Concurrent Engineering Working Group (CEWG)

Learning to Work Together

Cate Heneghan, Keith Warfield, Jairus Hihn
Jet Propulsion Laboratory/Caltech

CEWG History and Background

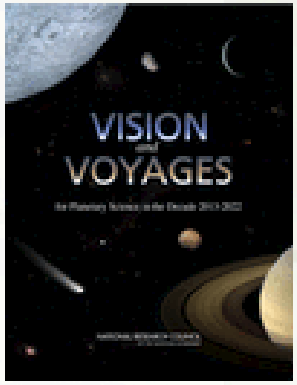
- Leaders of concurrent engineering teams from JPL, ESA, GSFC, GRC and Aerospace Corp. met for the first time in September 2010 to discuss common issues
- CEWG has over 50 members from 15 organizations
- Endorsed by the NASA Systems Engineering Community of Practice and the American Institute of Aeronautics and Astronautics
  - Meet twice per year and hold monthly telecons
  - In September 2012 CEWG held a one day meeting at JPL and organized a concurrent engineering session at the AIAA Space 2012 Conference
- If you are currently working on a CE Team or your company is starting to develop one and would like to get involved contact jhihn@jpl.nasa.gov

Objectives of CEWG and Participants

- Establish a forum to facilitate interchanges between aerospace organizations
- Engage the wider aerospace community in the utilization of concurrent engineering methods
- Build and leverage relationships between CE practitioners across NASA, other US government agencies and organizations within the aerospace community such as industry and academia, thereby increasing effectiveness and communication
- Provide and maintain a mechanism to exchange knowledge and lessons learned from their systems engineering experiences
- Identify common values and challenges among concurrent engineering teams to leverage benefits and align products and processes

Motivation to formulate CEWG

- Need to improve standardization or at least traceability between the different parameters and products produced by the major design teams
- Need to ‘standardize’ the team products arose during The National Academies’ Planetary Science Decadal Survey conducted in 2010
  - Mission studies were conducted by different teams and later compared and evaluated
  - Various problems arose afterward trying to compare the products of the different teams
- Need to ‘standardize’ the lower level working parameter sets is arising as teams find increasing need to work joint sessions
  - The ESA ESTEC team has been a leader in this area



Emerging Trends in CEWG

- A few common themes arose during our recent meetings
  - Establishment of Concurrent Engineering Architecture Teams
  - Conclusive need to use MBSE techniques to enhance concurrent teams and their products
  - Outreach through student engagement

Concurrent Engineering Architecture Teams

- Blends new and proven methods for a small team of architecture-level experts
- Evaluate architectural options to reveal unforeseen opportunities
  - Explore a broader trade space
  - Avoid driving to a baseline prematurely
  - Identify innovative, unforeseen paths
  - Rapidly analyze preliminary feasibility

JPL Architecture Team

GSFC Architecture Team

Comparison of Concurrent Teams

Traditional Concurrency

- Subsystem level trades
- Team Composition
  - Full compliment of Subject Matter Experts
  - Standard Team
  - 20+ subsystems
- Standard Product
- Standard Tools
  - Developed and approved by line organizations

Architecture Concurrency

- Trades across multiple designs
- Team Composition
  - Subject Matter Experts vary depending on study
  - Smaller Teams: 8-12
- Custom Product
- Custom Tools
  - Developed by line organizations

Benefits of MBSE

- MBSE enhances the ability to capture, analyze, share, and manage the information associated with the complete specification of a product, resulting in the following benefits:
  - **Improved communications** among the development stakeholders (e.g. the customer, program management, systems engineers, hardware and software developers, testers, and specialty engineering disciplines).
  - **Increased ability to manage system complexity** by enabling a system model to be viewed from multiple perspectives, and to analyze the impact of changes.
  - **Improved product quality** by providing an unambiguous and precise model of the system that can be evaluated for consistency, correctness, and completeness.
  - **Enhanced knowledge capture and reuse of the information** by capturing information in more standardized ways and leveraging built-in abstraction mechanisms inherent in model-driven approaches. This in turn can result in reduced cycle time and lower maintenance costs to modify the design.
  - **Improved ability to teach and learn systems engineering fundamentals** by providing a clear and unambiguous representation of the concepts.

"INCOSE Vision 2020; Model-Based Systems Engineering (MBSE)"; Highlights from MBSE Workshop; July 7, 2006

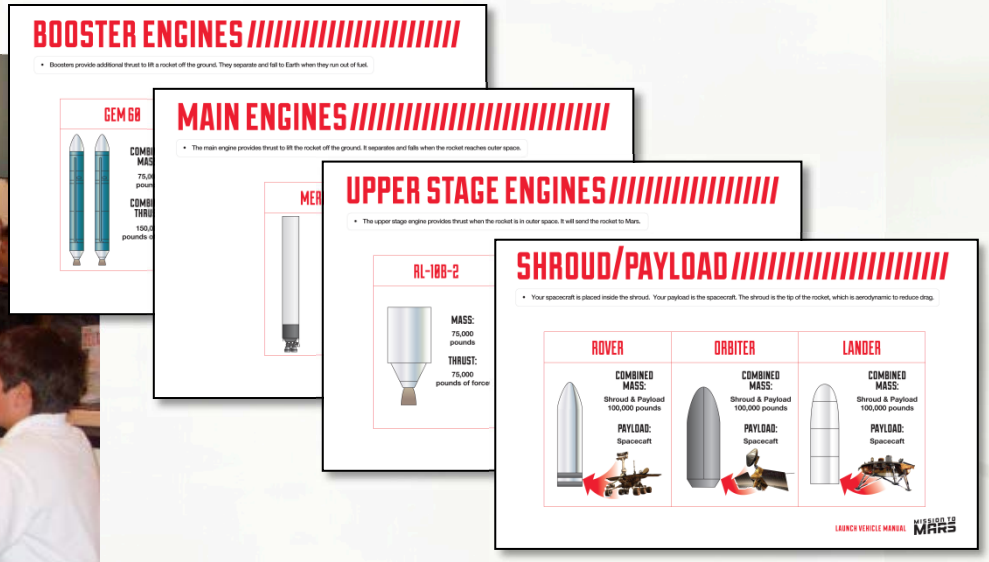
Taken from "Model-Based Systems Engineering (MBSE) Overview" by Joe Wolfrom of the Applied Physics Lab (APL)

Challenges of Infusing MBSE into Concurrent Teams

- MBSE represents a major paradigm shift in design, which creates many barriers of entry
- Barrier of entry within concurrent team
  - Subsystem experts need to learn new software application and revise design method
  - Too slow to use “raw” in a concurrent engineering setting
- Barrier of entry for the stakeholders
  - Need to sufficiently understand the new design methods and set of different products to incorporate into mature products downstream
- Barrier of entry for the institution
  - Need to make a significant investment in a new set of tools and infrastructure
  - Difficult to invest when an existing operational system meets current customer needs

Outreach to Middle Schools

- Students from 2 or more schools connect through videoconference on mission day at the Chicago Museum of Science and Industry and at a Challenger Learning Center
- Students collaborate to select a payload and design a launch vehicle capable of lifting the payload and sending it to Mars.



*From AIAA Space 2012 "*Mission To Mars*" by Tara Polsgrove of the Marshal Space Flight Center (NASA/MSFC)*

Outreach to Graduate Students

- NASA's Planetary Science Summer School
  - Intensive one-week study by a team of postdocs and graduate students who learn the process of developing a robotic mission concept using concurrent engineering methods and facilities
  - Hosted by JPL's Team X
    - Students paired with Team X Subject Matter Experts