



2022
Annual **INCOSE**
international workshop
HYBRID EVENT
Torrance, CA, USA
Jan 29 - Feb 1, 2022

Premier Systems Engineering Workshop

Inspire MBSE

Mark E Sampson MBSE Initiative Chair

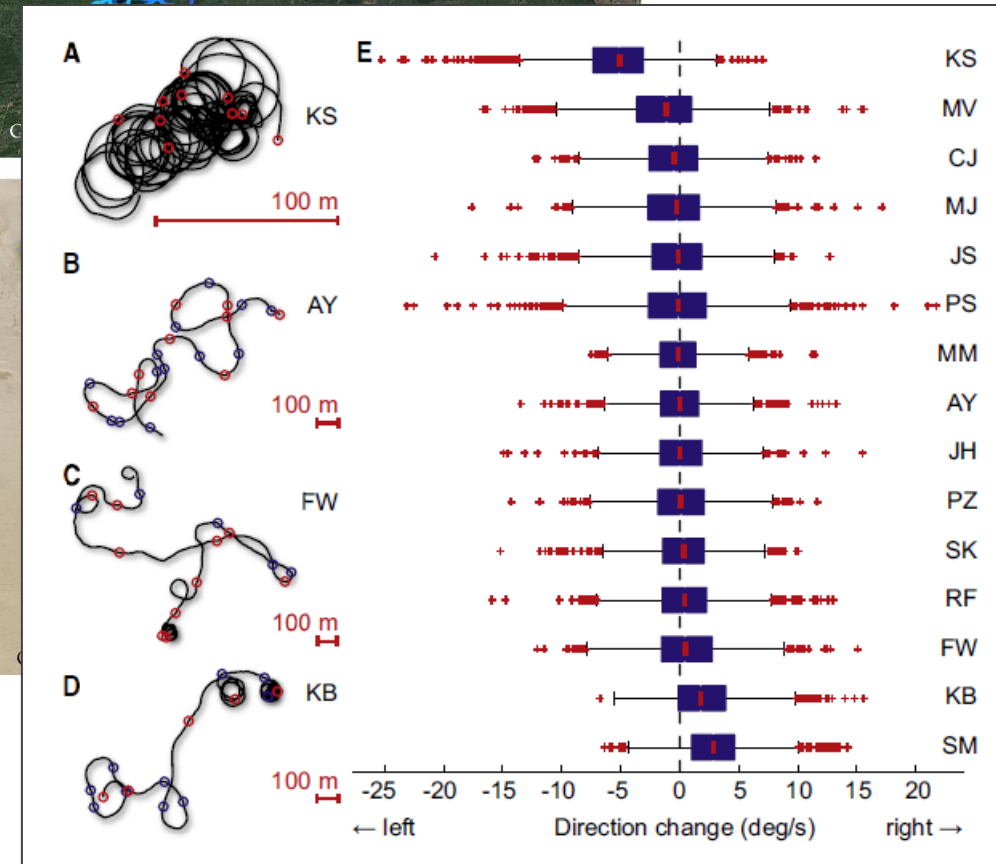
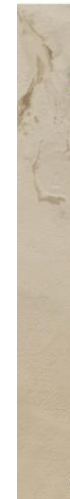
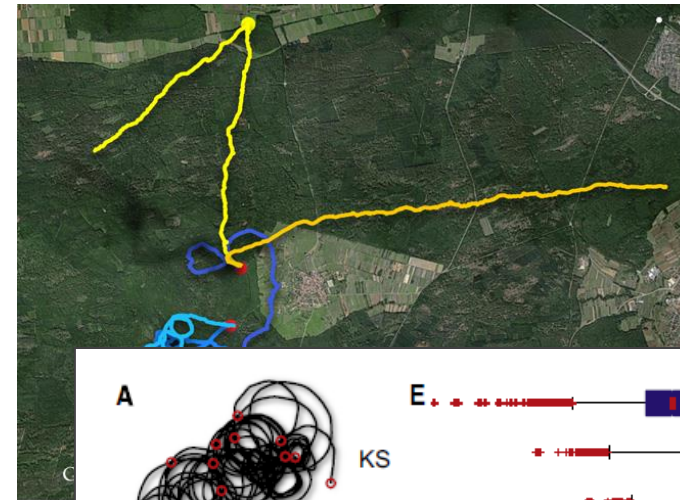
MBSE Workshop Kickoff...





Walking in circles...

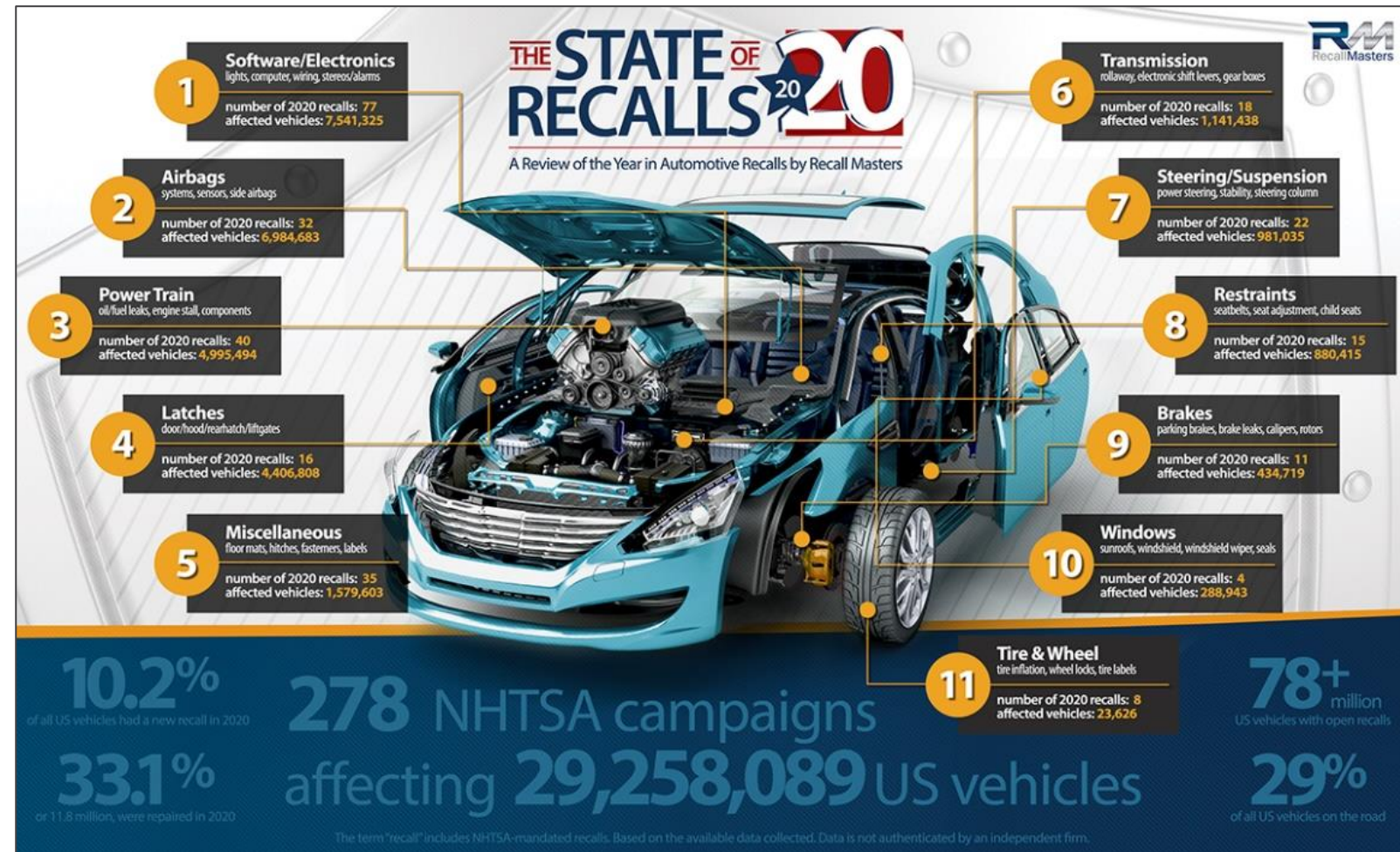
- Study by Max Planck Institute for Biological Cybernetic (Current Biology Sept. 29, 2009)
- “People really [do] walk in circles when they do not have reliable cues to their walking direction”
- Why?
 - Deviations in terrain
 - One leg stronger than the other
 - “increasing uncertainty about where straight ahead is”
- Blindfolded Test
- Compare this with your projects...
- ***We are missing guidance cues.***





Growing complexity in automotive...

- ~29 million automotive recalls in the US last year
- Per AlixPartners*, each recall costs ~\$500/vehicle, that's \$145 billion in direct costs fixing the problems in 2020
- Auto Manufacturers carrying ~\$113B in warranty reserves** (2.5% of revenue) on their books
- ...mostly due to cross organization/interdisciplinary communication issues



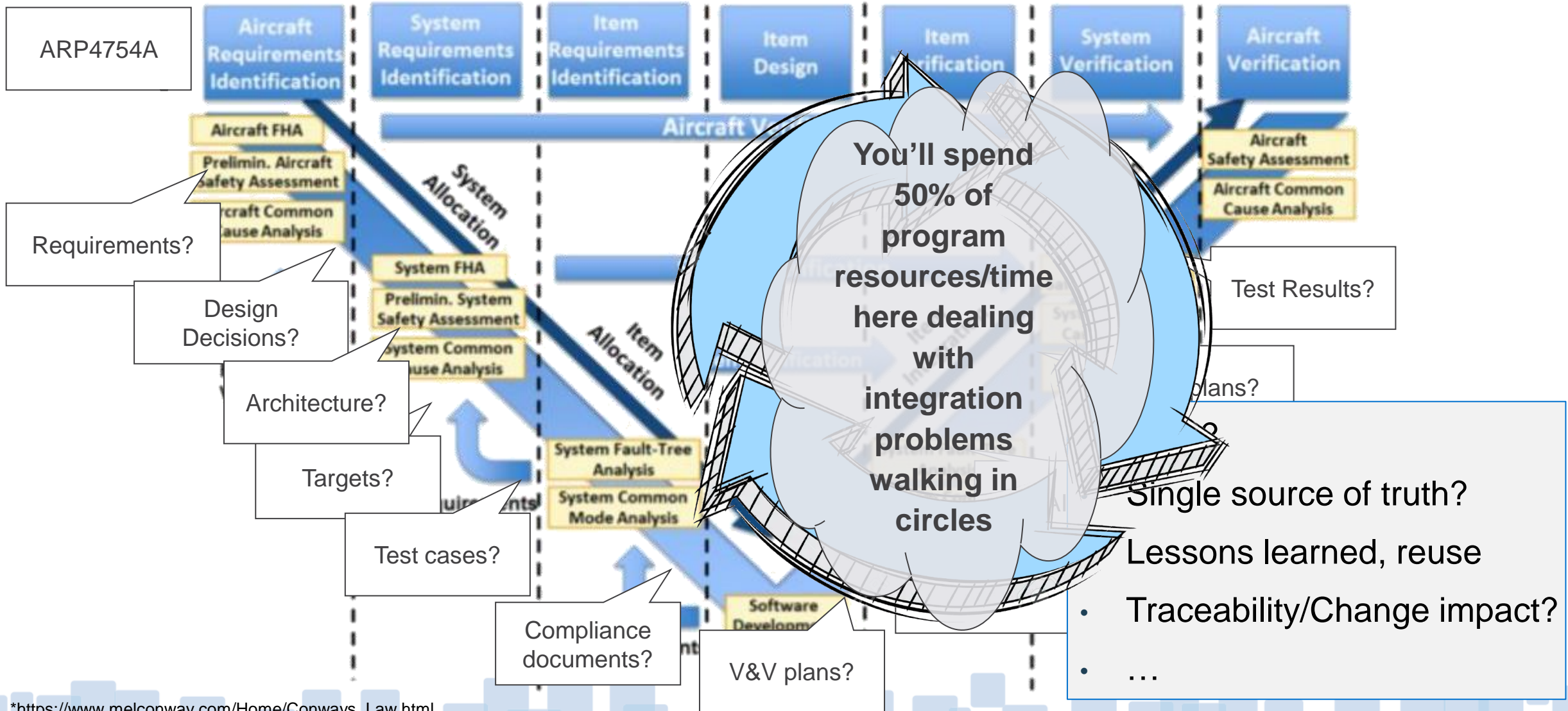
* http://lite.cnn.com/en/article/h_a9a78e0bc97dc033569b8b2fefe63d47

** <https://www.warrantyweek.com/archive/ww20200910.html>



Systems Development process...

Mel Conway* was right

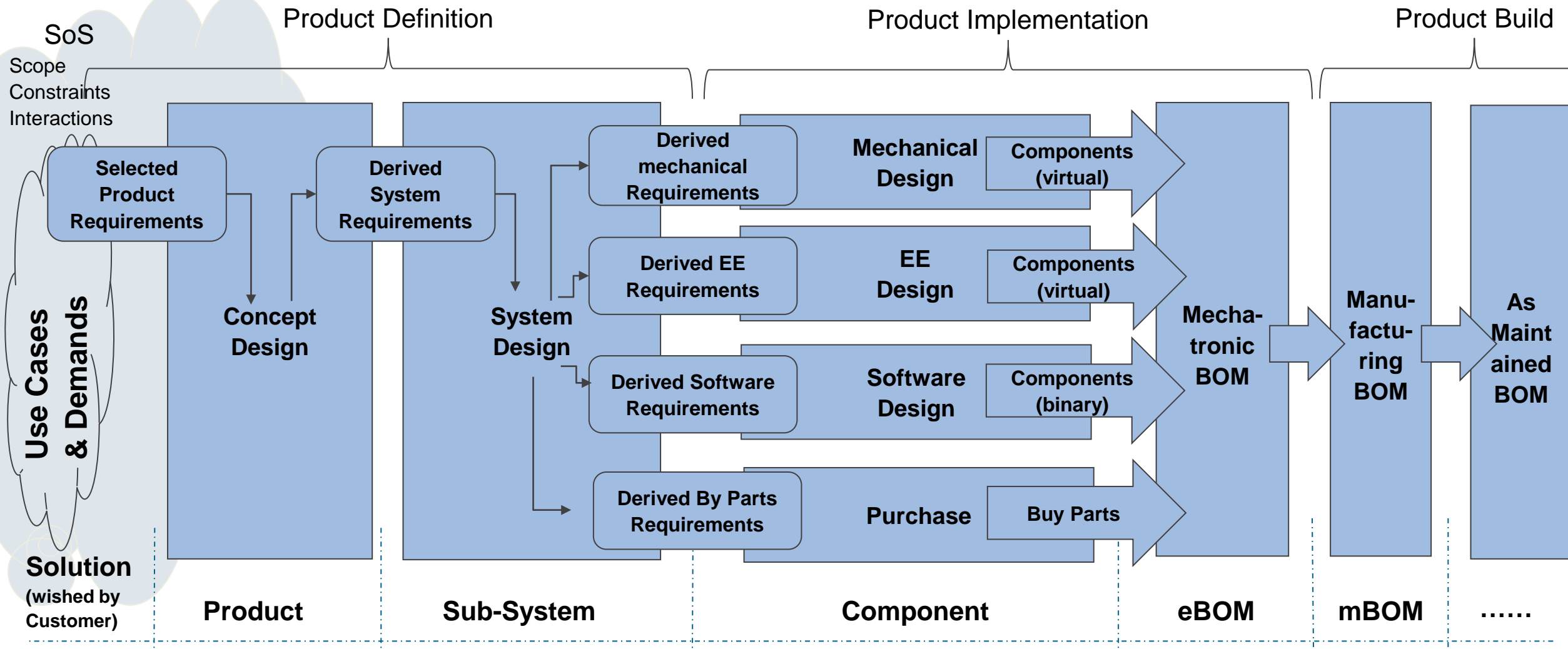


*https://www.melconway.com/Home/Conways_Law.html



MBSE Process...

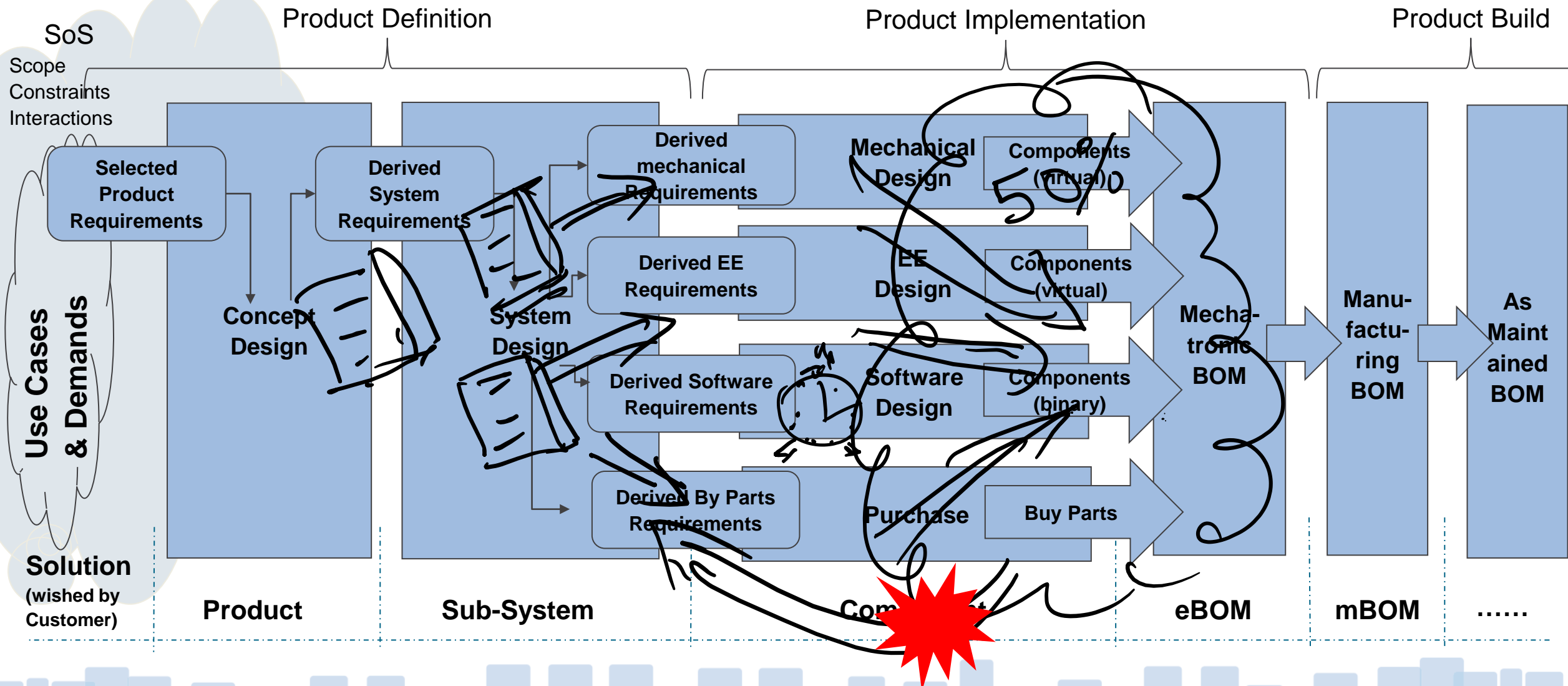
Shift left





MBSE Process...

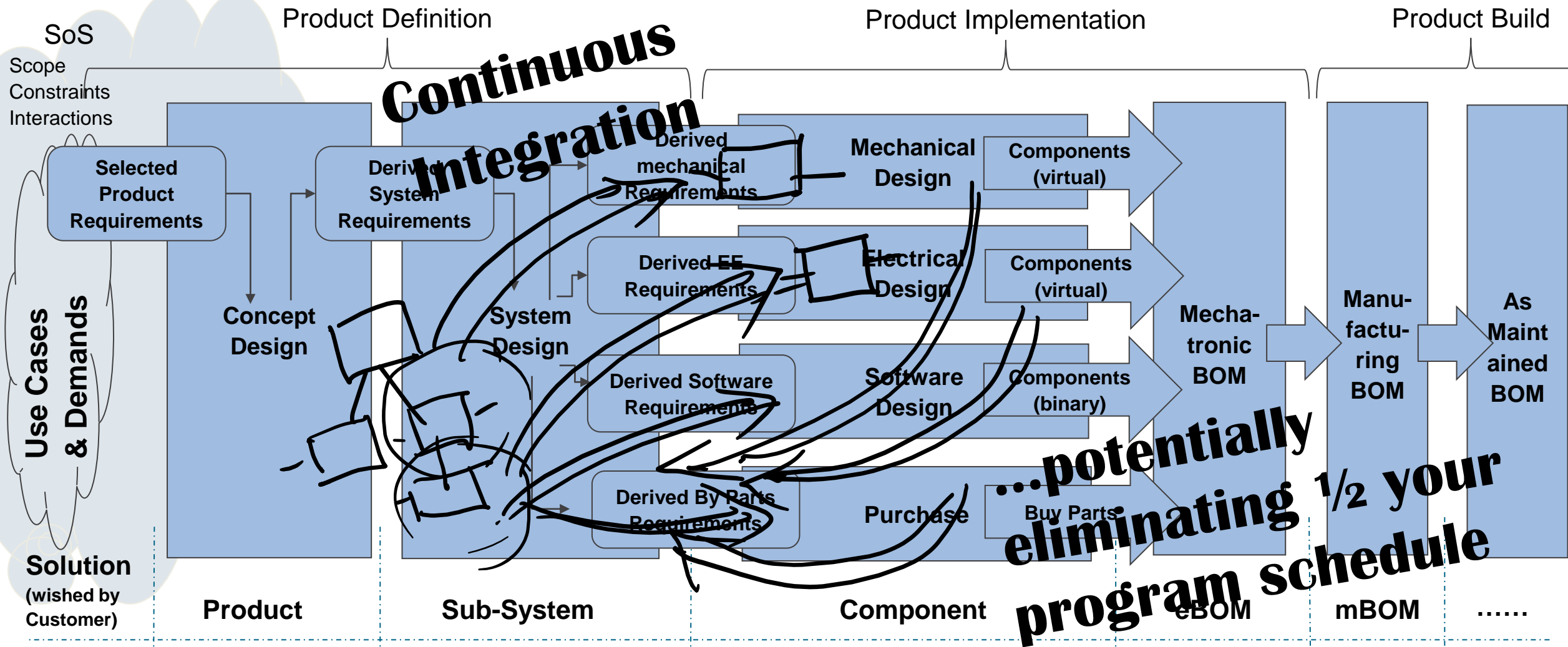
How it works today





MBSE → MBDC Process...

How it can work with an integrated product architecture





Insane Design Behavior

Solving the same problems over & over; going in circles

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:
Siloes/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

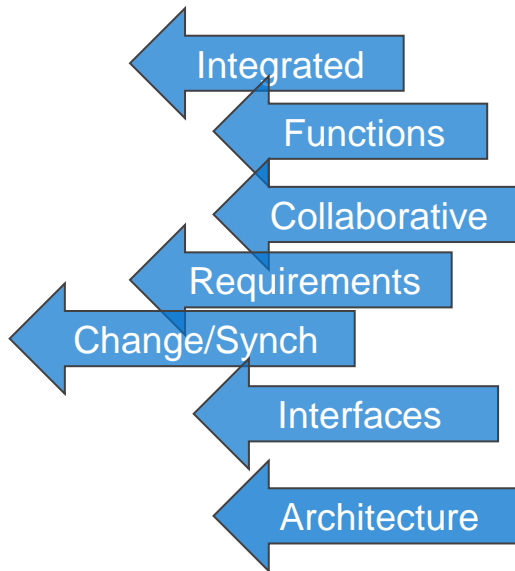
Interfaces

Architecture

“Water on the knee”

How lost are we?

MBSE Maturity



Capability Assessment:	Basic	Low	Medium	High	Advanced
System Modeling/Architecture	None	Visual models	Simulations	exchange/optimize	PL variation definition built into architecture decisions
PLE/Configuration (variation)	None	Variation documents, spreadsheets	Disconnected variation rules	Integrated variation rules	PL variation definition built into architecture decisions
Technical Risk (RAMS, cost,...)	None	Risk documents, spreadsheets	Integrated Risk Management Plans with aspects of RAMS (FMEA)	Standalone RAMS with FMECA Dash boards	Integrated RAMS, continuous risk assessment/alerts with dashboards
Interface Management	ICD in docs	Managed interfaces	Standard-based Interface library	Reused interfaces	Functions/logical allocation drives interface definitions
Logical Modeling	Logical description documents	Logical hierarchy	Isolated logical behavior models	Integrated logical behavior models	Logical architecture with allocation with traceability
Parameter Management	Unmanaged spreadsheets	Managed spreadsheets	Parameter library	Integrated with functions	Reusable parameter library with traceability
Feature/Functional Modeling	Functional description docs	Function hierarchy	Isolated functional behavior models	Integrated functional modeling	Functional arch with allocations & Traceability
Characteristic/Target Mgmt	None	Uncontrolled Excel/Docs	Controlled targets	Distributed targets/constraints	Integrated targets, budgets, with compliance reports
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
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, behavior models	Shared model repository	Integrated, component library	Model reuse with controlled parameters
Verification & Validation	Document-based test procedures	Managed test cases	Standard test libraries	Validation simulation & HIL/SIL	Focused testing, reuse results, swap out models
Design Management	unmanaged Cax/SW models	Locally Managed CAX/SW	Enterprise repositories	Integrated models (MIL, SIL,...)	Cross-domain design/optimization
CMMI Staged Levels:	(1) Initial	(2) Managed	(3) Defined	(4) Qualitative	(5) Optimizing

How lost are we?

Avg MBSE Maturity

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Avg Organization (best case)



Where are we?

Everyone dealing with design sanity problem

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You are here

Best Auto (best case)

Best Aero (best case)

Is SE education helping our circular design problem?

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Model Management	Uncontrolled, rules-of-thumb, heuristics	Uncontrolled, behavior 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
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Avg University (best case)

Avg Organization (best case)



MBSE Workshop 2022

Keynote speakers

University of Michigan, Under-Graduate Systems Engineering Program

- **George F. Hallow** (Professor of Practice in Aerospace Engineering)
- **Dr. Gorkin Cinar** (Asst. Professor of Aerospace Engineering)
- **Julia Weiss** (BSE)



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ABET Engineering Area Delegation and Board of Delegates Approves the Systems Engineering Program Criteria

SAN DIEGO (December 28, 2021) – The [International Council on Systems Engineering](#) (INCOSE) is excited to announce as of the 29th of October, the ABET Engineering Area Delegation and Board of Delegates has approved and accepted the Systems Engineering Program Criteria defined by INCOSE and six other professional societies and will implement these updates throughout 2022 and 2023. These criteria, developed by experienced engineering program evaluators representing ABET member societies, apply to all accredited systems engineering or similarly named programs and will help foster improvements to engineering education. This accreditation adds critical value to academic programs in technical disciplines where quality, precision, and safety are of the utmost importance.

INCOSE began its journey to achieve this accreditation in 2001 with John Clouet meeting with Wolt Fabrycky and Phil Brown; however, it was not a straightforward path. It would take 20 years, a couple of rejections, and the help of countless systems engineers between INCOSE and ABET to make it possible.

Art Pyster stated, “This is a real milestone in the discipline maturation. ABET has previously approved special criteria for more than two dozen other engineering disciplines such as biomedical, electrical, mechanical, and civil engineering. Systems engineering now takes its place beside them as a fully recognized academic discipline.”

About the International Council on Systems Engineering

The International Council on Systems Engineering (INCOSE) is a not-for-profit membership organization that promotes international collaboration in systems engineering practice, education and research. INCOSE’s mission is to “address complex societal and technical challenges by enabling, promoting and advancing systems engineering and systems approaches.” Founded in 1990, INCOSE has more than 70 chapters and over 17,000 members worldwide. For additional information about INCOSE visit www.incose.org. Become a [member](#) today.

About ABET

ABET is a nonprofit, non-governmental organization with ISO 9001:2015 certification. It began as the educational standard for licensed professional engineers in the United States. It accredits college and university programs worldwide, guaranteeing these programs meet quality standards to produce graduates who are prepared to enter the workforce. ABET’s program evaluators, commissioners, board members, and advisors include over 2,200 experts from industry, academia, and government. To learn more, visit <https://www.abet.org/about-abet/>.



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