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US Global Threats

Behavior of Threats

	HOSTILE	AGGRESSIVE	TESTING	ASSERTIVE	BENIGN
Russia		✓			
Iran		✓			
Middle East Terrorism	✓				
Af-Pak Terrorism			✓		
China		✓			
North Korea		✓			
OVERALL		✓			

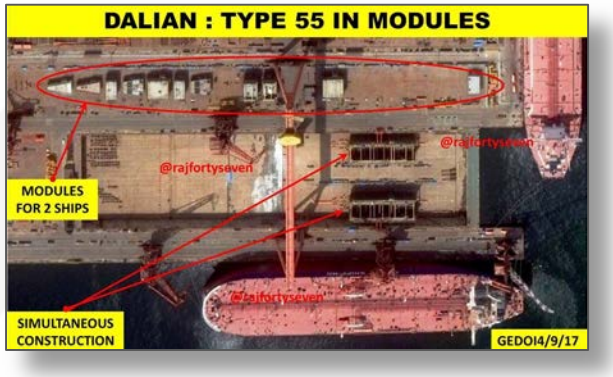
The Heritage Foundation: https://index.heritage.org/military/2017/wp-content/uploads/2016/11/2017_Index_of_Military_Strength_ThreatsBehavior.png

The Chinese P.L.A.N.

High-speed production: Chinese navy built 83 ships in just eight years

~COL Vinayak Bhat (RETD), Sept 20, 2017

- Article Highlights:
  - Chinese navy produces designs which surpass the most modern ships of the US Navy in size, volume, armament and quantity
  - By 2050, China is likely to have the largest navy in the world, unless the US Navy overcomes its resource crunch
  - The quality of ships, their armaments and performance is comparable with most modern countries
  - China's shipyards do not have the word "holiday' in their dictionary
  - Ships are built in modules
  - Chinese are also building submarines at a rapid pace; minimum of 4 subs at a time
- China is moving from a primarily coastal defense navy to a blue-water navy



Source: ***The Print***: https://theprint.in/security/chinese-navy-built-83-ships-8-years/10416/

Chinese Aircraft Carrier & Stealth Aircraft

- China expects to have its 3rd Aircraft Carrier launched by 2030
  - 28 – 36 J-15 Fighters
  - Opening of the Naval Aeronautical University with 450 new recruits
- J-20 Stealth Fighter
  - Entered Service in March
- Pterodactyl
  - Already utilized in Iraq and Syria

Sputnik News: https://sputniknews.com/military/201704051052323889-chinese-new-aircraft-carrier/
South China Morning Post: http://www.scmp.com/news/china/diplomacy-defence/article/2126564/chinese-navy-trains-more-fighter-pilots-expanded
CBS News: https://www.cbsnews.com/pictures/chinas-newest-weapons-of-war/23/

For Sale: China's lineup of brand new, souped-up tanks…

Jeffrey Lin & PW Singer, Aug 22, 2017

- CT-4 Main Battle Tank
  - GL-5 Hard-Kill Active Protection System
- VN17 Infantry Fighting Vehicle
  - Unmanned (remotely controlled)
  - 35mm Cannon
  - 7.62mm Machine Gun
  - HJ-2 Anti-Tank Missiles
- STZ-59 HIFV Heavy Infantry Tank
- All vehicles have some form of active protection

Popular Science: https://www.popsci.com/china-has-fleet-new-armor-vehicles
CBS News: https://www.cbsnews.com/pictures/chinas-newest-weapons-of-war/23/

Losing The Unfair Advantage?

"Managing complex, major system acquisitions has been a long-standing challenge for the federal government. Systems often cost more and take longer to develop and produce than originally planned, which forces agencies to request more funding to complete them, make trade-offs among programs, defer other priorities, or cancel programs after significant amounts of money have already been spent."

Government Accountability Office
https://www.gao.gov/key_issues/national_defense_space_system_acquisitions/issue_summary

How Can the US Field Technology Faster?

Trade Space Exploration of MBSE and MBE Integrated Workflows

NIST 2018 MBE Summit
Dr. J Simmons, PhD
Dr. Scott Ragon, PhD
Tony Davenport, BSME, MBA

April 03, 2018

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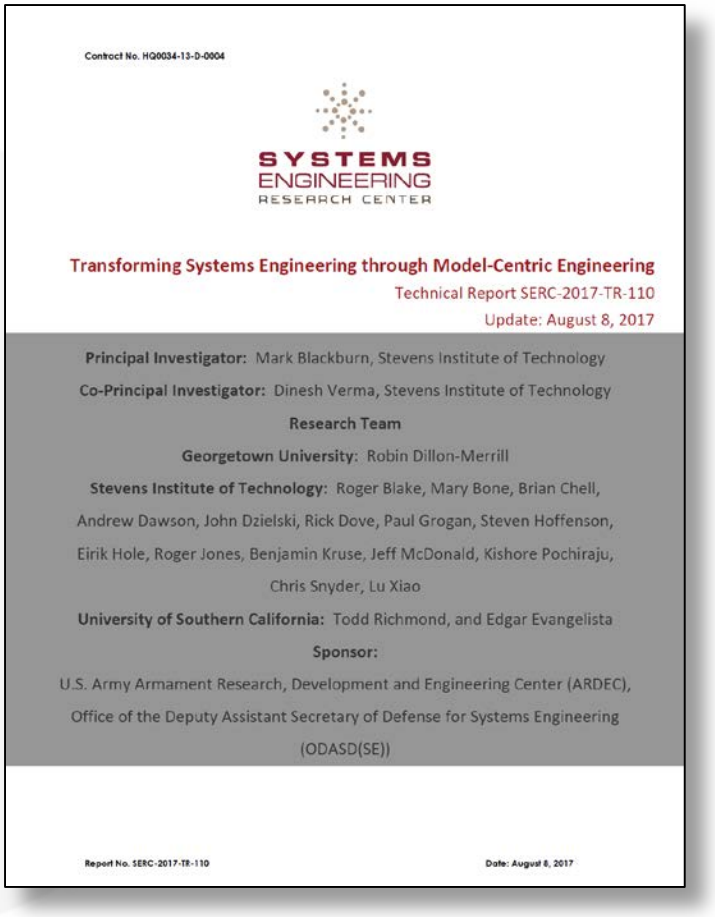
Stevens Institute / 2017 ARDEC Study

- Modeling Framework Requirements
  - HPC enabled
  - Single Source of Truth
  - Integration of multi-domain/physics models
  - Method for Model Integrity
- Systems Engineering (SE) activities… in the context of a Digital Thread



Contract No. HQ0034-13-D-0004

SYSTEMS ENGINEERING RESEARCH CENTER

Transforming Systems Engineering through Model-Centric Engineering

Technical Report SERC-2017-TR-110

Update: August 8, 2017

Principal Investigator: Mark Blackburn, Stevens Institute of Technology

Co-Principal Investigator: Dinesh Verma, Stevens Institute of Technology

Research Team

Georgetown University: Robin Dillon-Merrill

Stevens Institute of Technology: Roger Blake, Mary Bone, Brian Chell, Andrew Dawson, John Dzielski, Rick Dove, Paul Grogan, Steven Hoffenson, Eirik Hole, Roger Jones, Benjamin Kruse, Jeff McDonald, Kishore Pochiraju, Chris Snyder, Lu Xiao

University of Southern California: Todd Richmond, and Edgar Evangelista

Sponsor:

U.S. Army Armament Research, Development and Engineering Center (ARDEC), Office of the Deputy Assistant Secretary of Defense for Systems Engineering (ODASD(SE))

Report No. SERC-2017-TR-110 Date: August 8, 2017

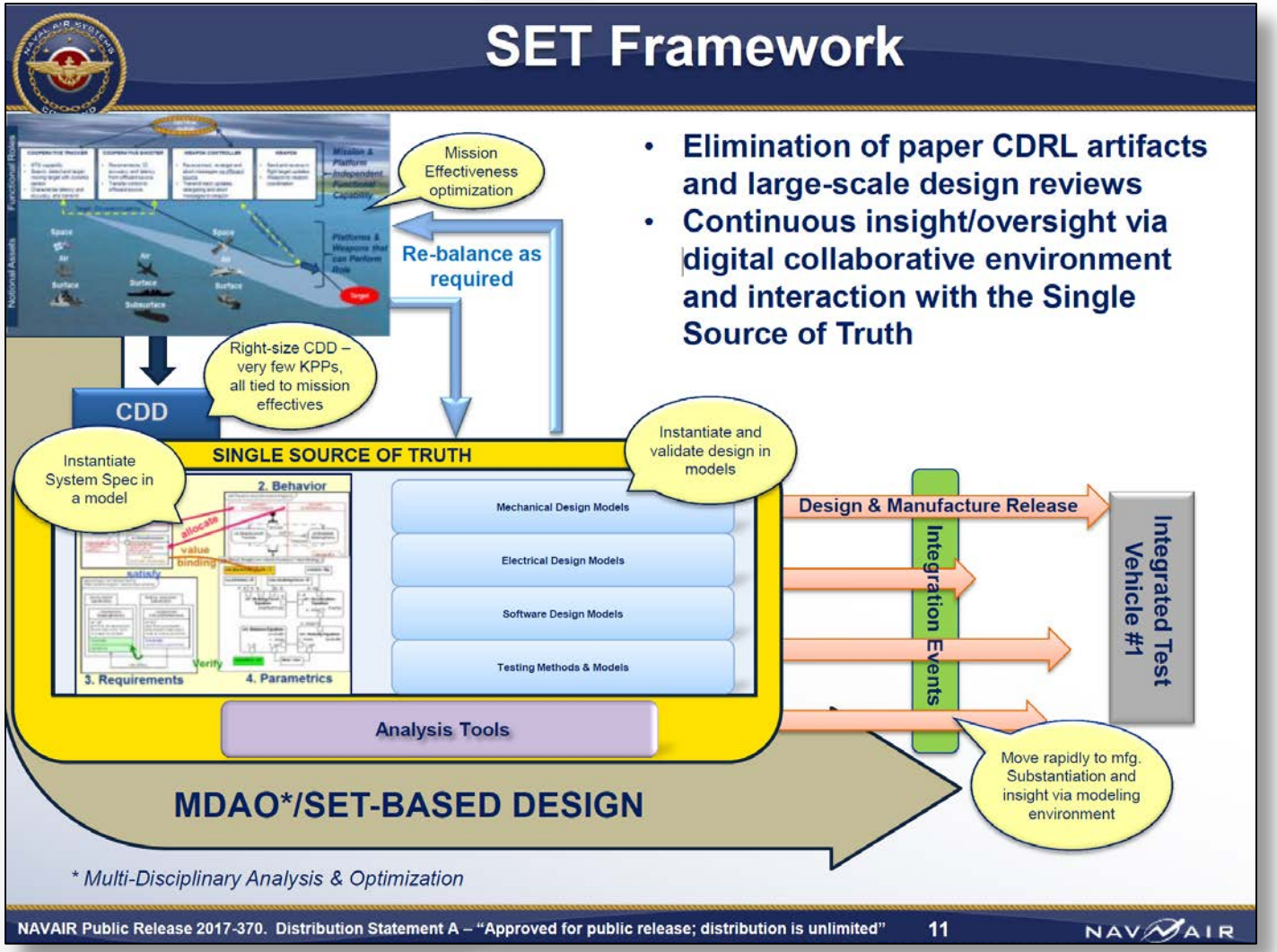
Blackburn, Mark, et al. SERC, RT-168: http://www.sercuarc.org/publications-papers/poster-ssrr-2017-rt-168-transforming-systems-engineering-through-model-centric-engineering/

Shared Vision (NAVAIR–ARDEC)

How SET Can Reduce Development Cycle Time

1. **Right-size CDD**
   - Narrow top of the requirements pyramid
   - Off-load requirements to other elements of SoS and via TTPs (CONOPS)
   - KPPs must be tied to mission effectiveness, Ao or Cost
2. **Eliminate or reduce SETR events**
3. **Eliminate/reduce CDRLs**
4. **MDAO enabled by HPC and multi-physics computational tools allows rapid optimization and design trades**
5. **Quality improvement at all levels – reduced rework due to requirements and design defects**
6. **Continual use of mission effectiveness modeling in design trade – reduce technical churn going after 100% compliance when 80% will satisfy mission**
7. **Allow asynchronous design and manufacture release decisions – Gov't involved real-time via IDE in production release decisions**
8. **Early T&E focused on model validation – allow models to do heavy lifting**

Systems Engineering Transformation



The New Acquisition Process (Major Concepts)

Department of Defense

- Develop a Mission Statement that includes Integrated Warfare Analysis
- Determine what Systems of Systems (SoS) can satisfy the mission—what technology is missing?
- Establish a Systems Engineering Model for missing technology that is offered to the US industrial base as part of the Request for Proposal (RFP)
- Determine winning proposal based on validation and verification of Systems Engineering model via Domain Expert Models
- Inspect work in near real-time throughout an asymmetric engineering and manufacturing process

The New Acquisition Process: Implied Needs

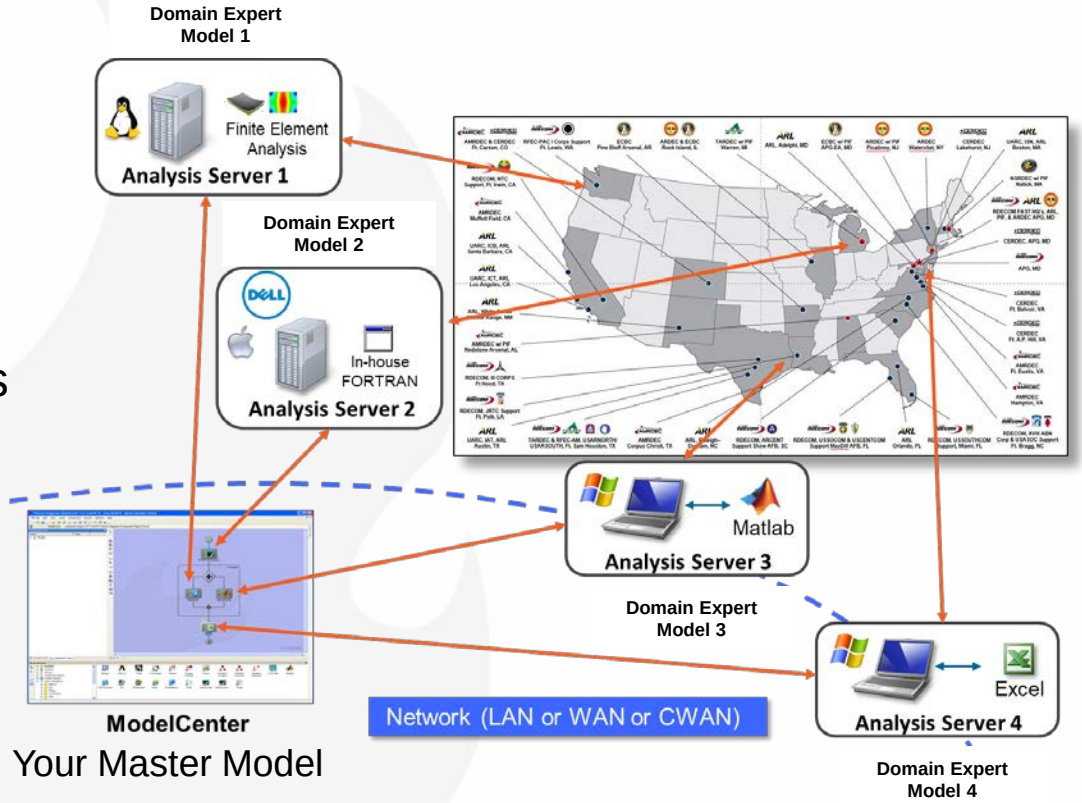
- **People**
  - Training in new process for systems engineers and domain experts
  - Awareness and interest in new process → Understand the advantages of the new process both as an organization and individually
  - Bring the Systems Engineers and Domain Experts together early in process
- **Process**
  - Domain Experts: Must build Models for reuse (understand inputs/outputs) and how to bound their Models.
  - Systems Engineers: Must understand how to ask the right questions of Domain Expert Models
- **Technology**
  - Must integrate MBSE to MBE solutions
  - Must share supply chain (Domain Expert) Models
  - Must manage and protect Intellectual Property (IP) of supply chain
  - Must follow security protocols yet still provide access
  - Must be easy to use at the individual level (or else it will not be used)

- ModelCenter Integrate
  - **Automate**
  - **Integrate**
  - To Create A Workflow
- ModelCenter Explore
  - **Iterate** The Workflow
  - Design Studies
  - Optimization
  - Risk/Reliability

Model as a Service

Work Directly w/ Industry SMEs while Protecting IP

- Models are created at Domain Expert Environment
- Master Model can get results from the Domain Experts
- IP (Models) never leave the Domain Expert Environment
- ModelCenter sends input values to Domain Expert Models
- Domain Expert Models execute locally in Domain Environment and then send back results
- Master Model only sees links to input/output variables of remote Domain Expert Models
- Bounds can be put on variables to minimize misuse of Domain Expert Models



- ModelCenter Integrate
  - **Automate**
  - **Integrate**
  - To Create A Workflow
- ModelCenter Explore
  - **Iterate** The Workflow
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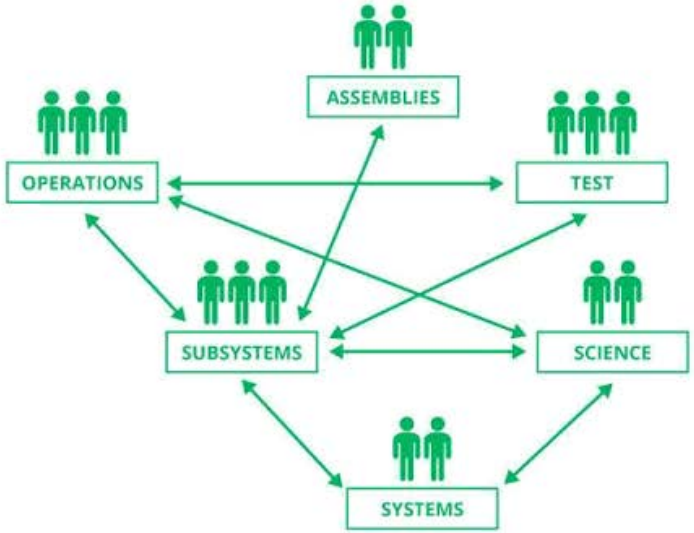
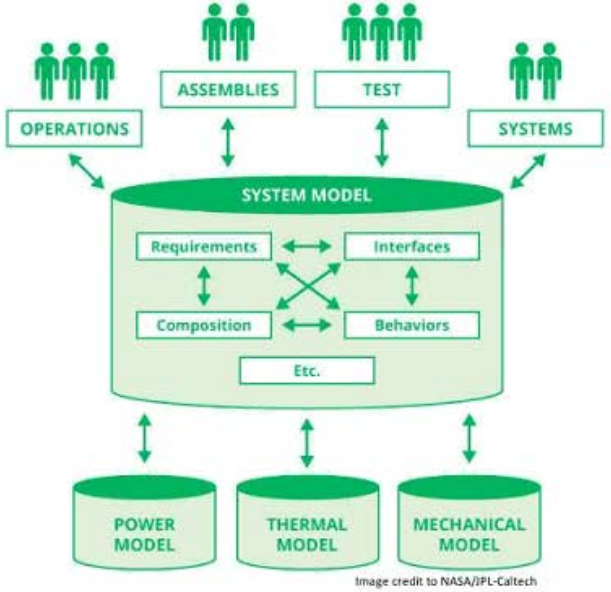
  - Optimization
  - Risk/Reliability
- ModelCenter MBSEPak
  - Integrate **Systems Engineering** Models with **Domain Expert** Models

MBSE in a Nutshell



Traditional Systems Engineering



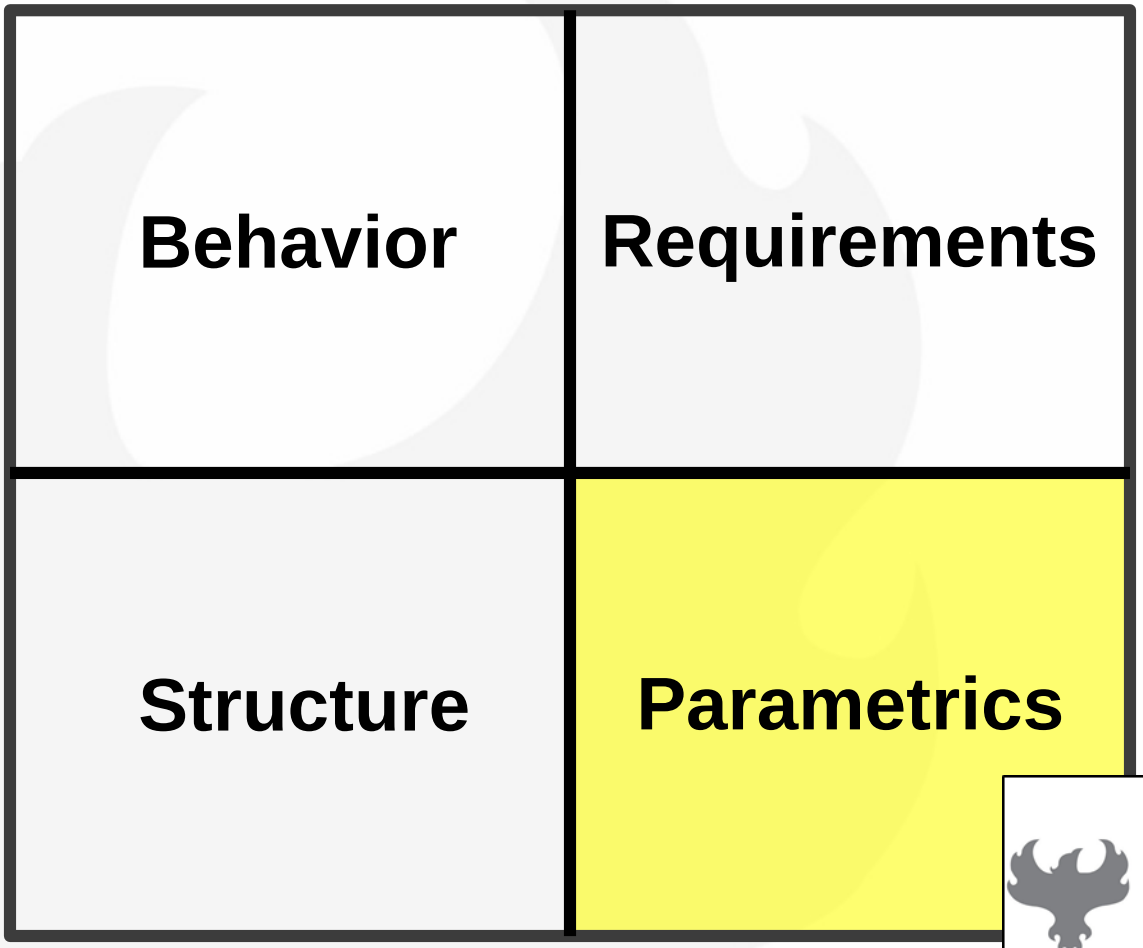
Model Based Systems Engineering

Massachusetts Institute of Technology

http://sysengonline.mit.edu/

From March 2017 Phoenix Integration Webinar

The Four Pillars of SysML



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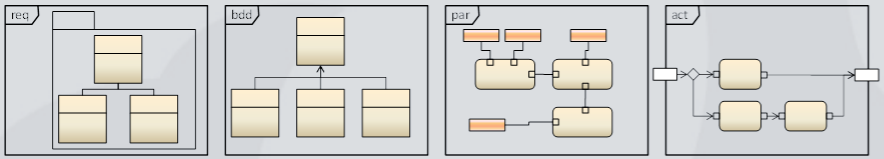
ModelCenter®

Technical Need #1: Digitally Connect Systems Engineering Models to Domain Expert Models

System Model (SysML)



Requirements
Architecture
Behavior
Traceability

Systems Engineering Model

- Analysis requests
- Analysis specifications

Bridge the Gap

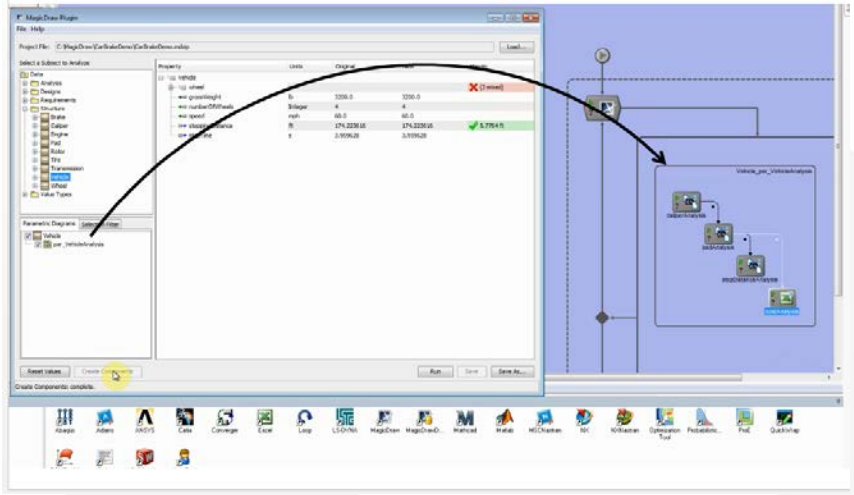
Bidirectional Integration via ModelCenter

- Performance estimates
- Trade study results

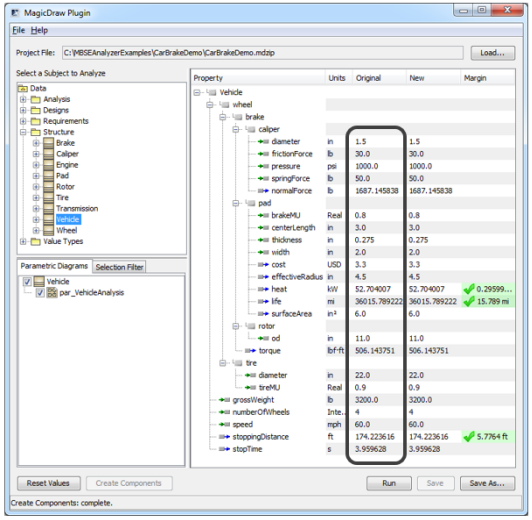
ModelCenter

Analysis
Optimization
Visualization

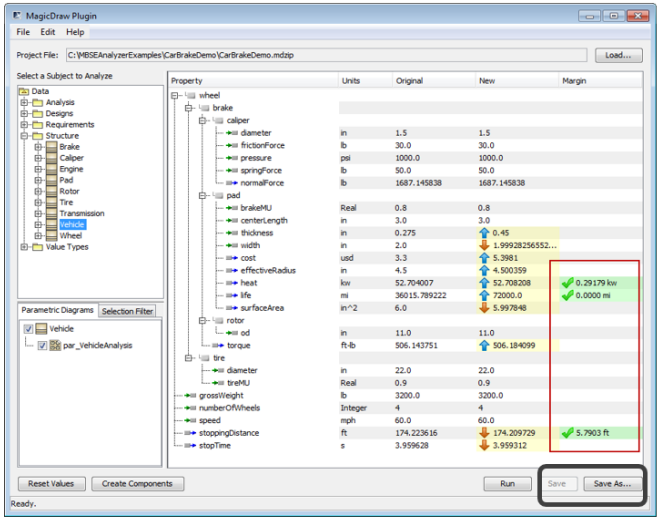
Domain Engineering Models



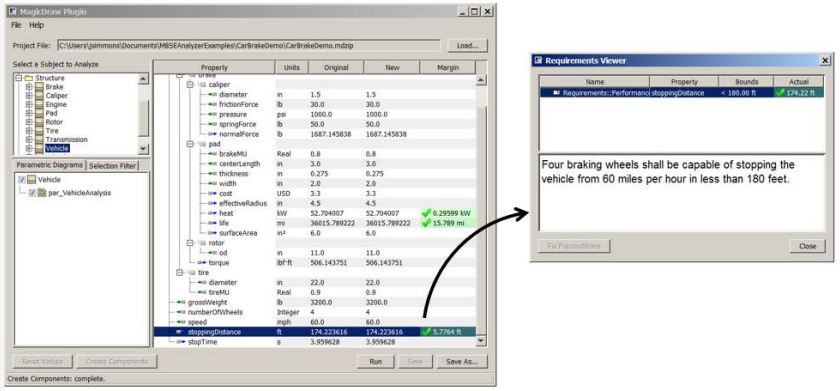
Generate workflow from SysML…



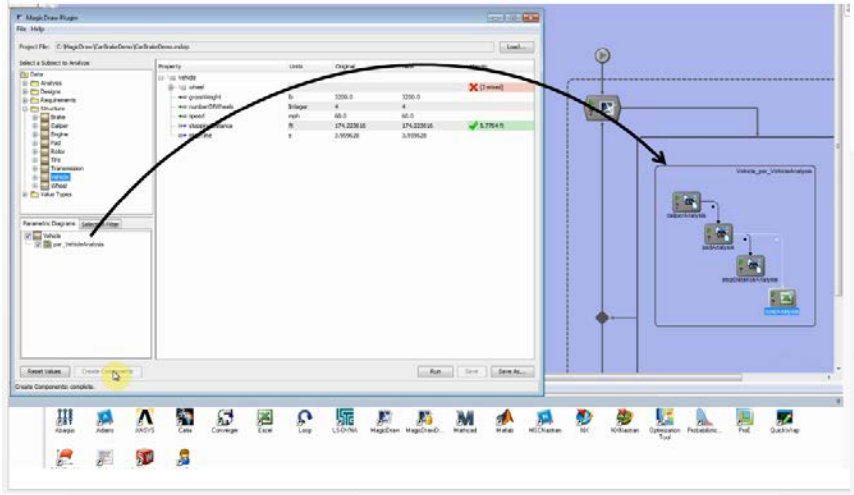
Import current design values from SysML into SME Models…



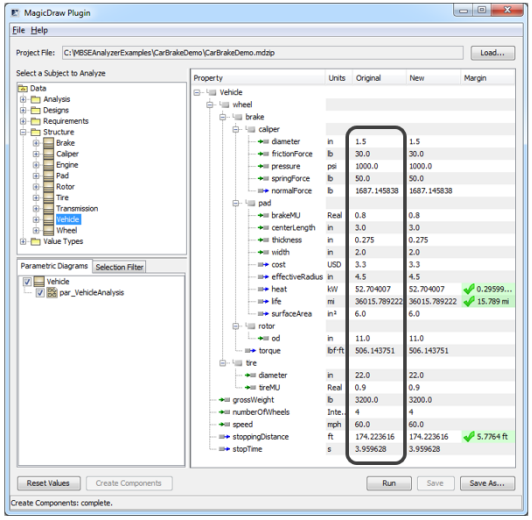
Push back to SysML with a single click…



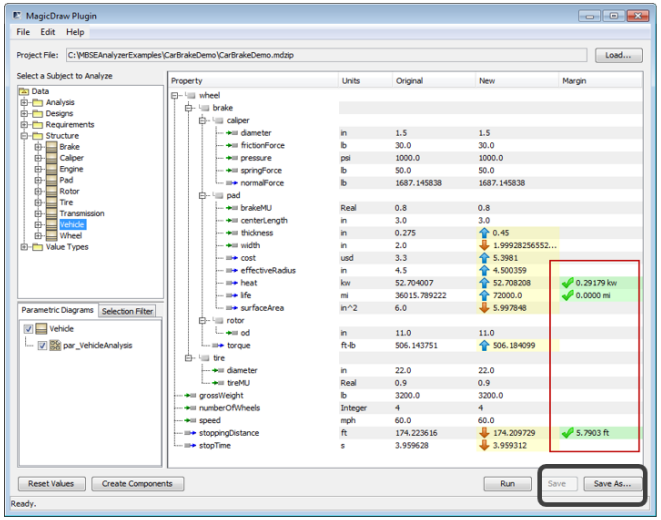
Review/verify Requirements stored in SysML Model.



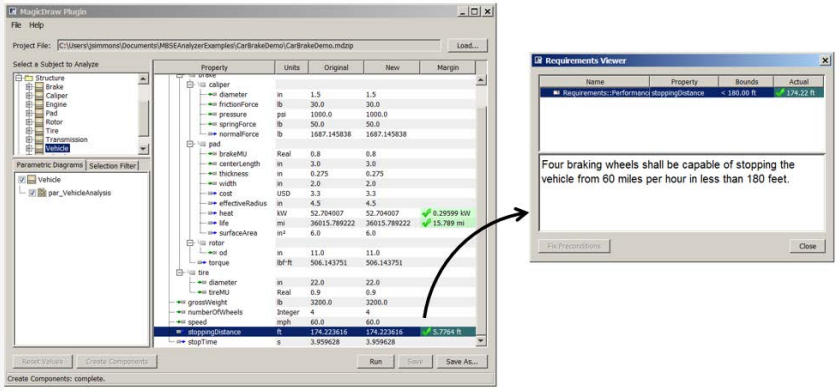
SMEs are using the same analysis as the Systems Engineers…



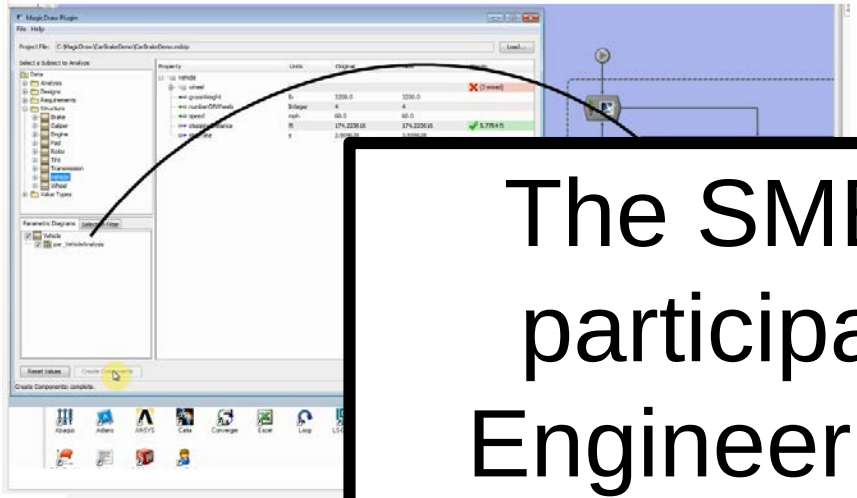
With the same values…



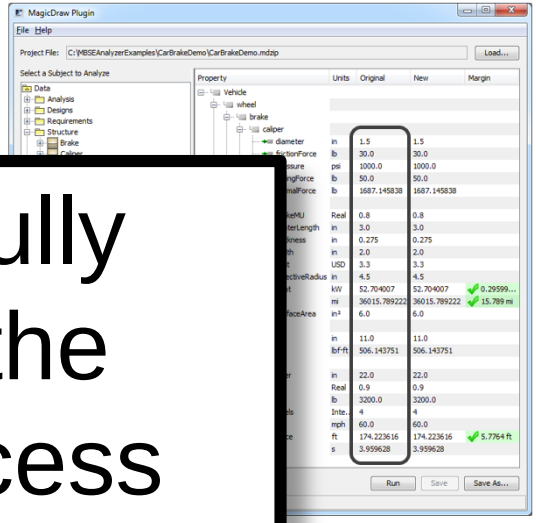
And storing the results in the Single Source of Truth…



With the same context as other SMEs and Systems Engineers!



SMEs are u
As the S

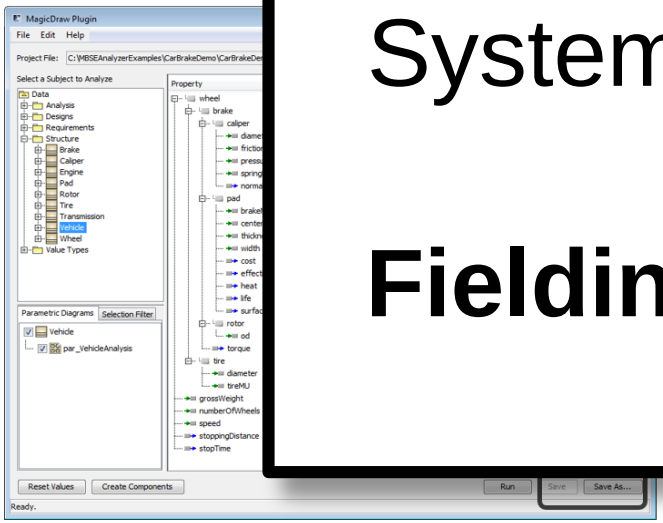


me Values…

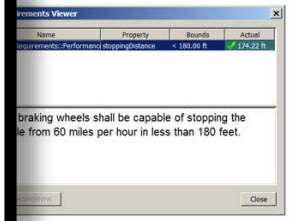
The SMEs are fully participating in the Engineering Process without having to be Systems Engineers…

==

Fielding Technology Faster!



And Storing the Results in the Single Source of Truth…



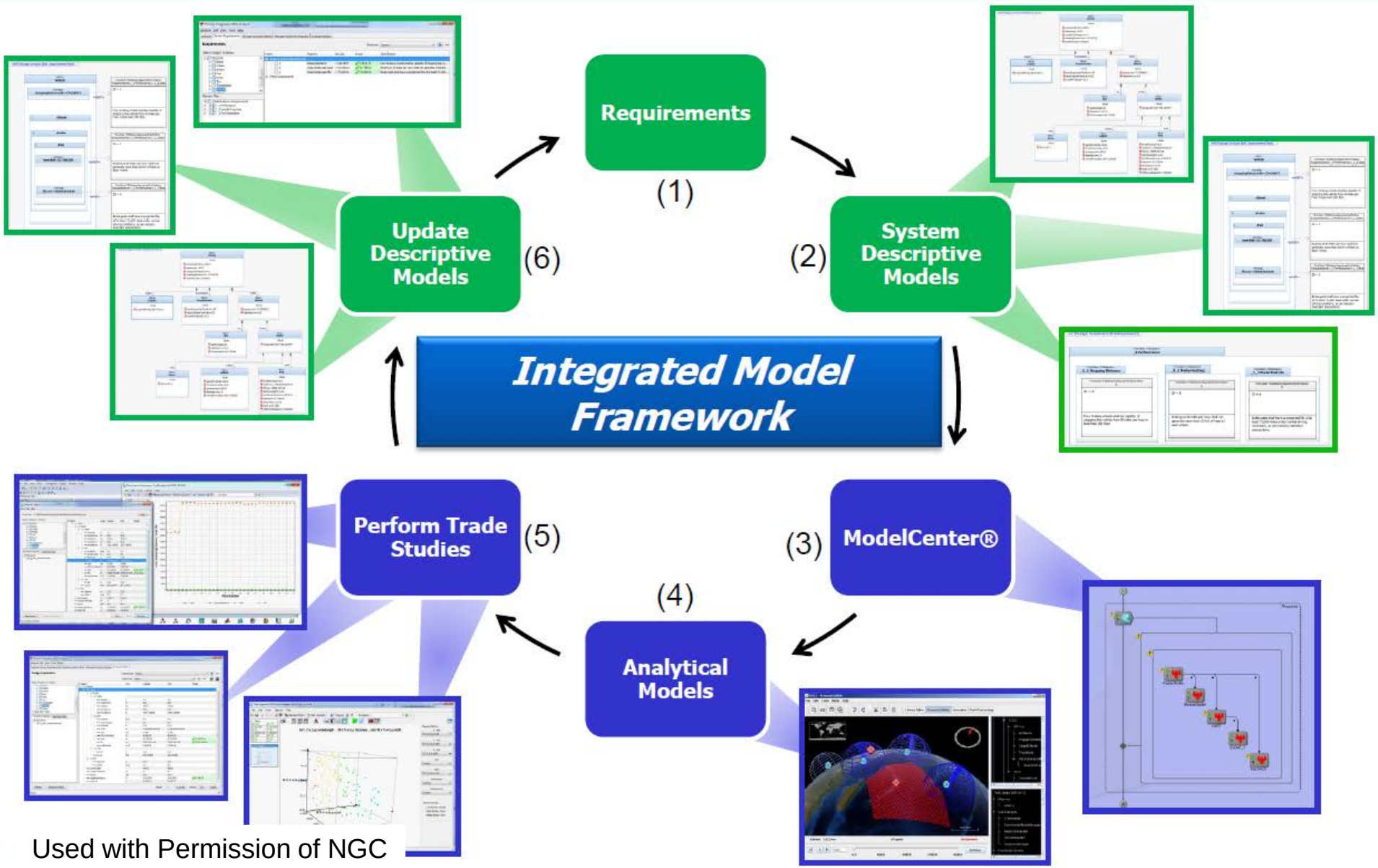
With the same context as other SMEs and Systems Engineers!

Examples

Integrated Model Framework Example

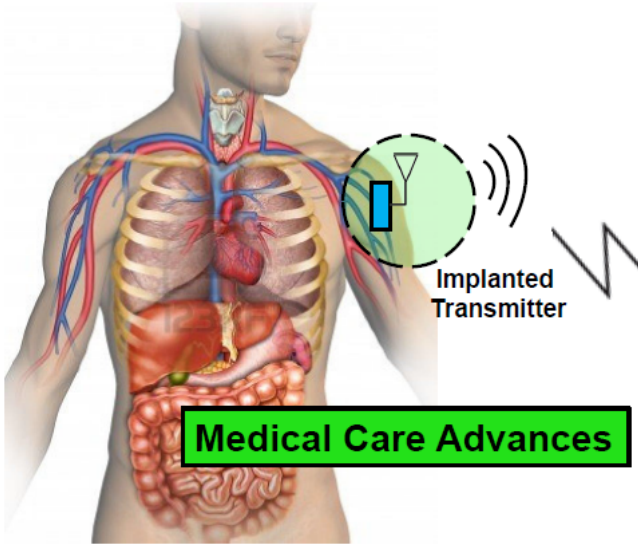
Descriptive to Analytical and Back

NORTHROP GRUMMAN



Used with Permission of NGC

What Is Biotelemetry?



Medical Care Advances

Cloud

Rx

Router/Receiver

- Measuring, recording and monitoring of real time physiological parameters such as ECG, EOG, EMG and neural spikes, over some distance via radio-frequency signals
- Why is it important ?
  - Health Care, Neuroscience & Brain Machine Interfaces
- Why implant ?
  - Reduce infections
  - Higher fidelity

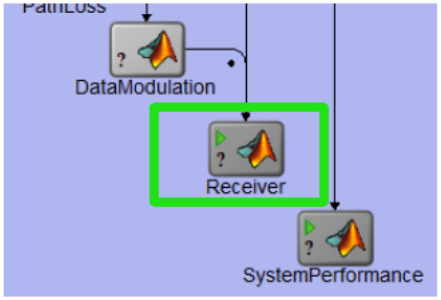
Un-tethered Neuroscience Experiments
(eliminates wires, etc.)

Source: Guevremont et al, Neurophysiology 2007

From **Integrated Safety and Performance Trade Studies** by Kerron Duncan (NGMS/Ph.D. Candidate, JHU)

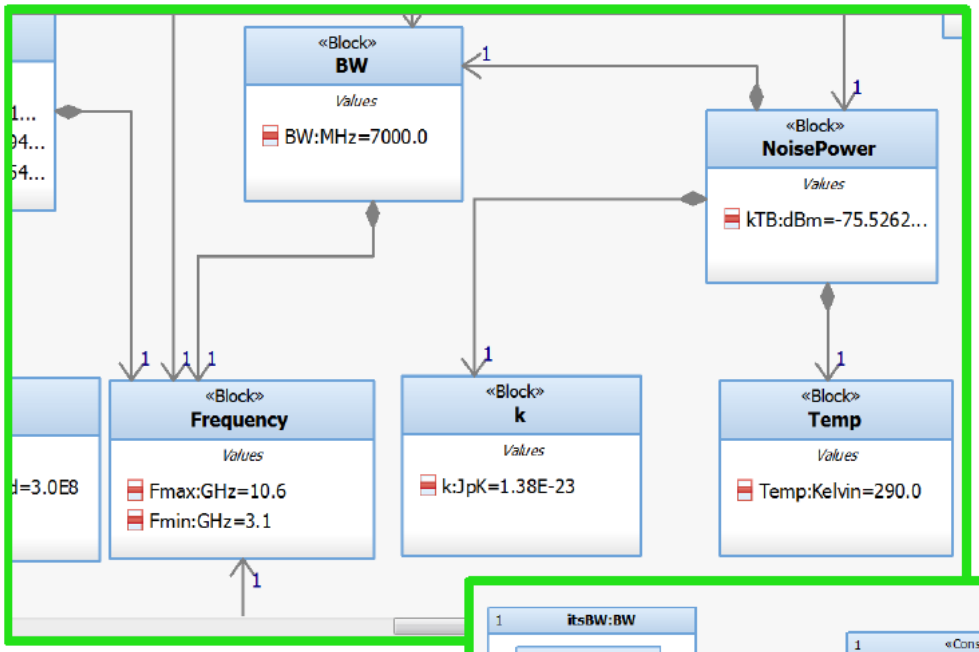
Parametric Diagrams Developed of Each Module in Rhapsody

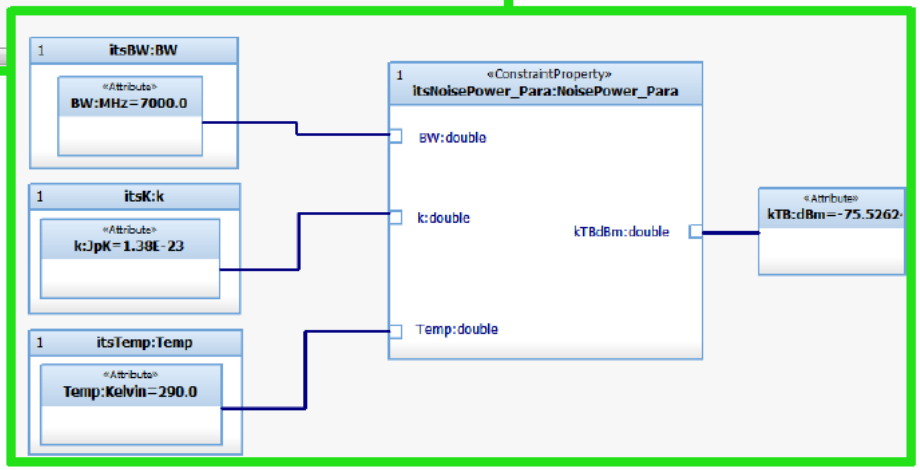
Receiver Noise Power Example (kTB) Linked to Model Center

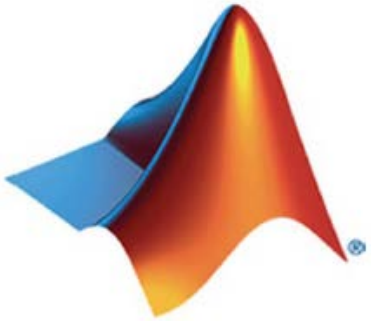


ANSYS

CST



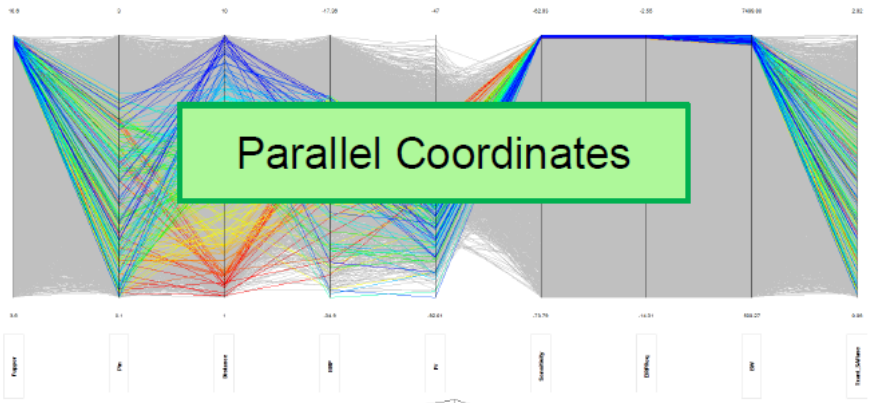


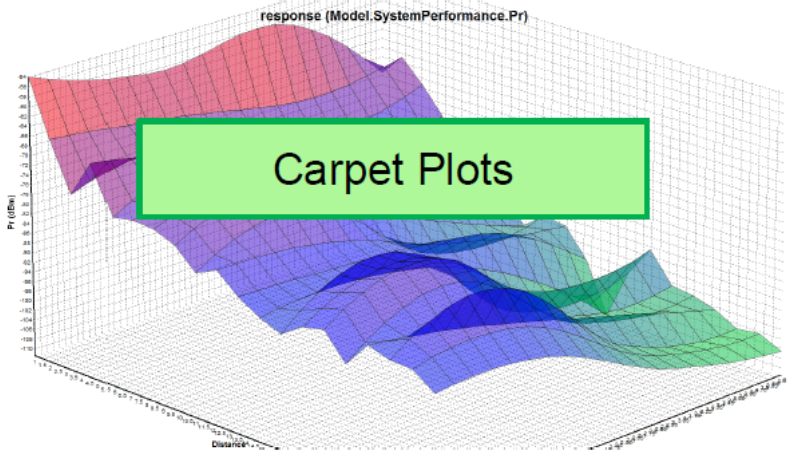


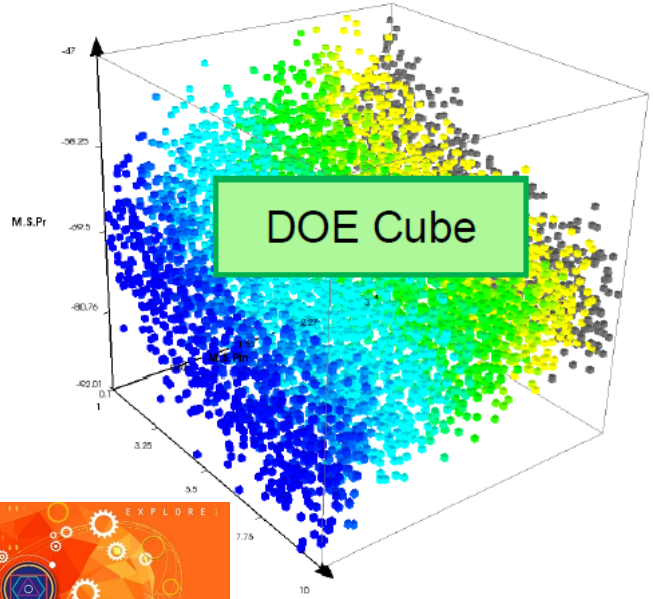
From **Integrated Safety and Performance Trade Studies** by Kerron Duncan (NGMS/Ph.D. Candidate, JHU)

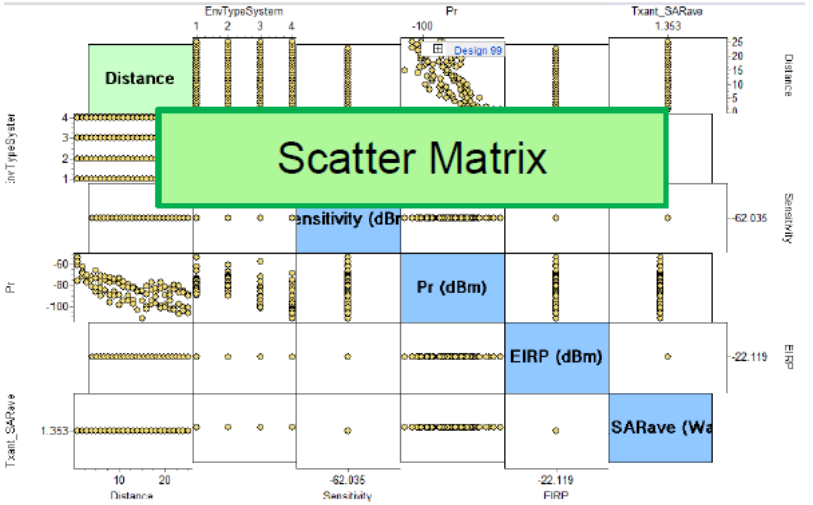
Integrated Performance & Safety Model

Trade Space Visualization & Analysis



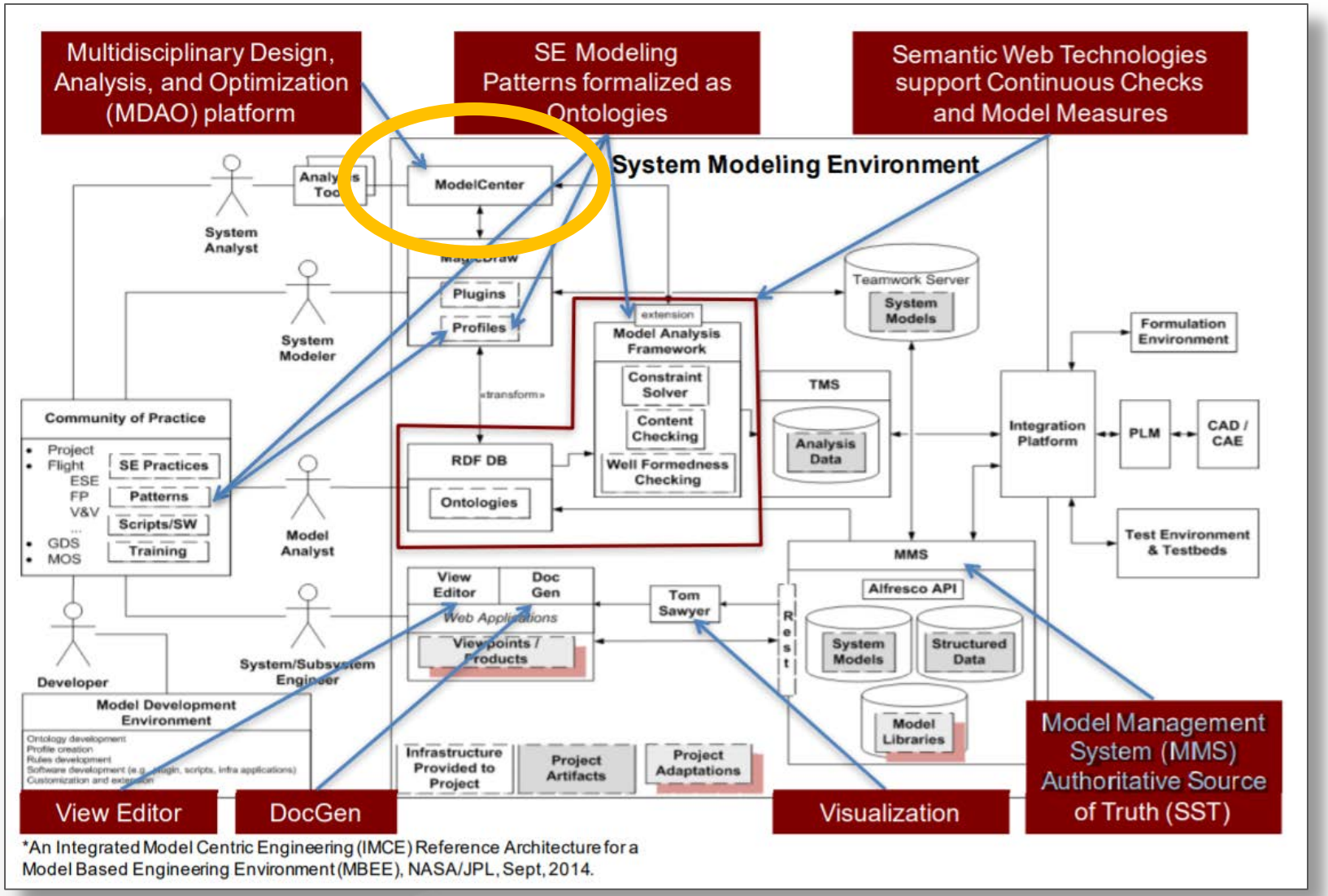






From **Integrated Safety and Performance Trade Studies** by Kerron Duncan (NGMS/Ph.D. Candidate, JHU)

An IMCE Reference Architecture



*An Integrated Model Centric Engineering (IMCE) Reference Architecture for a Model Based Engineering Environment (MBEE), NASA/JPL, Sept, 2014.

Trade Space Exploration of MBSE and MBE Integrated Workflows

NIST 2018 MBE Summit
Dr. J Simmons, PhD
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Tony Davenport, BSME, MBA

April 03, 2018

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Definition of Terms

- **MBE**: "Model Based Engineering" - The application of models and simulation to engineering activities.
- **MBSE**: "Model Based Systems Engineering" - A subset of MBE that specifically deals with systems engineering models and architectures (i.e., SysML, etc.).
- **Workflow:** An integrated collection of automated models and simulations in support of MBE activities.
- **MDAO**: "Multi-Disciplinary Analysis and Optimization" - A subset of MBE that is cross-discipline by nature and aimed at providing insights into holistic system performance.
- **MaaS**: "Model as a Service" - A distributed engineering method allowing engineers to share models and workflows while managing ownership of Intellectual Property.