# MBSE Workshop
# Opening Plenary

Find a seat and strap in…

SIEMENS
Ingenuity for life

# MBSE: Failing Faster Earlier Once

**Mark Sampson**
***MBSE Initiative Chair, INCOSE***

# Doing the math…

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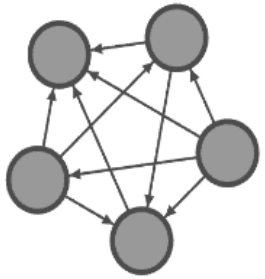
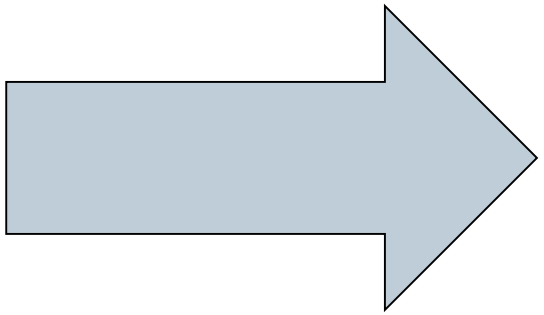
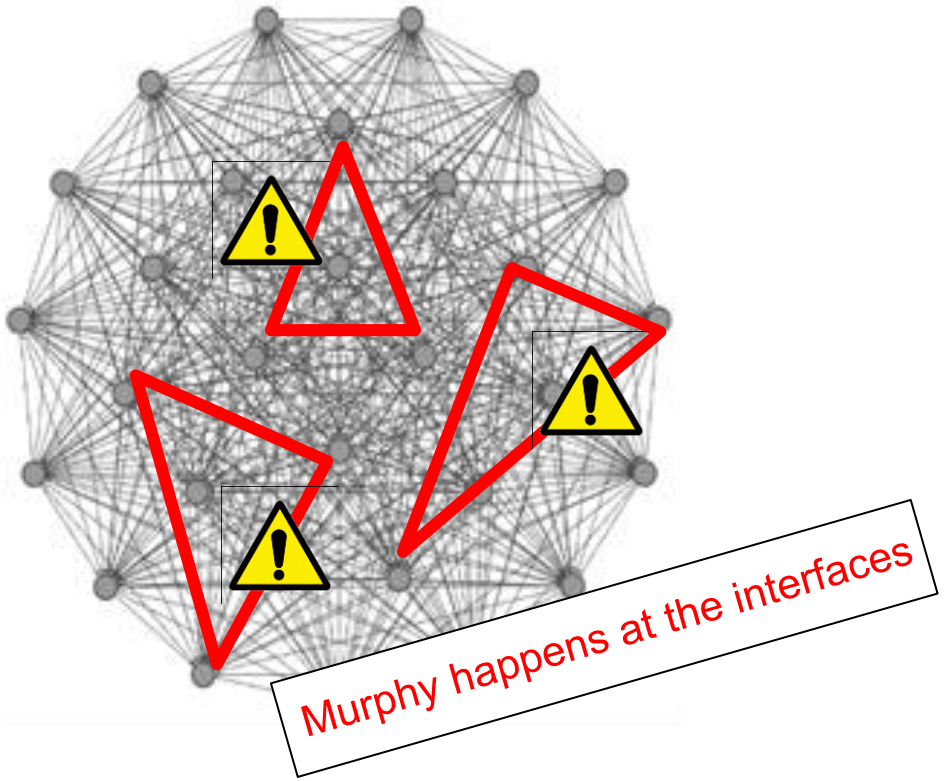


Nodes = 5
Potential Links = 10
Networks=$2^{10}$ 1024






Nodes = 30, potential links = 435, unique configurations = $2^{435}$
Number of atoms in the universe est. between $2^{158}$ and $2^{246}$

# Integrated MBSE Vision
# What does the integrated digital thread look like…

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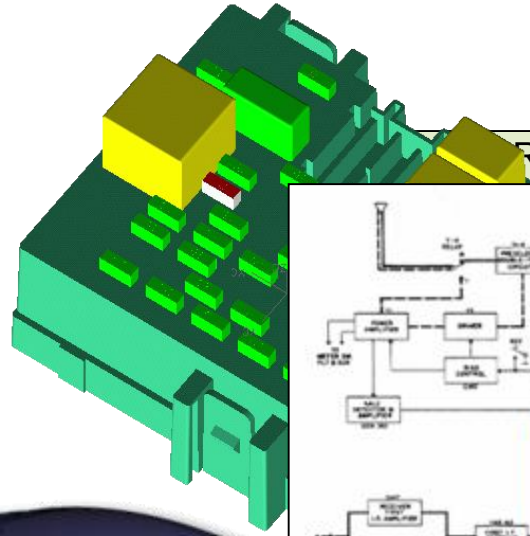
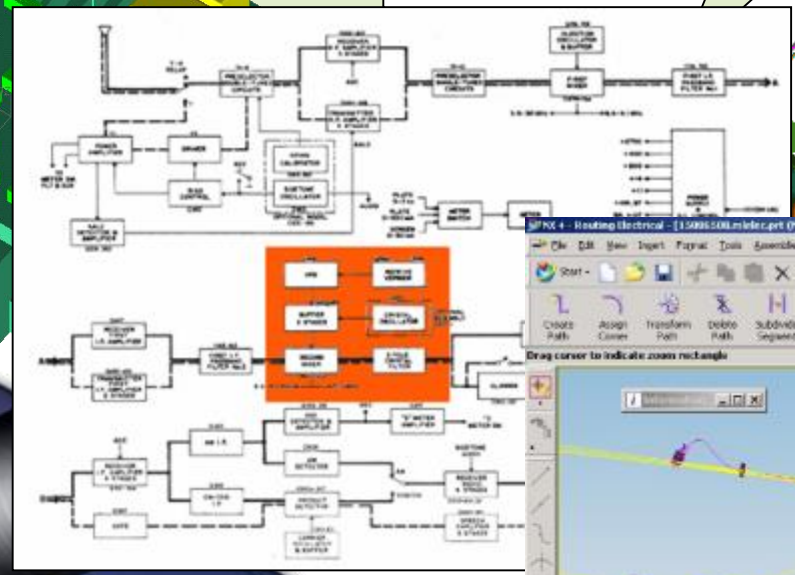
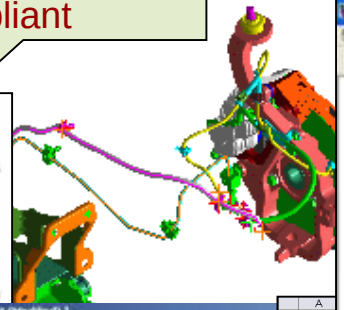
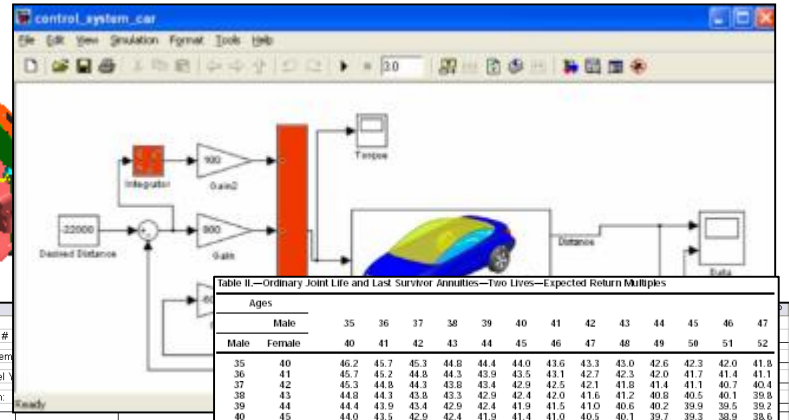


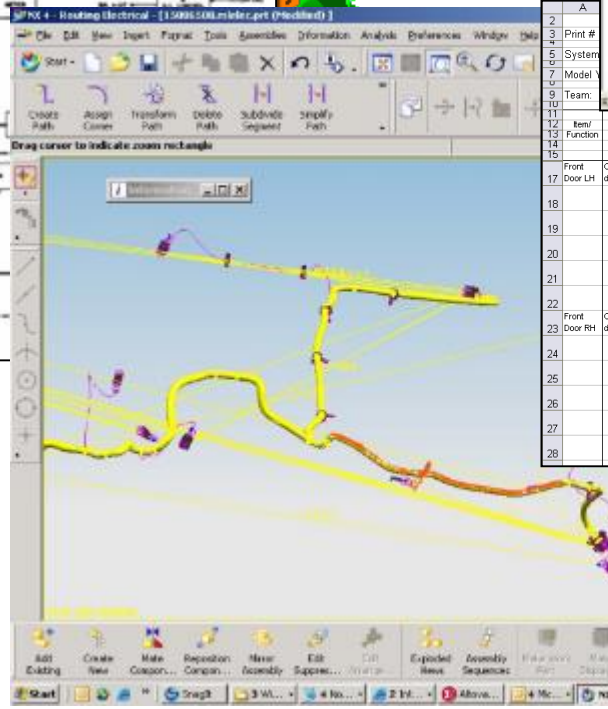
Rating:

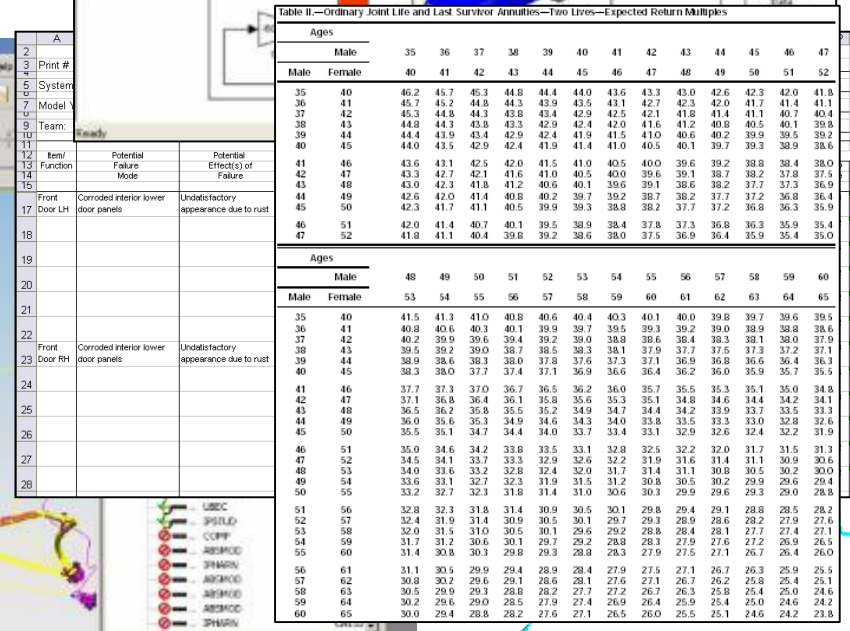


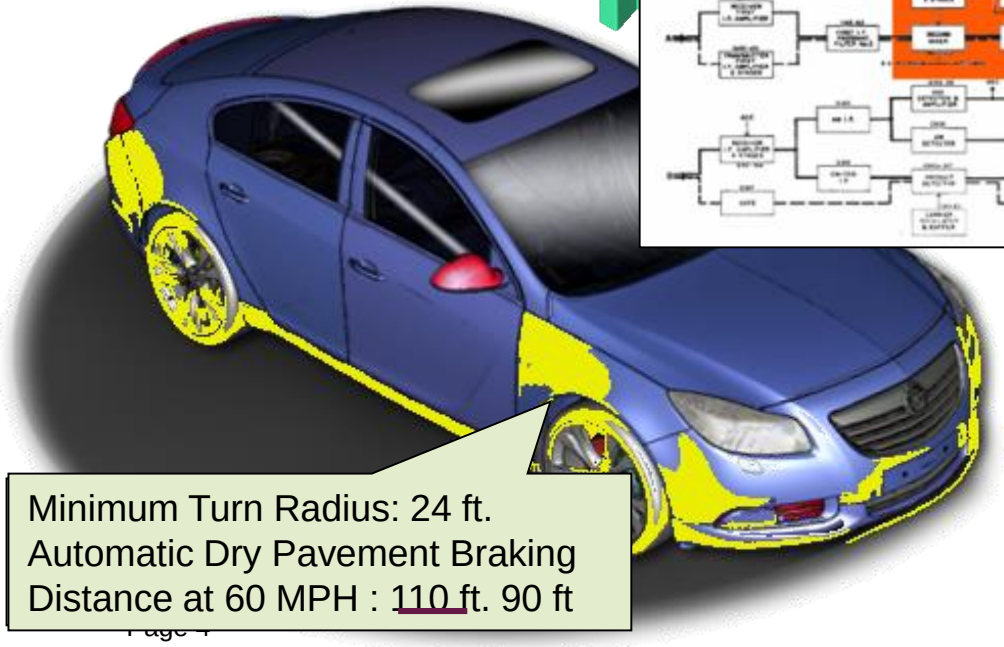
Hydraulic Fluid:
SAE 1340 not-compliant









Minimum Turn Radius: 24 ft.
Automatic Dry Pavement Braking
Distance at 60 MPH : 110 ft. 90 ft

# Recent Headlines from other industries…

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The New York Times

## *Boeing Says Charges Tied to 737 Max Grounding to Reach $8 Billion*

Boeing 737 Max planes parked at the municipal airport in Renton, Wash. The Max planes have been grounded after two were in
Lindsey Wasson for The New York Times

By David Gelles

July 18, 2019

The financial fallout from the troubled 737 Max jetliner continues to swell for Boeing, which on Thursday announced $7.3 billion in costs that will hit its bottom line.

**Boeing 737 Max..**
**Grounded since mid-March**
**07/19/2019**

CNBC MARKETS BUSINESS INVESTING TECH POLITICS CNBC TV

TECH

## Walmart sues Tesla over solar panel fires at seven stores

PUBLISHED TUE, AUG 20 2019 • 4:33 PM EDT | UPDATED WED,

Lora Kolodny
@LORAKOLODNY

**KEY POINTS**

- Walmart is suing Tesla for breach of contract after Tesla solar panels ignited atop seven of its stores.
- Tesla and Walmart have been partners on clean energy initiatives for years; more than 240 Walmart stores have Tesla solar systems installed.
- Walmart has also pre-ordered at least 45 Tesla electric semi-trucks to add to its vehicle fleet.




TRENDING NOW

Here's a signals t red

This S&P sent a s signal—

**Tesla Solar Panels…**
**Defective connectors/grounding**
**Amazon joins the suit as well**
**08/20/19**

# Do you see the problem?

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# Case Study: Fuel Pump Control Module

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Fuel pump control module bad placement…

- Resulting in Bi-Metal Corrosion, failed ECU
- 86,000 vehicles recalled.. $8.6M direct costs

# How about now?
# Even when you were evaluating places to put it

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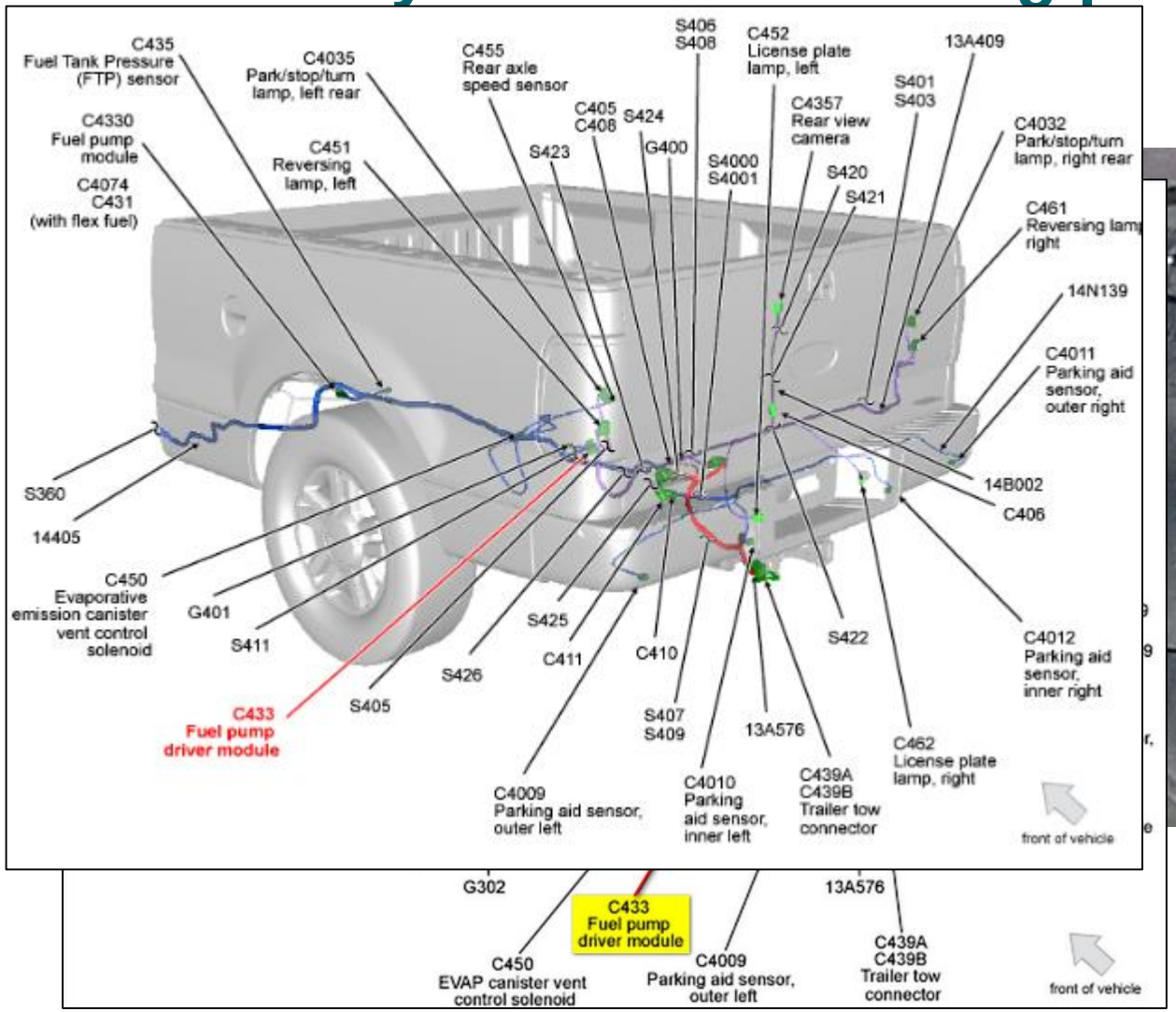


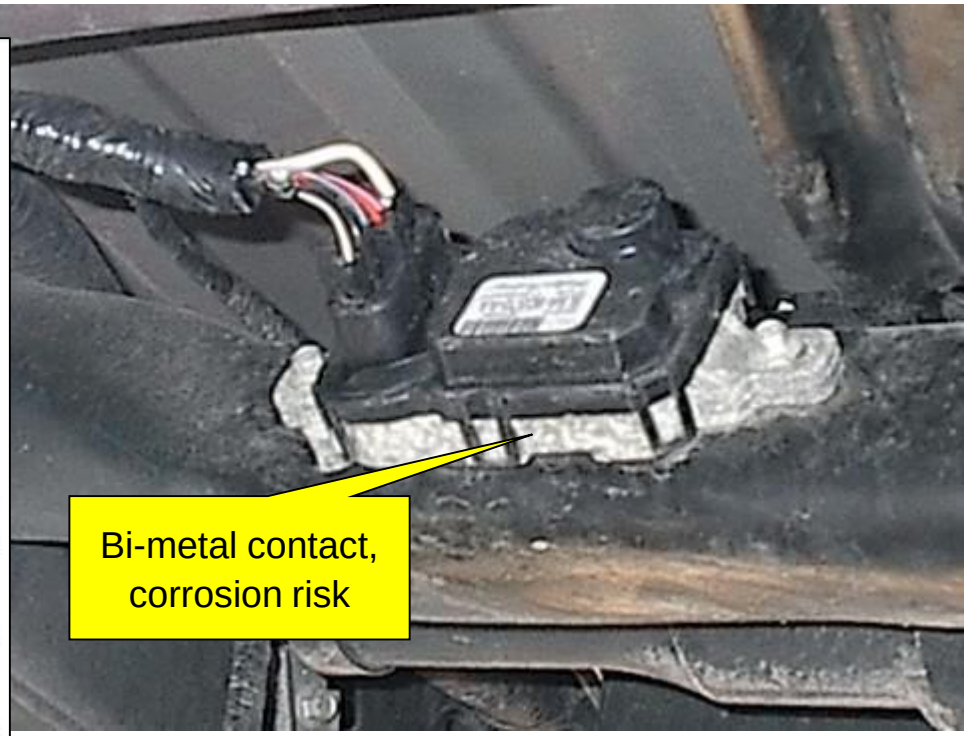


**What about purchasing?**
**Supply chain?**

# Imagine this working across an entire supply chain!
# Model Based Design Chain (MBDC)

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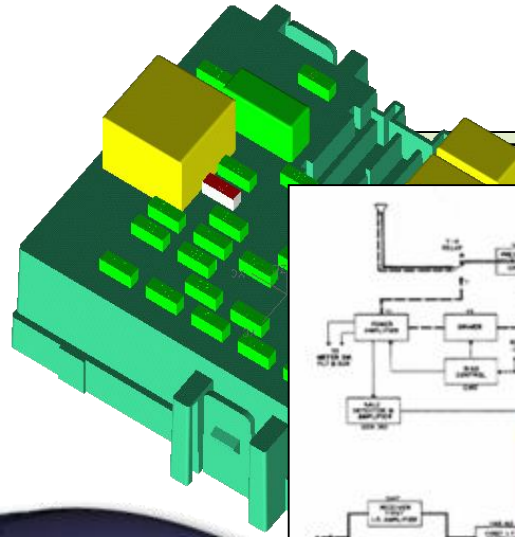

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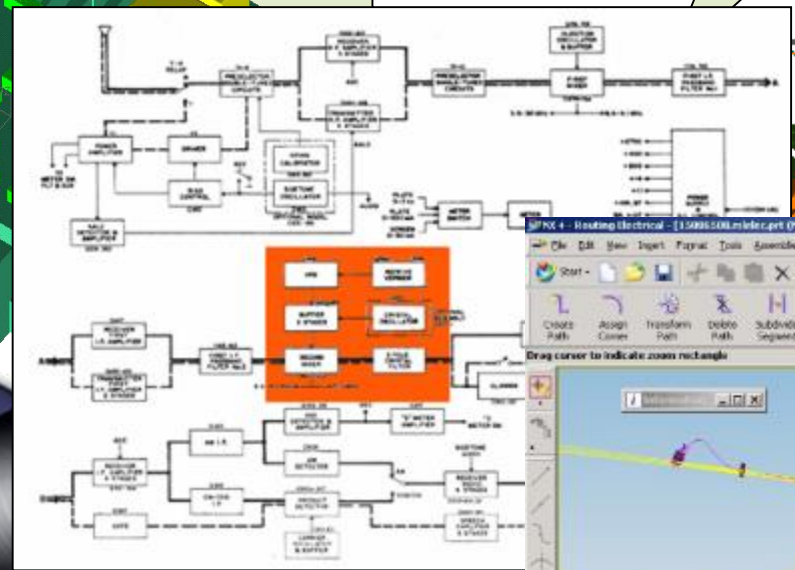

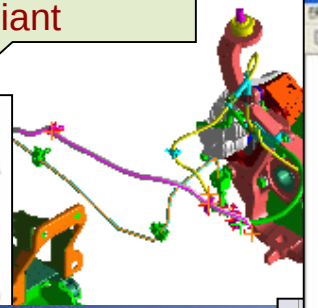

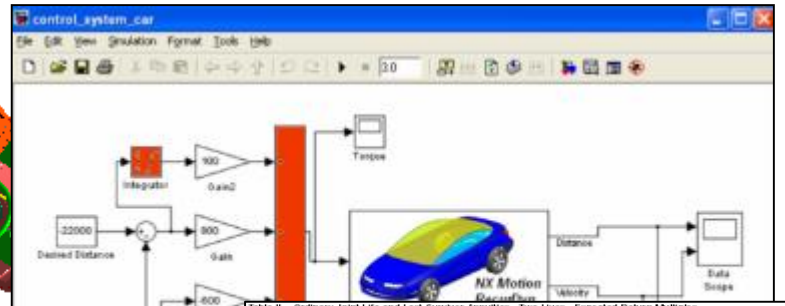


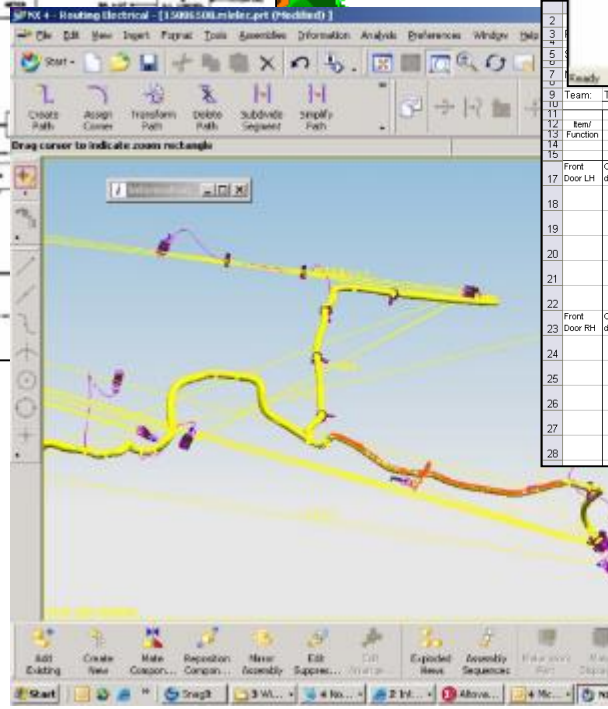

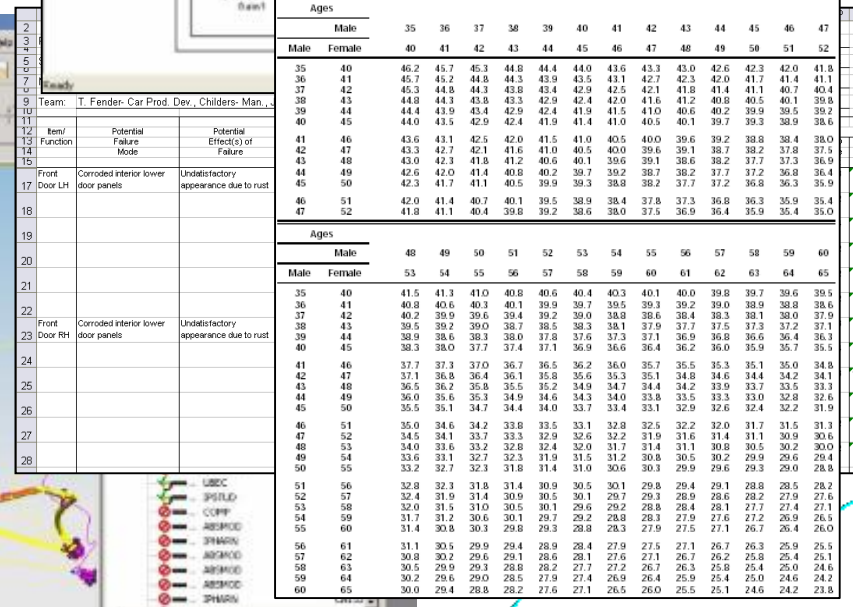

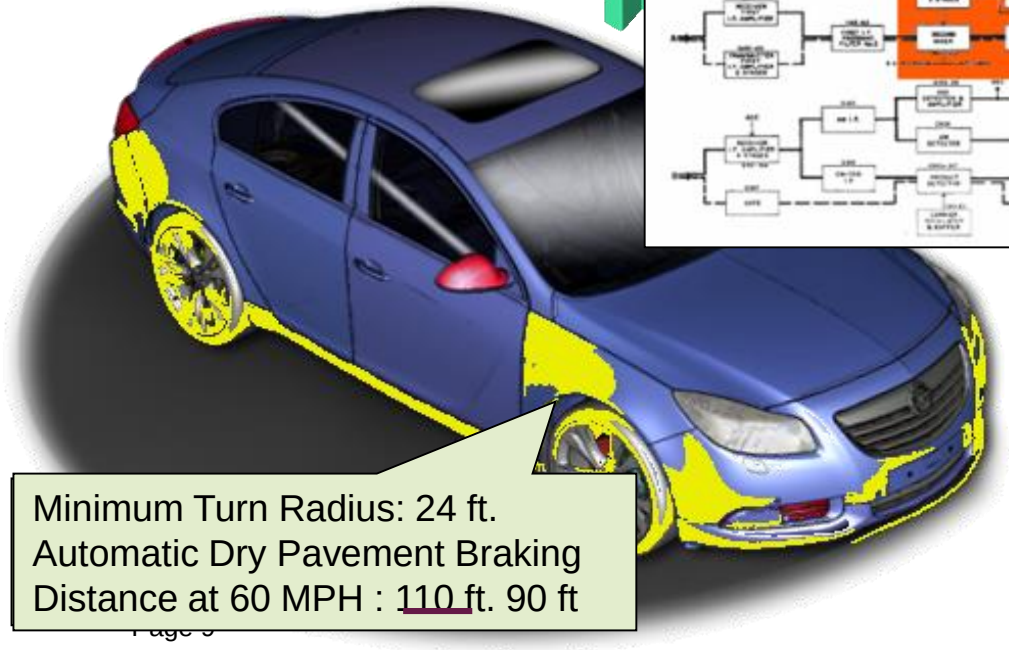

Minimum Turn Radius: 24 ft.
Automatic Dry Pavement Braking Distance at 60 MPH : 110 ft. 90 ft

# MBSE Process…
## Shift left…

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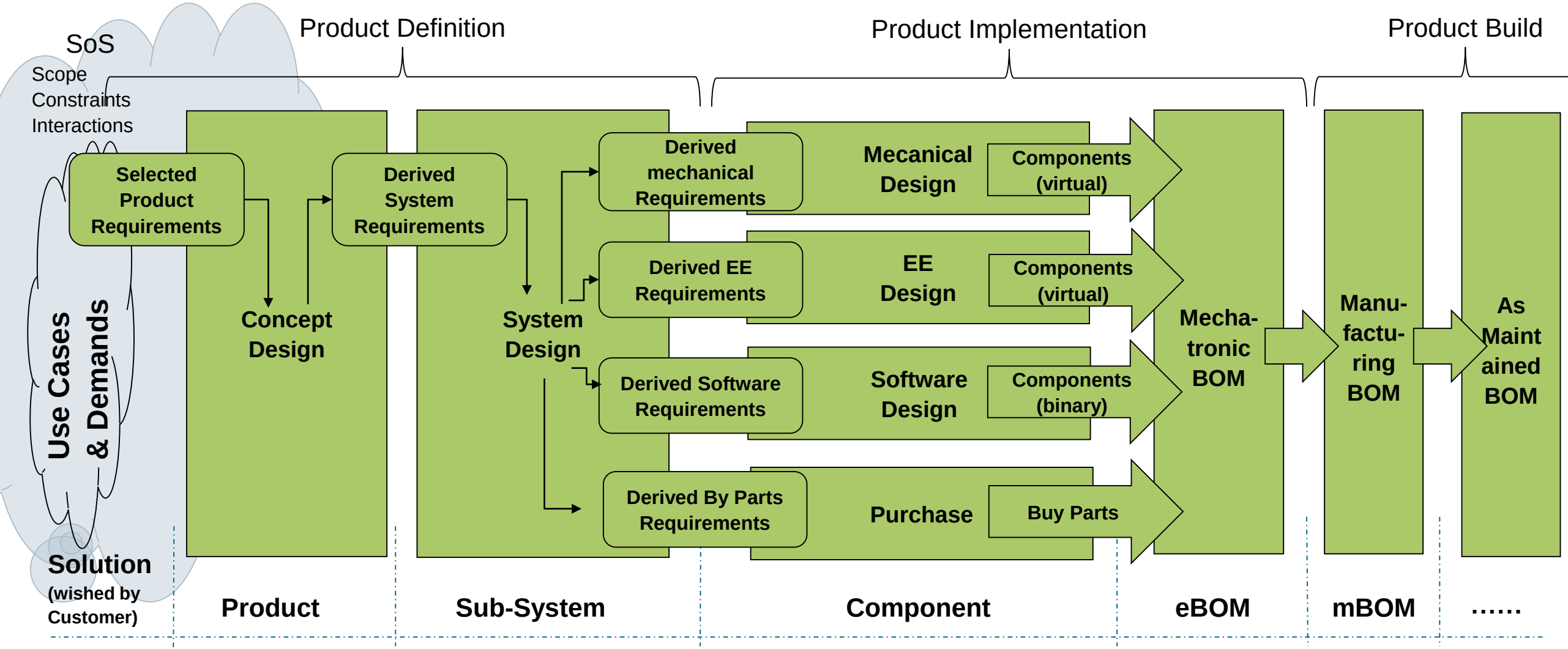

# How do we learn the lessons from the threads?
# How to store/recall from somewhere so we don't repeat them

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Problem resurface metric: how long does a problem once solved take to come back

- Auto: ~3 years
- High Tech ~6 mo.
- Aero ~15 years

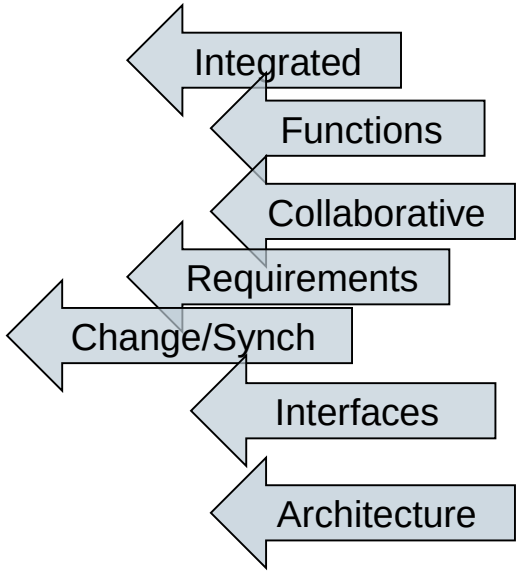
Cross-Domain problems result from:

- Siloed/Disconnected Decisions
- Form follows function, Problems follow functions
- Everyone involved, including purchasing
- Disconnected requirements
- Uncommunicated change
- Happen at domain/organizational boundaries
- Migrate with people (overt or covert)
- Missing/disconnected product architecture

Integrated
Functions
Collaborative
Requirements
Change/Synch
Interfaces
Architecture

**"Water on the knee"**

# Where are we? Our Murphy-risk profile?




| Capability Assessment: | Basic | Low | Medium | High | Advanced |
|---|---|---|---|---|---|
| **MBSE Process Maturity Level 4** | | Disintegrated----------Integrated | | | |
| **System Modeling/Architecture** | PPT in docs | Disconnected Visio models | Sys Models with Simulations | Multiple model exchange/optimize | Integrated architecture models for cross-domain sim/optimize |
| **PLE/Configuration (variation)** | None | Variation documents, spreadsheets | Disconnected variation rules | Integrated variation rules | PL variation definition built into into architecture decisions |
| **Technical Risk (RAMS, cost,...)** | None | Risk documents, spreadsheets | Integrated Risk Management Plans with aspects of RAMS | Standalone RAMS with FMECA Dash boards | Integrated RAMS, continuous risk assessment/alarms with dashboards |
| **MBSE Process Maturity Level 3** | | | | | |
| **Interface Management** | ICD in docs | Managed interfaces | Standard-based Interface library | Reused interfaces | Functions/logical allocation drives interface definitions |
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| **Change Management** | Document-based change process | Isolated models included in change | Impact analysis & suspicion mgmt | Metrics with History for improvement | Project level reuse, starting point for next project |
| **MBSE Process Maturity Level 1** | | | | | |
| **Requirement Management** | Uncontrolled spreadsheets & docs | Managed Docs | Standalone solutions (disconnected) | RM/traceability exchange | Connected, configured, cross-domain traceability with reuse |
| **Model Management** | Uncontrolled, rules-of-thumb, hieristics | Uncontrolled, behaivor models | Shared model repository | Integrated, component library | Model reuse with controlled parameters |
| **Verification & Validation** | Minimum to no planning | Manually testing everything | Isolated validation simulations | Integrated simulation (HIL, SIL) | Focused testing, reuse results, swap out models |
| **Design Management** | unmanaged Cax/SW models | Locally Mananged CAX/SW | Enterprise repositories | Integrated models (MIL, SIL,...) | Cross-domain design/optimization |

# Where are we?

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Avg Organization (best case)

Best Auto (best case)

Best Aero (best case)

# …by industry

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Medical/Healthcare | Semiconductor | Aerospace | Automotive | Government

# Integrated MBDC Journey

Example:
OEM electronics mfg & Semiconductor supplier

- Power of shared Product Architecture
- Identify supply chain disconnects
- Shift to right together
- Slash system integration effort

…realize total value of Product Architecture driving supply chain

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Disconnect

Disconnect

Integrated MBDC possibilities

OEM equipment

Semiconductor Supplier

# Dishonesty/Meta-Dishonesty

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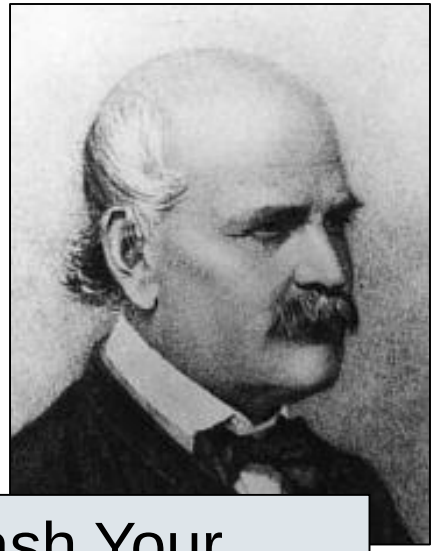
"Semmelweis Reflex"
*"…to dismiss/reject out of hand any information, automatically, without thought, inspection, or experiment"*

Fore-ordained answers
…will the answer provided by SE tools be accepted

Don't waste your time on the wrong answers, unless…

**Dr. Ignaz Semmelweis (1818-1865)**

**Early Germ Theory**



Wash Your Damn Hands

[http://en.wikipedia.org/wiki/Semmelweis]

# Organization SDB's (Self-Defeating Behaviors)…

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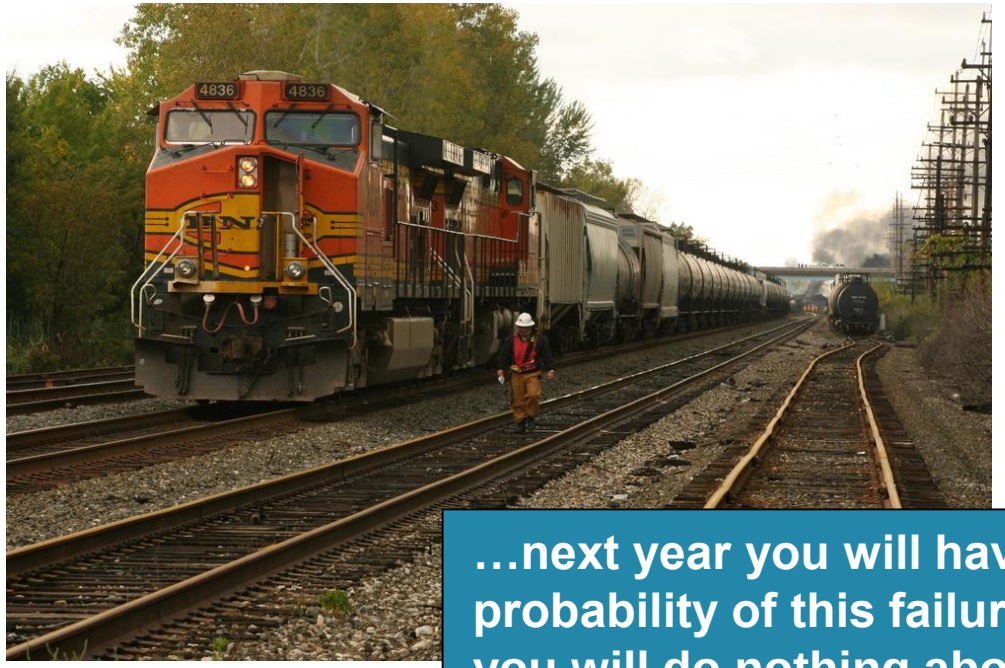
- No process for the tools to work within
- No time/money to use tools
- No backing for resources
- No training on tools
- Expecting tools to run themselves
- Thinking tools are static
- Not convincing the customer of the tool benefits
- No mechanism for using tool results
- Applying the tool to everything
- Funneling everything through a gate keeper
- Expecting "paper" results from tools
- "where's the hardware?"
- Rewarding fire-fighters vs. fire-preventers
- Blockading support organizations (…they cost too much, etc.)




**…next year you will have a 90% probability of this failure…but you will do nothing about it!**

**Dr. Stephen Wheelwright (Harvard Business School)**

[Covey 1995, Sampson 2000]

# Organizational SDB's continued…

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How prepared is your organization?

Culture change vs. getting lucky…

**Buckminster Fuller's Magic Log**

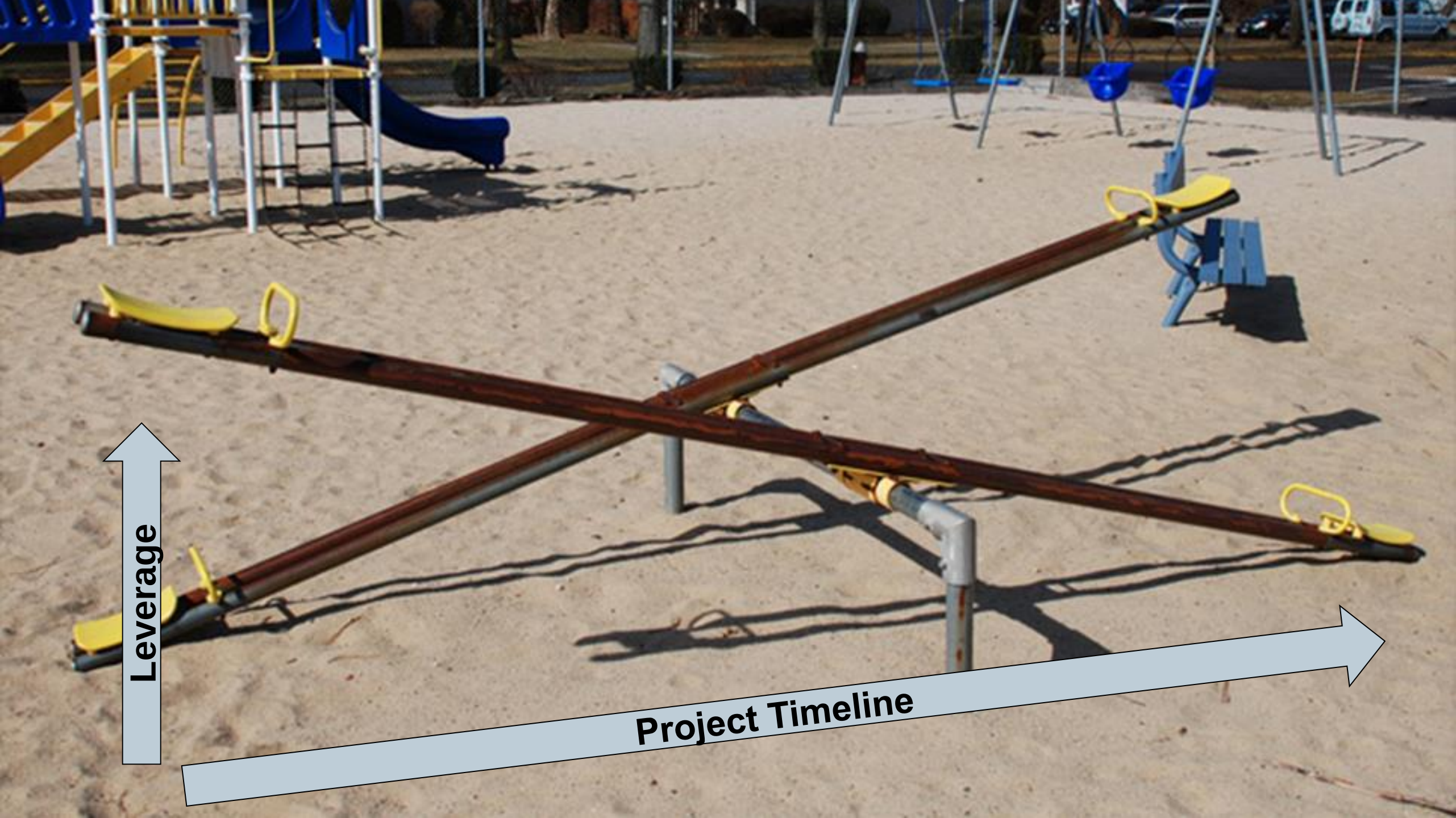
Model-Based Enterprise Capabilities Matrix Challenge Team
Chaired: Joe Hale/Al Hoheb

19 November 2018

**INCOSE Model-Based Enterprise Capabilities Matrix (1.6a)**

| Model-Based Capability Stages | Stage 0 | Stage 1 | Stage 2 | Stage 3 | Stage 4 | Comme |
|---|---|---|---|---|---|---|
| Workforce/Culture | | | | | | |
| MBSE Approach/Objectives | Awareness that MBSE may be used and may be beneficial | Sub-Discipline Tool use (e.g., CRADLE, DOORS) | Full System Models. Modeling results used to inform systems engineers in system analysis, design, and integration. | Full System Models; Model views translated into more traditional views for use and understanding by organization. Modeling results support decision making. | Full System Models; Organization familiar and competent in using modeling views for key system decisions | MBSE Approach/Objectives are we communicated to, and understood Program/Projects, CIO, S&MA, etc. |
| Model-Based Tool Use | Not using enterprise and system level modeling tools, not covering the system life cycle | Limited use of enterprise and system level modeling tools, not covering the system life cycle | Use of specific enterprise and systems model(s) within System Engineering organizations. | Use of specific enterprise and systems model(s) within Systems Engineering organizations - understanding how external systems engineering models relate. | Use of specific enterprise and sytsems model(s) within Systems Engineering organizations across an enterprise. | Expecting different tools to be used and Contractor, and across Contrac |
| SE-driven Model Building | Models are not developed for the system or enterprise engineering processes | Models are developed for parts of the system engineering or enterprise engineering processes | Full System/Enterprise Models are developed | Multiple System Models are integrated for the enterprise | Multiple enterprise models are interfaced within or across mission areas | Model structure/architecture driven and evidentiary artifacts |
| Lifecycle Coverage | No models or models only address specific problems within a life cycle phase | Models cover only Single life cycle Phases | Models cover Multi-Phases; Limited Reviews | Multi-Contiguous Phases | End-to-End, Top-to-Bottom | Across all Phases and down to lowe |
| Institutional Adoption (e.g., agency, service, center) | Some parts of the institution have adopted (e.g., new programs/initiative, pilot programs, and business case driven) | Adoption by institution Enterprise or Systems Engineering Organizations. | Common implementation basis across institution. | Consistent institutional approach across organizations with variations as appropriate for specific needs. | Policy and practice driven across the institution. | Tools, training, and IT infrastructure Institutional resources |
| Organizational Adoption (e.g., entrprise, program, project) | Some parts of the organization have adopted (e.g., new programs/initiative, pilot programs, and business case driven) | Adoption by organization Enterprise or Systems Engineering Organizations. | Common implementation basis across organization. | Consistent organization approach across programs/projects with variations as appropriate for specific needs. | Policy and practice driven across the organization. | Discussion about whether this is at |
| Definition of roles and responsibilities | Model-based Knowledge, Skills, and Abilities (KSAs) are completely undefined and unknown | Model-based Knowledge, Skills, and Abilities (KSAs) are defined for modelers | Model-based Knowledge, Skills, and Abilities (KSAs) are defined for roles involved with modeling; Enterprise Architect, SE, PM, IT, modelers, etc.. | Model-based Knowledge, Skills, and Abilities (KSAs) are defined for roles involved with enterprise management | People who need to be active are identified and involved. Sufficient staffing and staffing plan ensures all roles are fulfilled. | Moved up from Processes/Methodc you are in the organization |
| Modeling Development Skills | None, or ad-hoc for all staff | Modeling of components of the Enterprise or System. | Novice Modellers on full Enterprise or System - subsystem models. | Expert Model development lead with experience practicing modeling on at least 1 project that successfully completed at least 3 major technical reviews that used models in support of the review. | Expert Model development lead that sets modeling standards and evaluates the model product quality of other modelers | More than just modeling tool experti model structure/architecture that su |
| Modeing Use skills | None, or ad-hoc for all staff | Can generate tool standard digital artifacts as needed to evaluate the Enterprise or System. | Can generate tool custom digital artifacts as needed to evaluate the Enterprise or System. | Can generate custom digital artifacts across tools, models, and data sets to evaluate the Enterprise or System. | Can contribute to defining the enterprise, system, and other data needed by the complete team to perform analysis for IPTs, reviews, audits, and other technical and programmatic decisions. | This covers a role that all governme conduct model based acquisition |
| Modeling-related Training/KSA development | No training | Modeling on specific tools with respect to their role as a user or modeler | Training and initial experience to perform their modeler or user roles. | Demonstrating role capabilities using the models, coaching and instructing others | Provide leadership in proposing, designing, and delivering training that is appropriate for the modeling and user roles | Multilevel training series, including " execution. Paul Walter to help flesh |
| Common Language | System terminology defined for the project or program. | Common Glossary/Data Dictionary | Top Tier Ontology is defined for the enterprise. | Discipline Ontologies | Common, tiered taxonomies/ontologies is defined and consistent with accept community standards. | A hierarchy of taxonomies and onto subordinate domain/discipline Lowe rov., moved up from Tools & IT Infras |
| SE Processes/Methodology | | | | | | |

Cows drink…


Leverage
Project Timeline

SIEMENS
Ingenuity for life

# Thank you