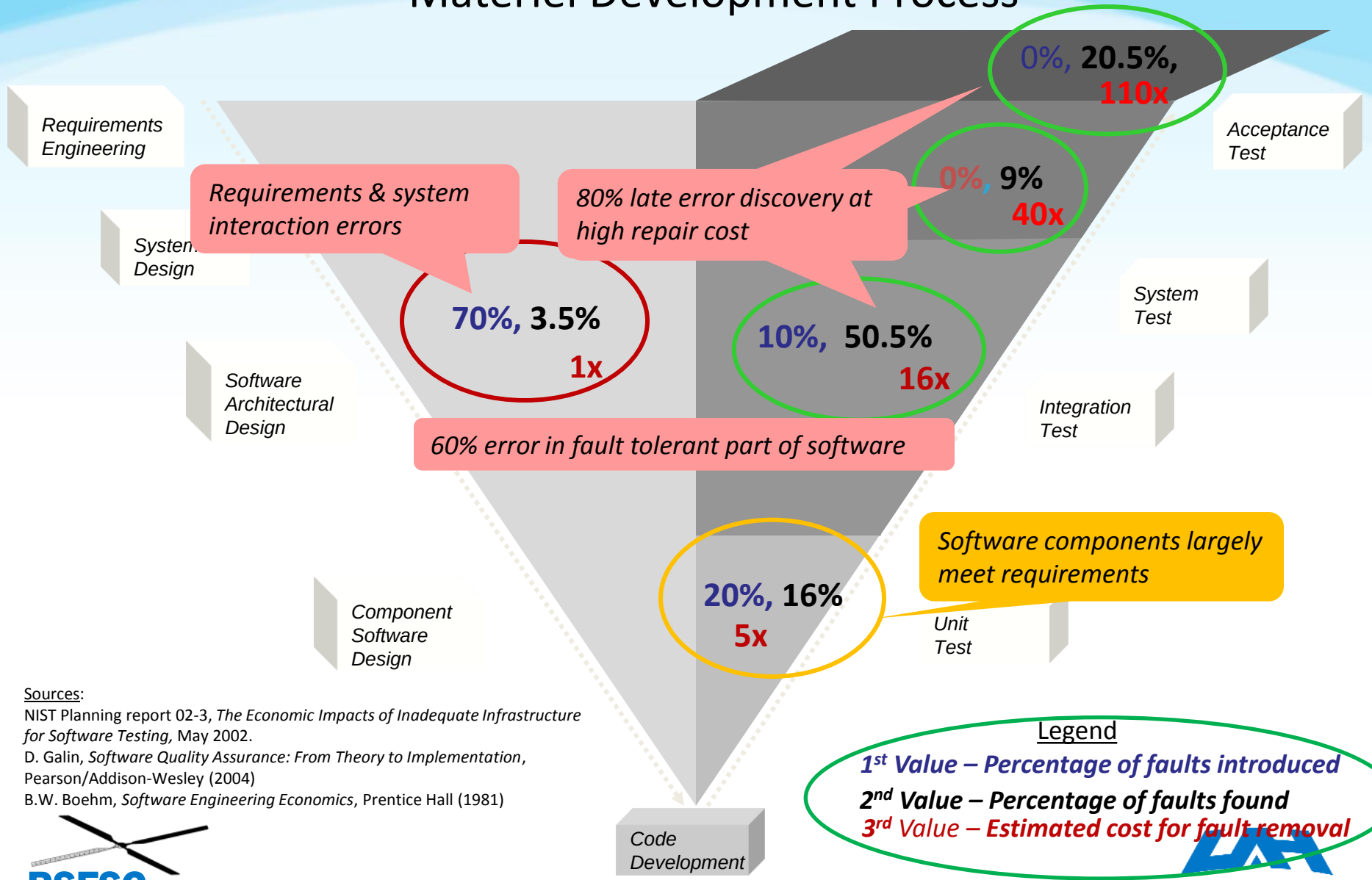
Complex Systems Integration Environment

- Changes in technology are occurring much faster than changes in standards and methods of compliance
- As systems become more complex, traditional systems engineering, contracting methods and airworthiness processes and standards
  - May not be sufficient to ensure safety of the platform while supporting the acquisition process throughout the lifecycle
  - Can drive weight into the design as well as cost without significantly improving the safety and mission effectiveness of systems
  - Try before you build – Virtual prototyping of technology while assessing system level performance
- The acquisition process must clearly articulate the buyers intent in terms of mission effectiveness and capability in order to
  - Create affordable systems and understand the trade space
  - Better assess cost and schedule risk starting at source selection through airworthiness determination and fielding

Early Problem Identification in the Materiel Development Process



Sources:
NIST Planning report 02-3, *The Economic Impacts of Inadequate Infrastructure for Software Testing,* May 2002.
D. Galin, *Software Quality Assurance: From Theory to Implementation*, Pearson/Addison-Wesley (2004)
B.W. Boehm, *Software Engineering Economics*, Prentice Hall (1981)

Legend

1st Value – Percentage of faults introduced

2nd Value – Percentage of faults found

3rd Value – Estimated cost for fault removal

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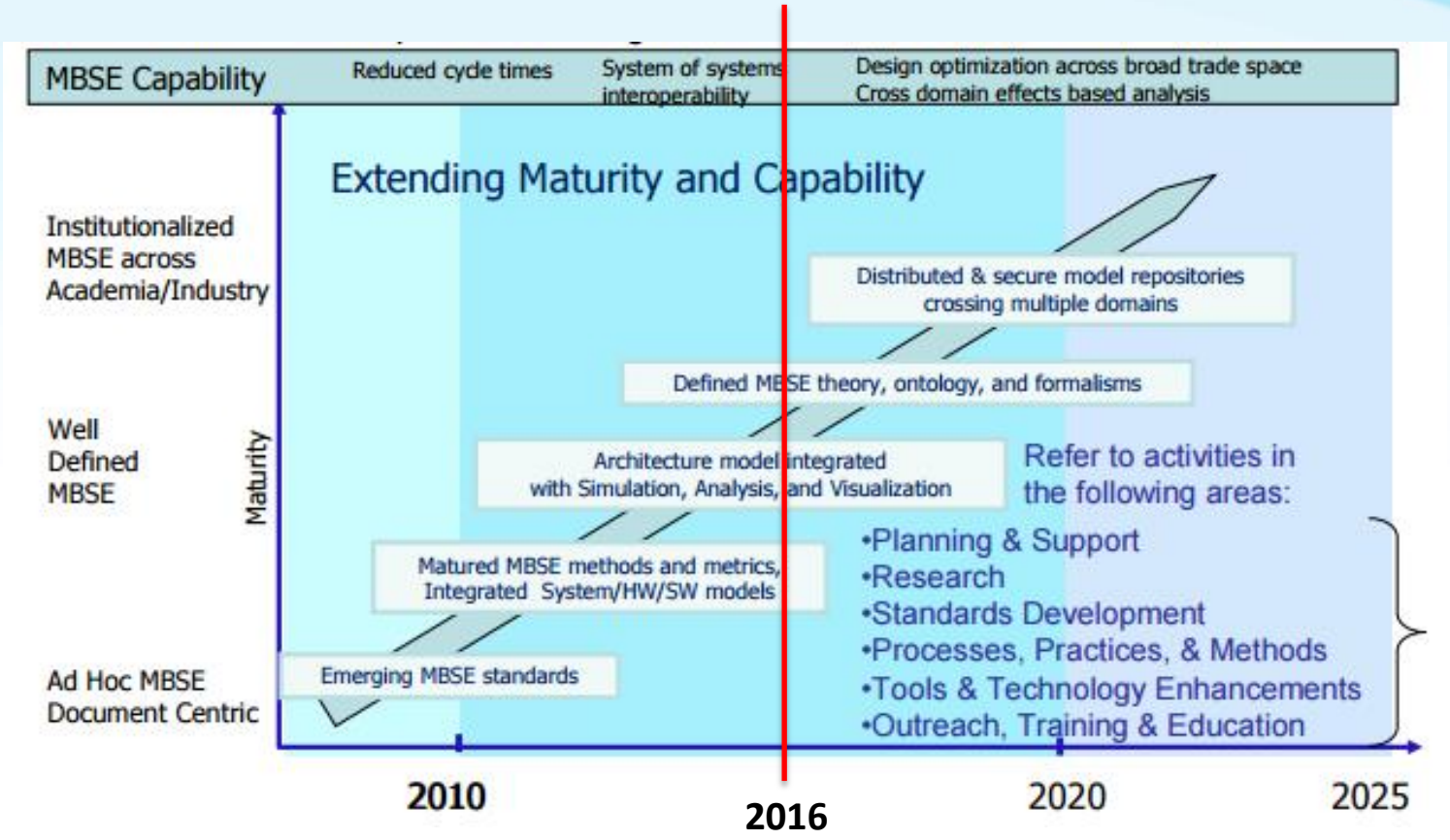
INCOSE MBSE Roadmap



Where is the "State of Practice" within Government and Industry on this Roadmap??

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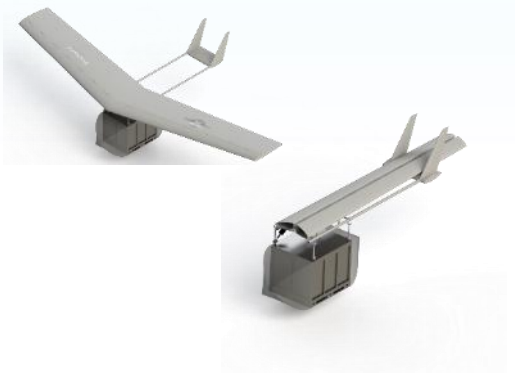
RSESC Complex Systems Integration Lab (CSIL)

- The CSIL at UAH provides the necessary environment for
  - Providing the necessary synchronization required between Trade Studies (Technology Push) and Systematic Operations Analysis (Technology Pull)
  - Executing the IPPD tradeoff methodology leveraging existing tools available from S&T and other efforts
  - Integrating new tools and methods as they become available
  - Integrating a broad range of tools into a singular environment
  - Providing the necessary methodology and stakeholder environment for successful FVL AoA execution
- ISEEM faculty, GRA and student engagement has grown significantly with the initiation of MBSE coursework and projects
- Provides a local and low-cost location for Government and industry collaboration necessary to support decision making throughout the Acquisition Process
- Early development of restricted area for classified efforts

Current Research Projects involving MBSE

- NASA – Nuclear Thermal Propulsion (w/Propulsion Research Center)
- PM Utility – UH-60M Improved System Safety (Lightweight FBW)
- PM Apache - Ground Fire Acquisition Demonstration (GFAD) Capability Integration Investigation on the AH-64E Apache
- AMRDEC SED - Architectural Analysis and Design Language (AADL) Graphical Editor for OSATE
- Industry – Support for AADL Algorithm Development
- Industry – Other Classified Projects
- Proposals Pending
  - Aircraft Carrier Overhaul Process Model
  - FVL support for MSAD AADL Improvements
- Additional Industry Focused Projects in Work



Planned Focused Areas

- Program Management Dashboards
  - Utilize one model
  - Entities get updates on status for their respective area
  - Begins with the development of the Acquisition Strategy and SEP
- Cost Capability Analysis
  - Evolving requirements from OSD
  - Already required for Air Force Projects
  - Impossible to do with a schedule and a spreadsheet
- Integration of Safety Products with Requirements Development
  - Integrated FHA and FTA like products that align with model development
  - Safety requirements and traceability integral model development
  - Includes software and hardware

Curricula Status

- Systems Engineering Modeling
  - Course offered in previous semester (Fall ‘16)
  - 11 students (1 senior undergraduate, 10 graduate)

- Development of Complex Systems Models
  - Course offered in current semester (Spring ‘17)
  - Course objective will be development & simulation of a complex system model
  - 6 students enrolled
  - Student projects with RSESC, PEO Aviation & NASA MSFC

- Planned curricula improvements
  - Revised sequence of topic coverage for next offering of SE Modeling (Fall ‘17)
  - Include objective of preparing students for OMG SysML certification
  - Better support for tool use (Cameo Enterprise Architecture)

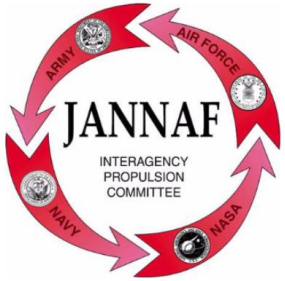
Recent Publications

- "Virtual Systems Integration using Model Based Systems Engineering"
  - Co authored by Dale Thomas & Bryan Mesmer
  - Presented in Session: IS-07/SSEE-07, Model-Based Systems Engineering: Methodologies and Tools II, September 15, 2016

- "Integrated System Modeling in SysML for Small Satellites"
  - Authored by Lloyd Walker & Dale Thomas
  - Presented in MST-17, Modeling and Simulation Integration and Architectures, January 12, 2017

- "Human Mental Models and Their Effects on Human and System Interactions within Socio-Technical Systems"
  - Co authored by Elizabeth Patterson & Dale Thomas
  - Presented at 15th CSER, March 23-25, 2017

- "Nuclear Thermal Propulsion Modeling Using Model Based Systems Engineering"
  - Co authored by Alexander Aueron & Dale Thomas
  - To be presented at JANNAF In-Space Chemical Propulsion Technical Interchange Meeting, 4-6 April 2017.



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Questions

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