INCOSE MBSE Workshop kickoff

Mark Sampson/Troy Peterson
INCOSE MBSE Initiative

What is MBSE?

"Model-based systems engineering (MBSE) is the formalized application of modeling to support system requirements, design, analysis, verification and validation activities beginning in the conceptual design phase and continuing throughout development and later life cycle phases.

-INCOSE Handbook/Vision

MBSE:
Failing Faster
Earlier
Once

What problem are we trying to solve?

Walking in circles…

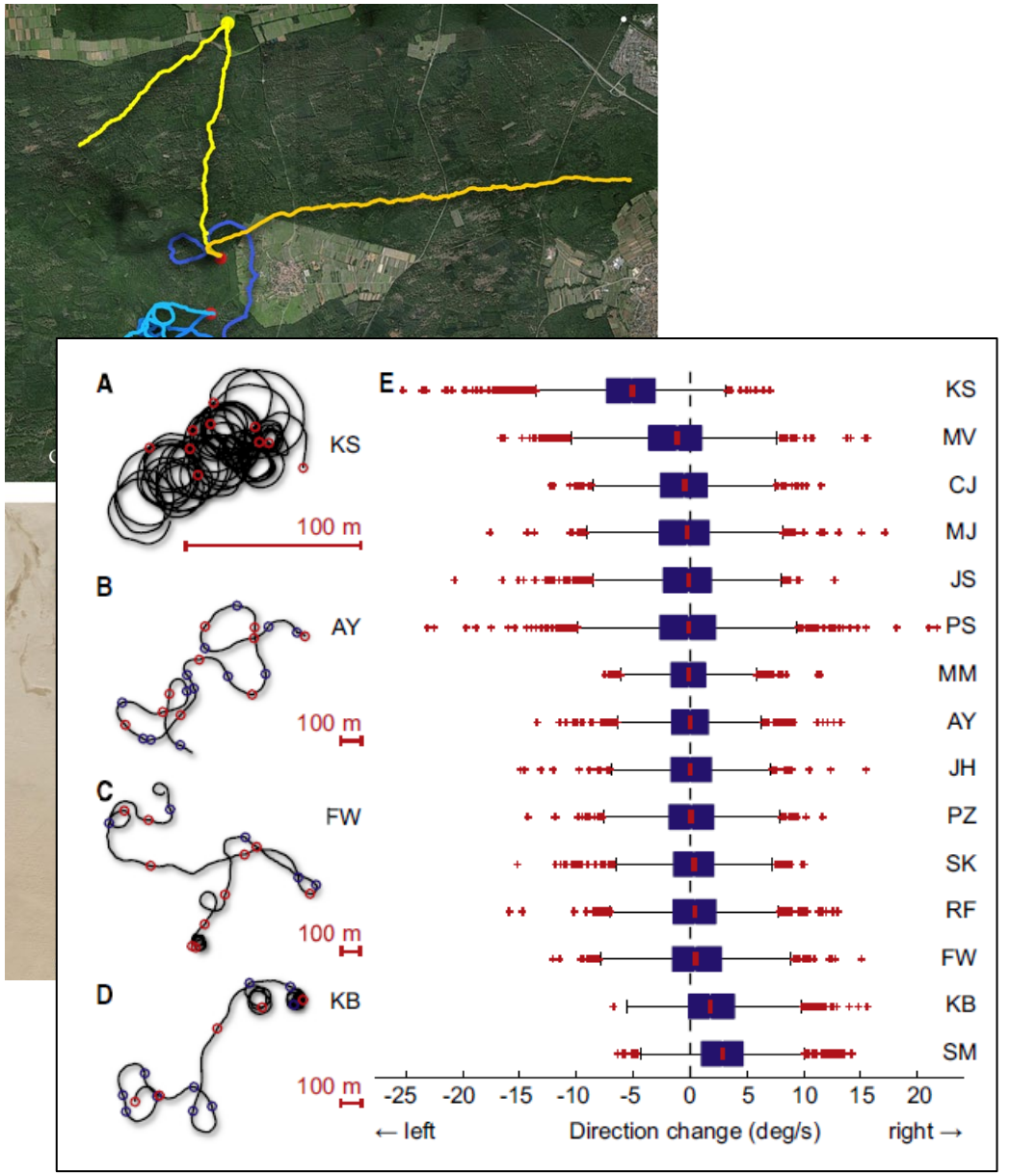
Study by Max Planck Institute for Biological Cybernetics
(Current Biology Sept. 29, 2009)

"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 results…
Compare this with your projects…
We are missing guidance cues.



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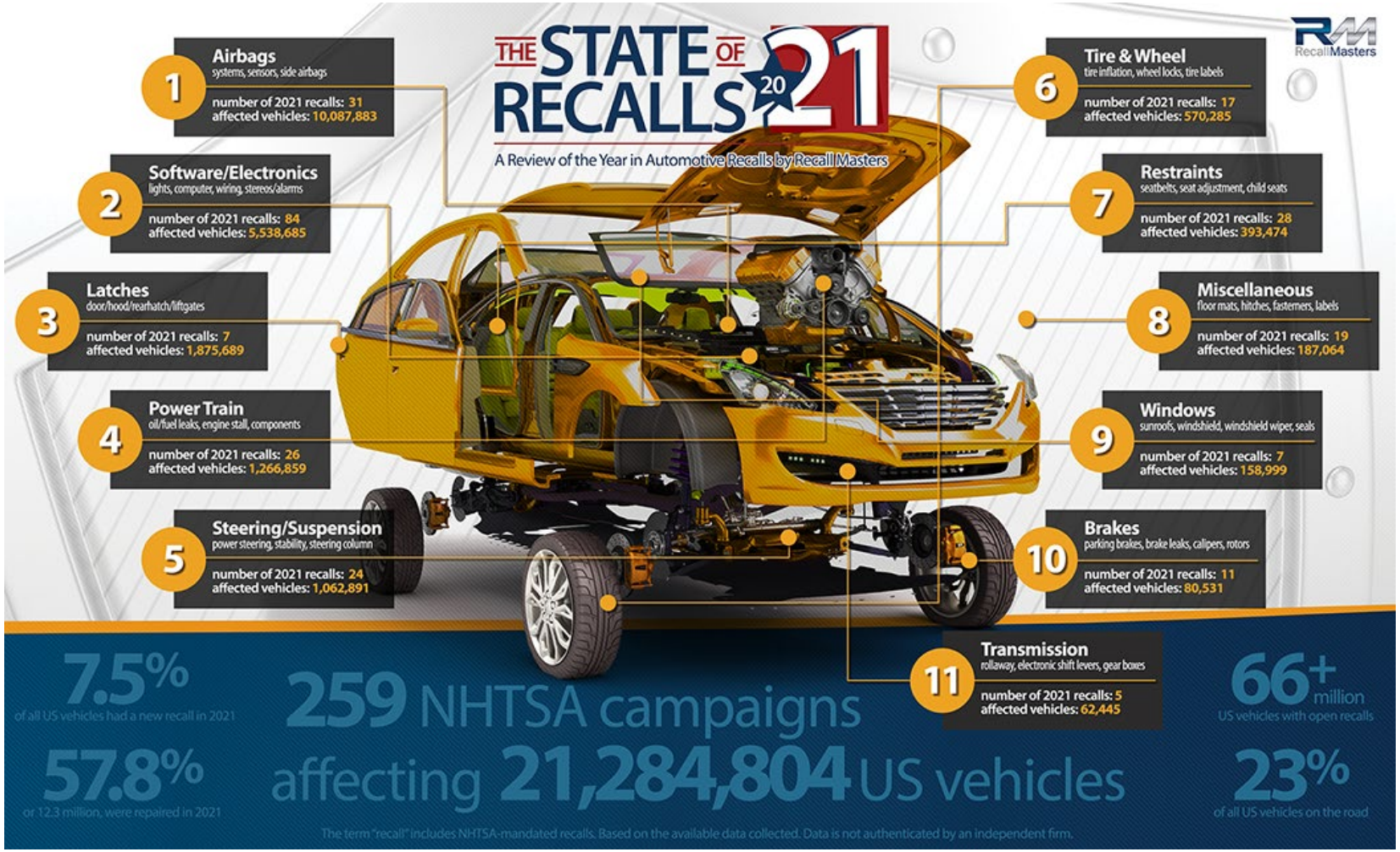
Growing complexity in automotive…

- ~21 million automotive recalls in the US in 2021
- Per AlixPartners*, each recall costs ~$500/vehicle, that's $105 billion in direct costs fixing the problems in 2021
- 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

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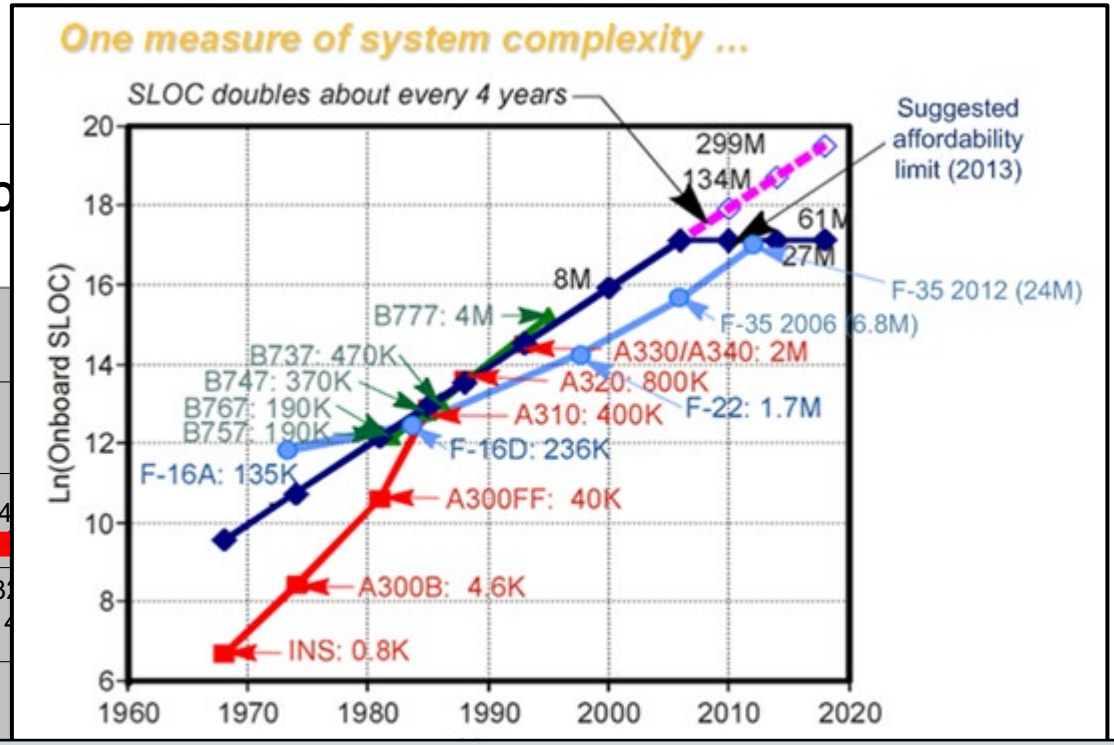
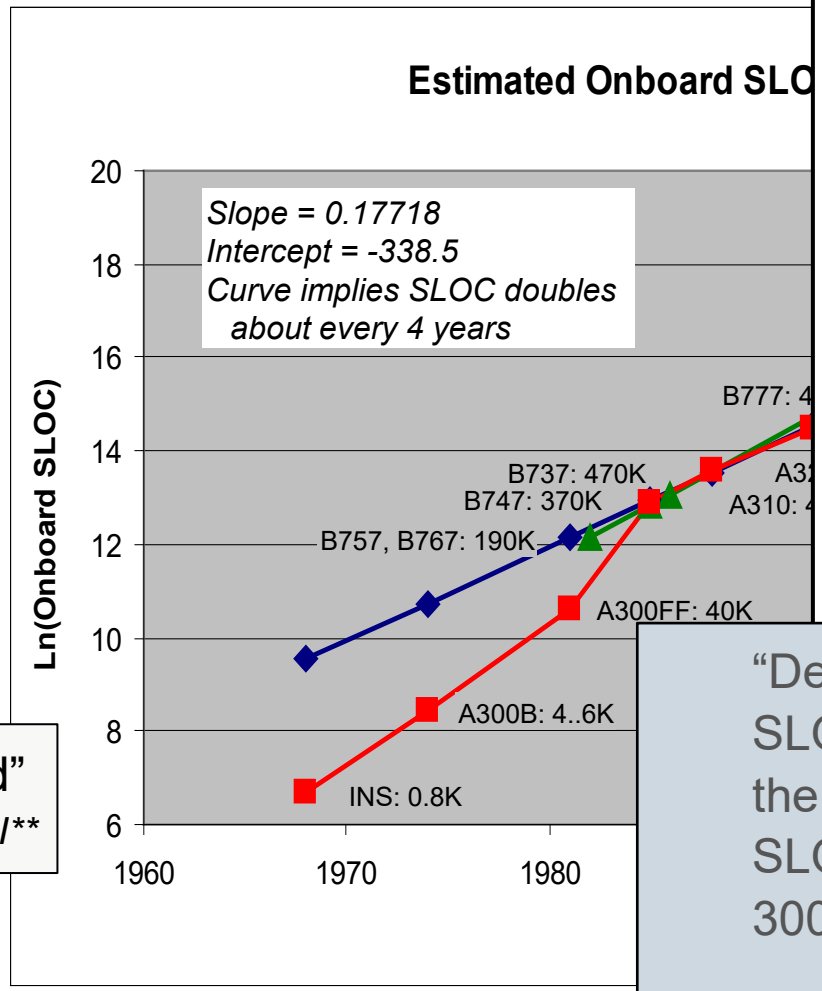
Unprecedented Product Complexity: becoming unaffordable…
Norm was right (Augustine's Law #16)*





"Integrate, then build"
*AVSI***

"Development effort, which increases exponentially with SLOC, is increasing at an alarming rate. For example, the F35 has approximately 175 times the number of SLOC as the F16. But, it is estimated to have required 300 times the development effort"

https://savi.avsi.aero/about-savi/

*https://en.wikipedia.org/wiki/Augustine's_laws
**avsi.aero

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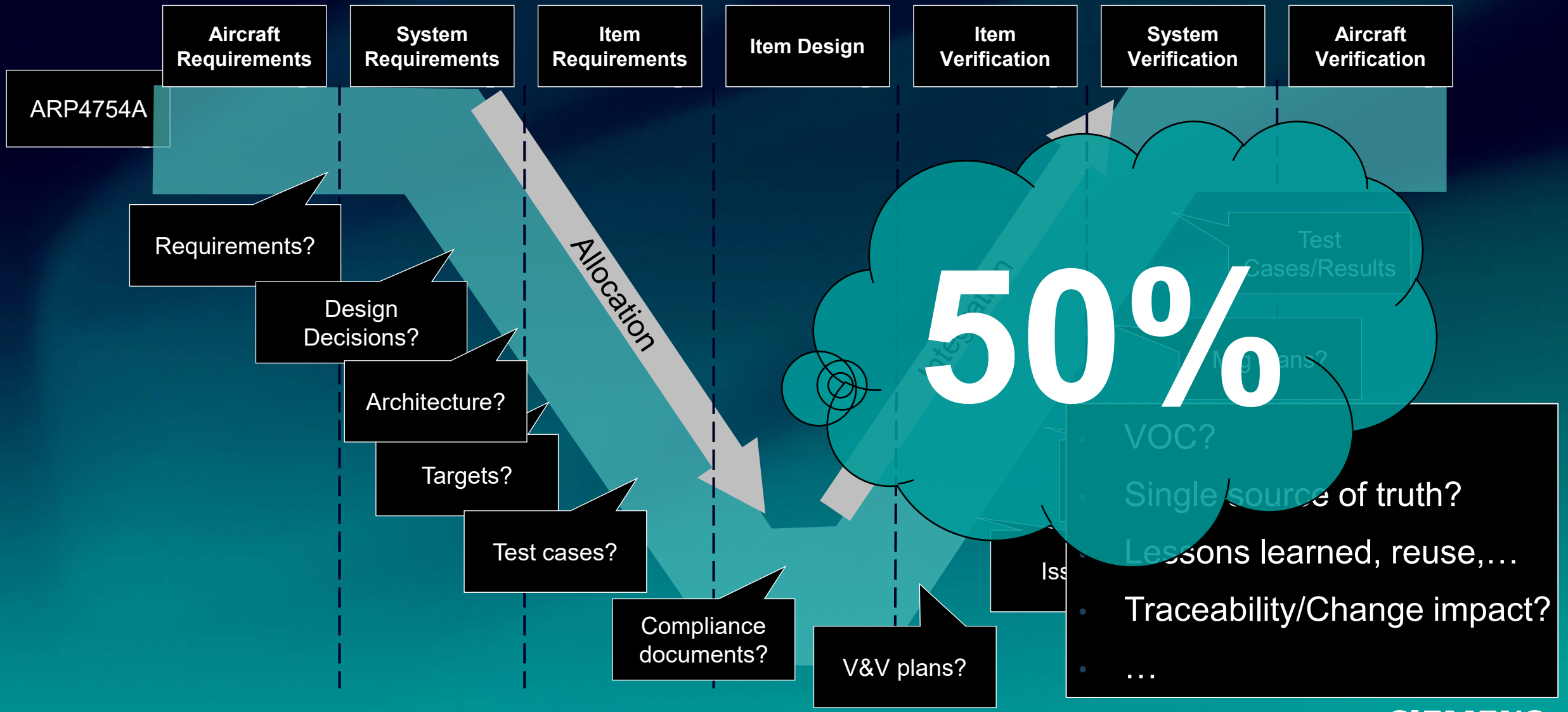
The result of a siloed product development process…
Mel Conway was right *



*https://www.melconway.com/

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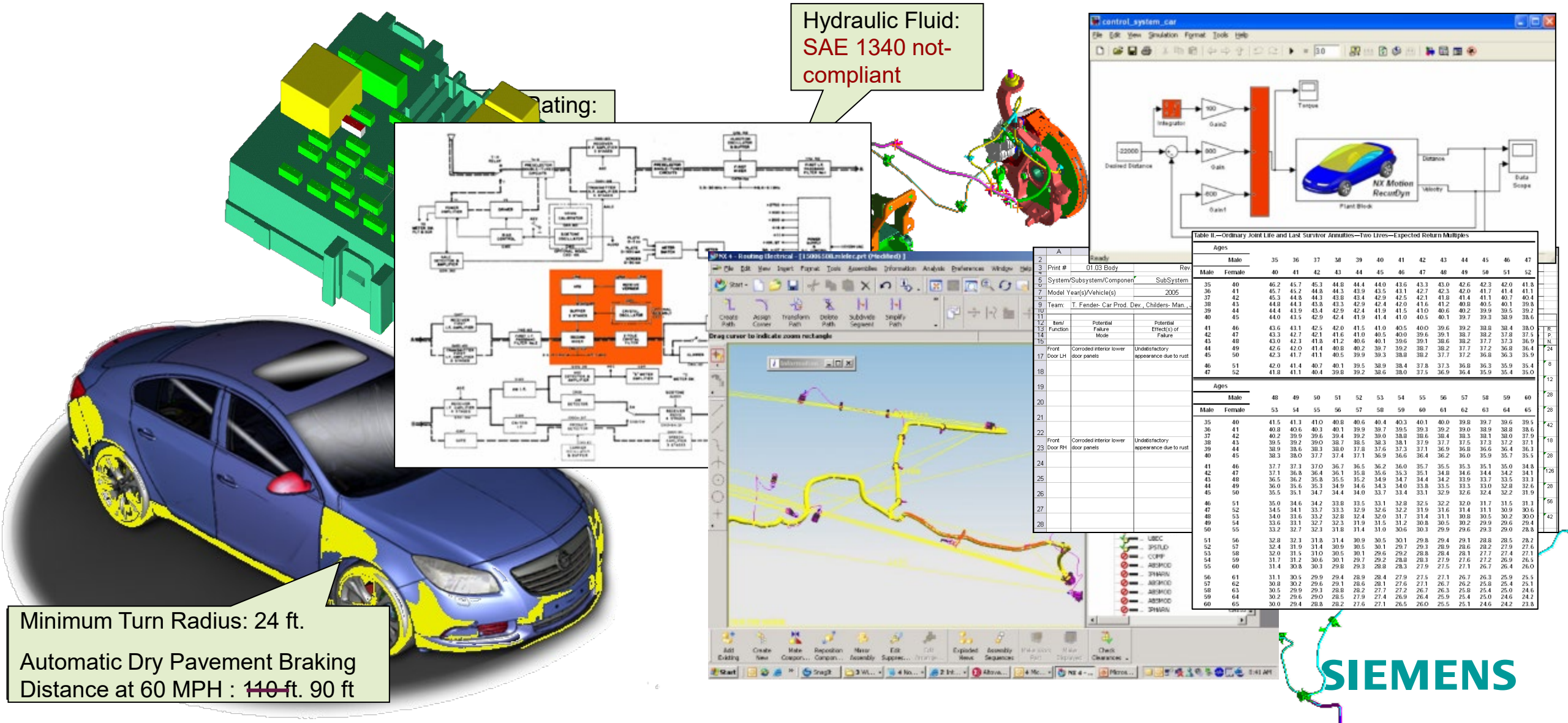
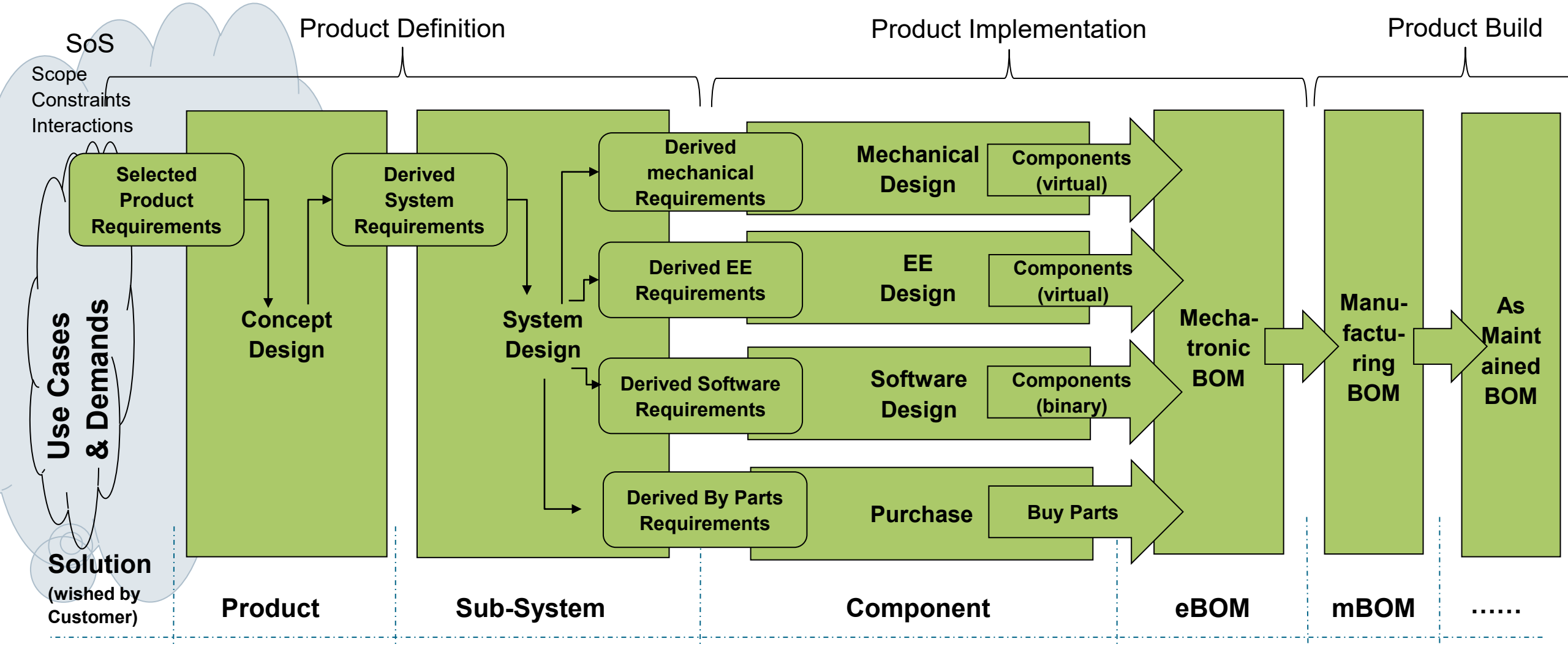
INCOSE Integrated MBSE Vision
What does the integrated digital thread look like…



Systems Engineering Process…

Shift left…



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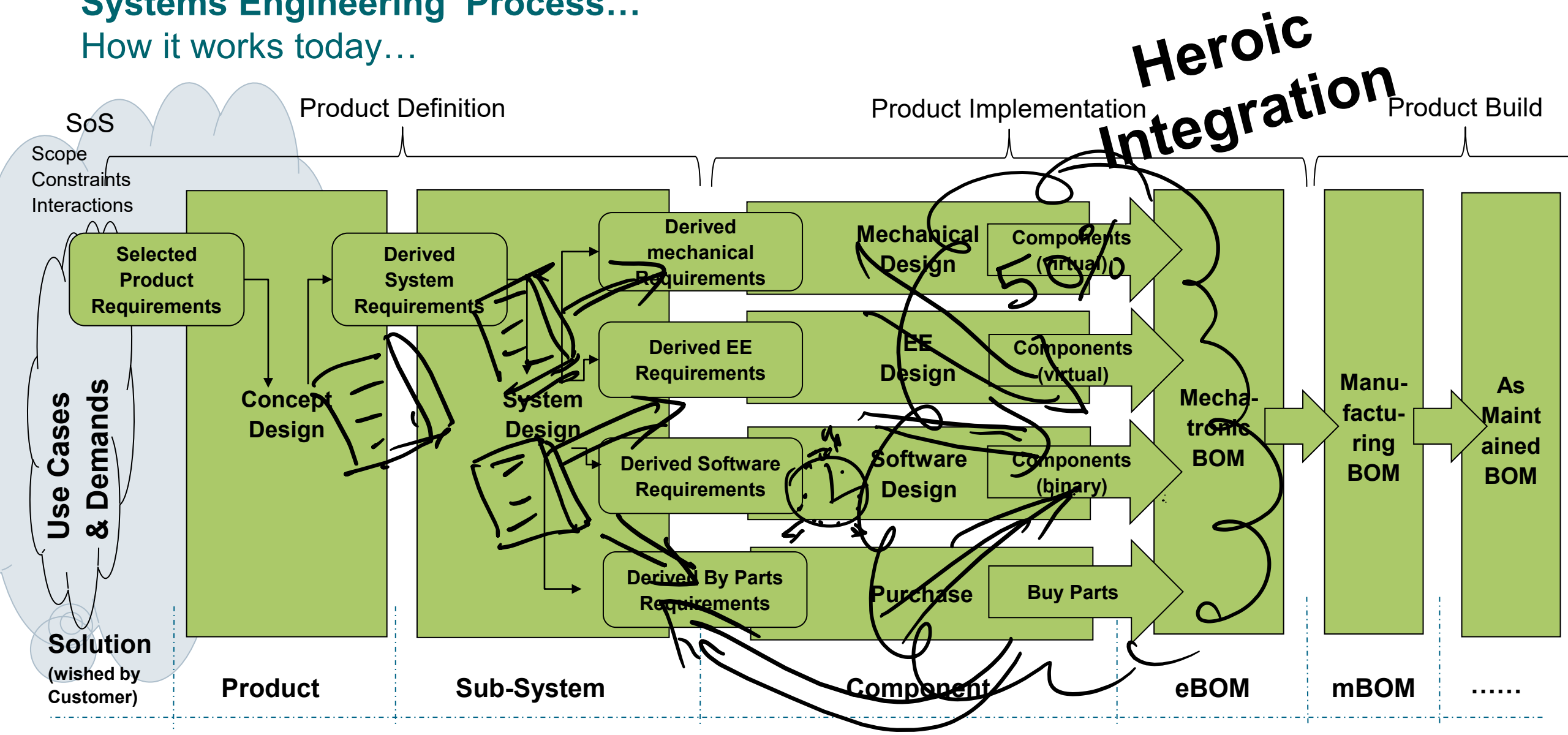
Systems Engineering Process…

How it works today…



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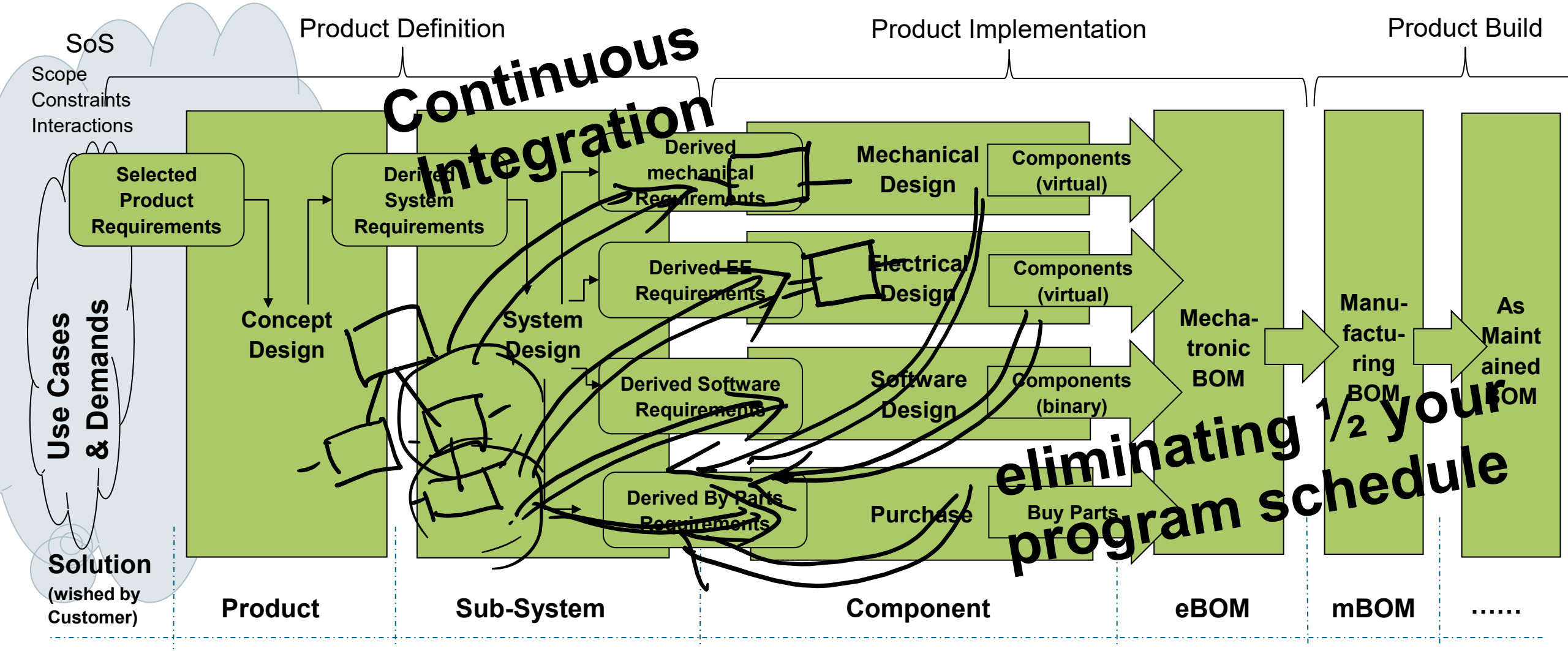
Integrated MBSE Process…

How it can work with a model-based integrated product architecture



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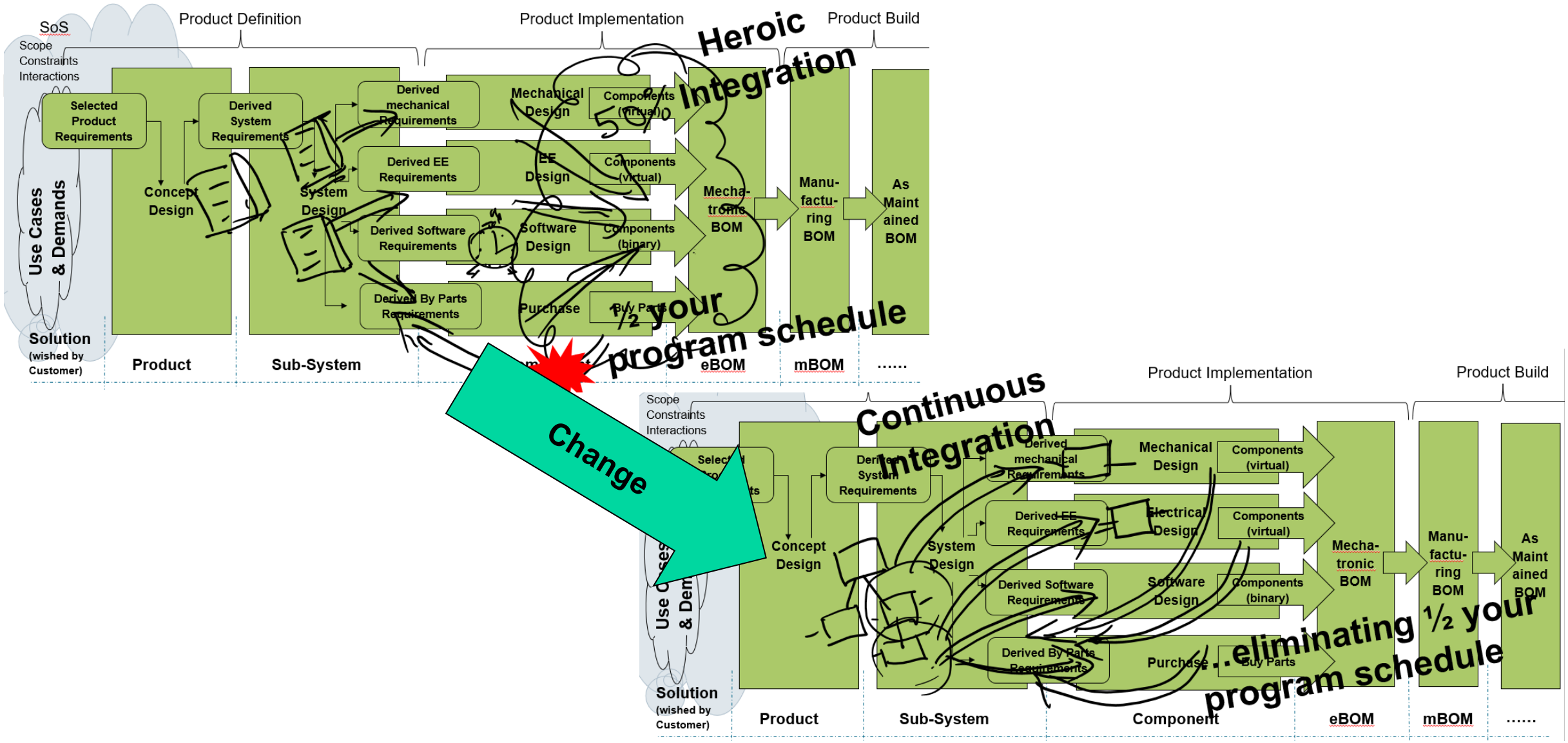
This will require change…



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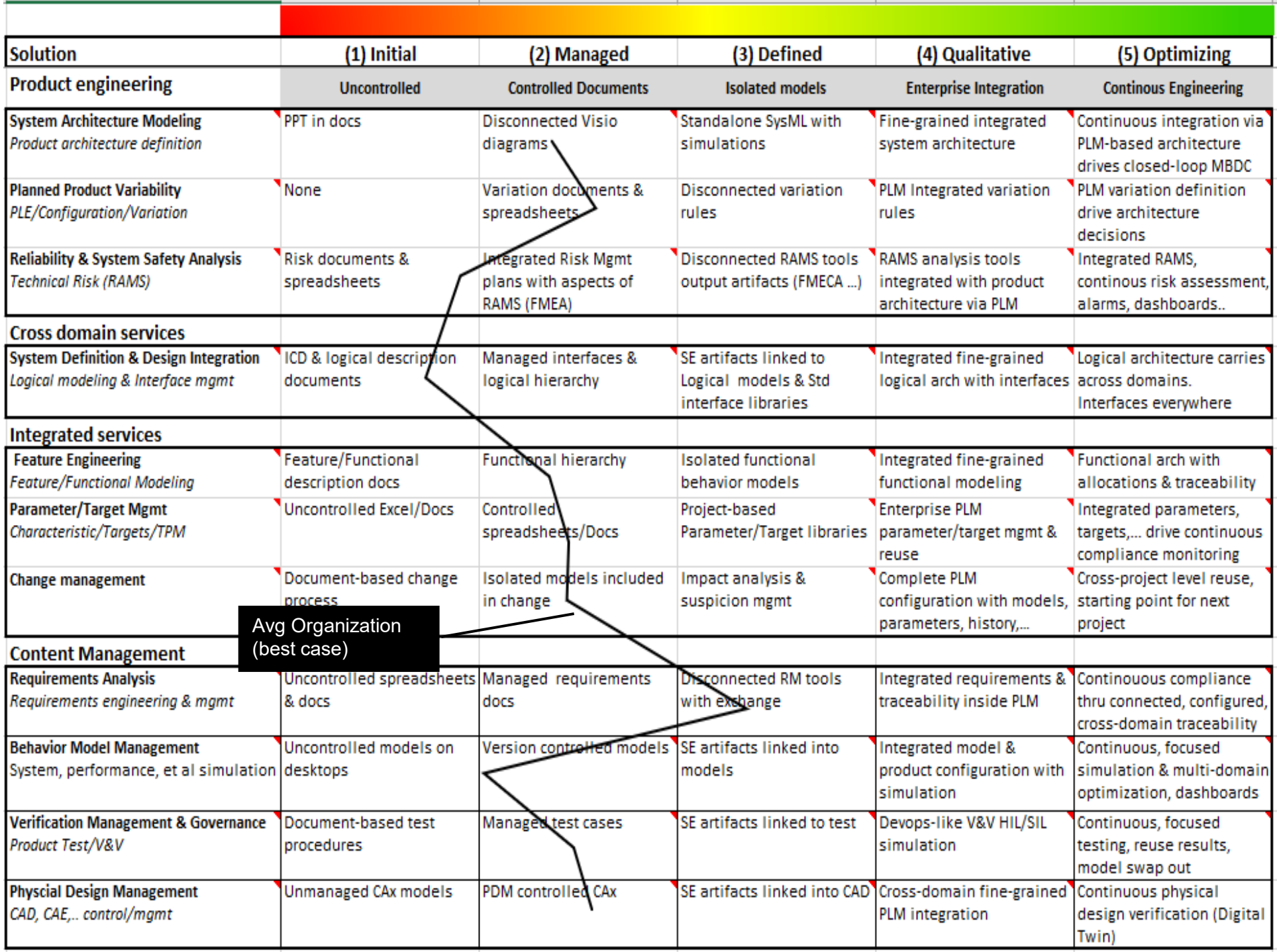
Where are we?

Avg MBSE Maturity

Solution	(1) Initial	(2) Managed	(3) Defined	(4) Qualitative	(5) Optimizing
Product engineering	**Uncontrolled**	**Controlled Documents**	**Isolated models**	**Enterprise Integration**	**Continous Engineering**
System Architecture Modeling *Product architecture definition*	PPT in docs	Disconnected Visio diagrams	Standalone SysML with simulations	Fine-grained integrated system architecture	Continuous integration via PLM-based architecture drives closed-loop MBDC
Planned Product Variability *PLE/Configuration/Variation*	None	Variation documents & spreadsheets	Disconnected variation rules	PLM Integrated variation rules	PLM variation definition drive architecture decisions
Reliability & System Safety Analysis *Technical Risk (RAMS)*	Risk documents & spreadsheets	Integrated Risk Mgmt plans with aspects of RAMS (FMEA)	Disconnected RAMS tools output artifacts (FMECA ...)	RAMS analysis tools integrated with product architecture via PLM	Integrated RAMS, continous risk assessment, alarms, dashboards..
Cross domain services					
System Definition & Design Integration *Logical modeling & Interface mgmt*	ICD & logical description documents	Managed interfaces & logical hierarchy	SE artifacts linked to Logical models & Std interface libraries	Integrated fine-grained logical arch with interfaces	Logical architecture carries across domains. Interfaces everywhere
Integrated services					
Feature Engineering *Feature/Functional Modeling*	Feature/Functional description docs	Functional hierarchy	Isolated functional behavior models	Integrated fine-grained functional modeling	Functional arch with allocations & traceability
Parameter/Target Mgmt *Characteristic/Targets/TPM*	Uncontrolled Excel/Docs	Controlled spreadsheets/Docs	Project-based Parameter/Target libraries	Enterprise PLM parameter/target mgmt & reuse	Integrated parameters, targets,... drive continuous compliance monitoring
Change management	Document-based change process	Isolated models included in change	Impact analysis & suspicion mgmt	Complete PLM configuration with models, parameters, history,...	Cross-project level reuse, starting point for next project
Content Management					
Requirements Analysis *Requirements engineering & mgmt*	Uncontrolled spreadsheets & docs	Managed requirements docs	Disconnected RM tools with exchange	Integrated requirements & traceability inside PLM	Continouous compliance thru connected, configured, cross-domain traceability
Behavior Model Management System, performance, et al simulation	Uncontrolled models on desktops	Version controlled models	SE artifacts linked into models	Integrated model & product configuration with simulation	Continuous, focused simulation & multi-domain optimization, dashboards
Verification Management & Governance *Product Test/V&V*	Document-based test procedures	Managed test cases	SE artifacts linked to test	Devops-like V&V HIL/SIL simulation	Continuous, focused testing, reuse results, model swap out
Physcial Design Management *CAD, CAE,.. control/mgmt*	Unmanaged CAx models	PDM controlled CAx	SE artifacts linked into CAD	Cross-domain fine-grained PLM integration	Continuous physical design verification (Digital Twin)



Where are we?

Everyone is challenged

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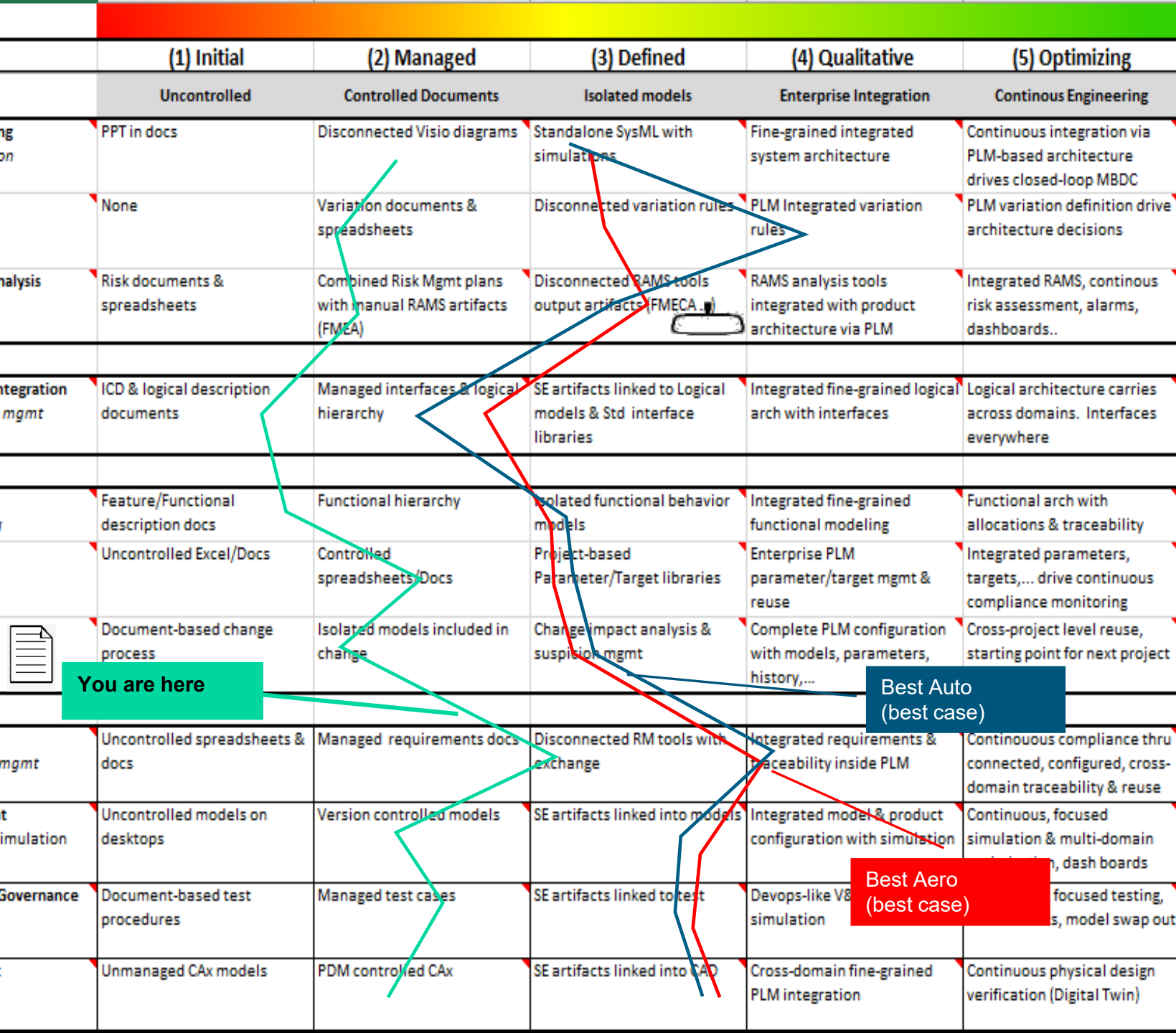

Is SE education helping our design sanity problem?

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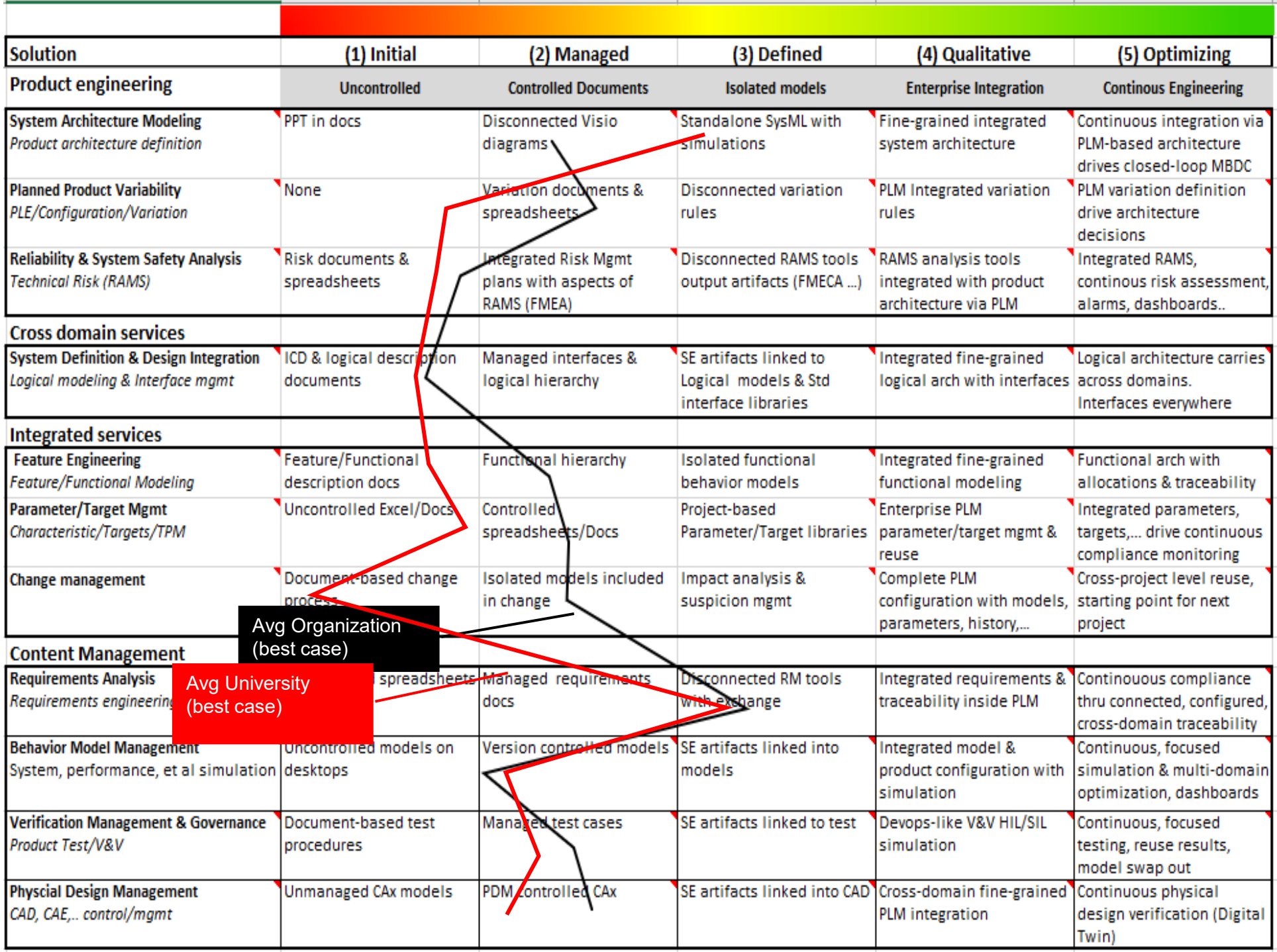

Barriers to implementation

Problem is information exchange not data exchange

PLM is about information; managing the digital thread

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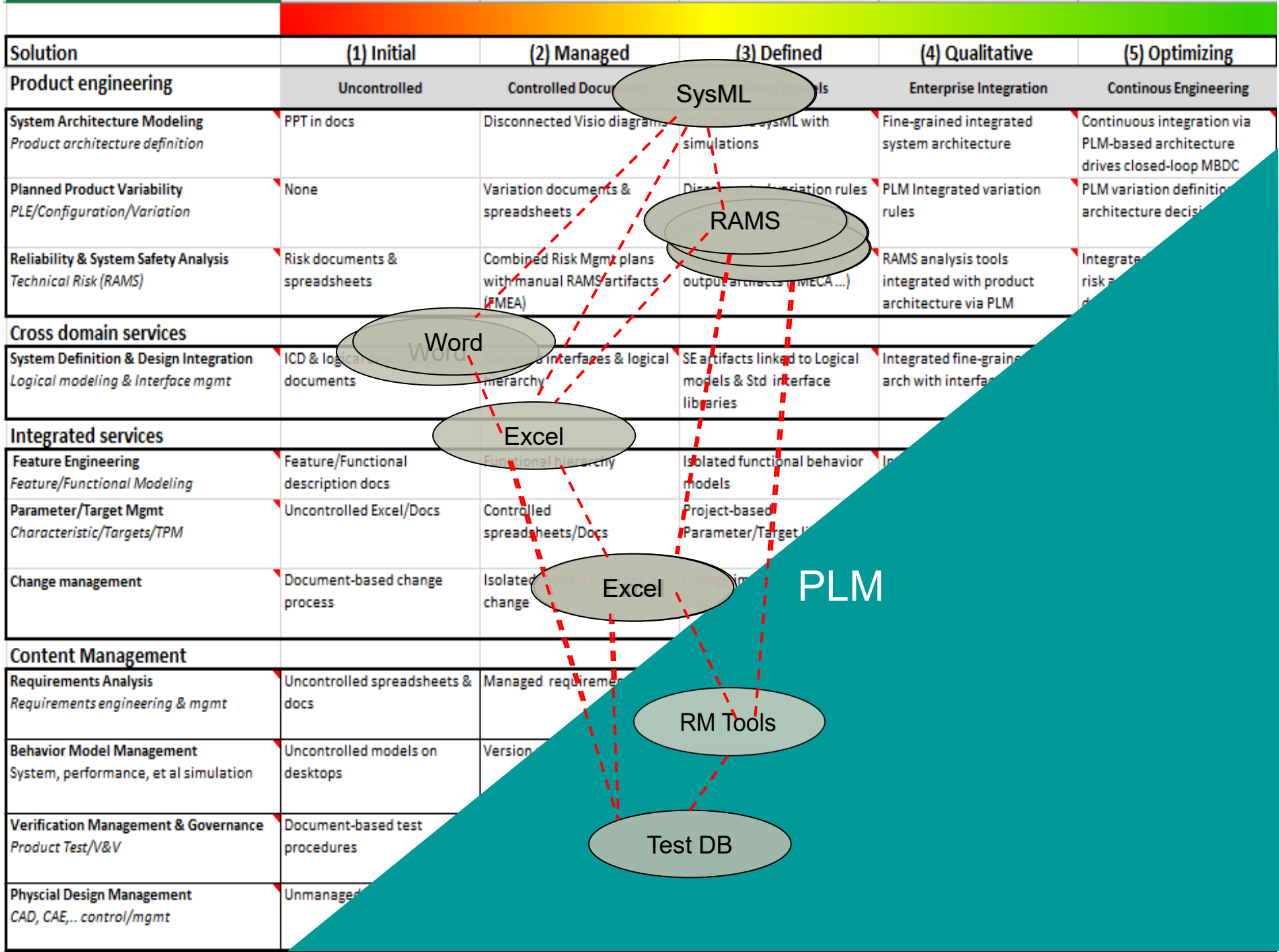
Verification Management & Governance *Product Test/V&V*	Document-based test procedures				
Physcial Design Management *CAD, CAE,.. control/mgmt*	Unmanaged				



"We're pretty good at chip design, 90% of them work as designed, 50% of them fail when we plug them in."

-IEEE

Where do we start?

Some realizations…

- Implementing MBSE on a complex product in a complex organization operating in a complex world = systems engineering problem[3]
- This is not an individual tool problem (MCAD works, ECAD works, Mfg works,…systems fail when you bring them together) that consumes half of program schedules today
- It's not at a tool problem, it's an integrated MBSE journey—Start Integrated, Stay Integrated

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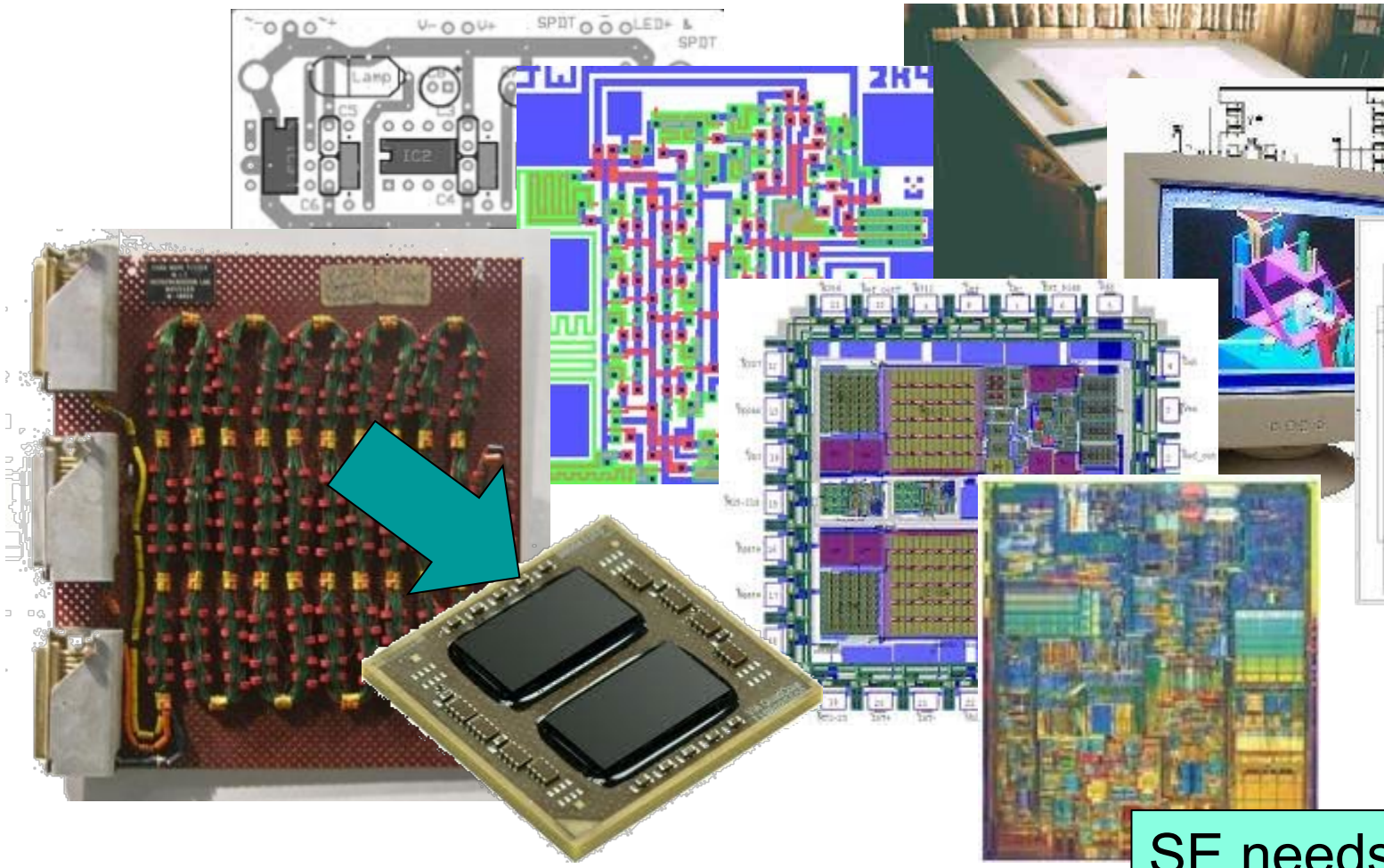
High-tech Experience…
Moving from drafting tables to HDL's

Documents

Document Generation

Disconnected System Models

MBSE



SE needs to go thru a similar journey

MBSE Workshop Agenda (2023)…

Day 1:

13:00	13:20	Kickoff: Our View on state of MBSE (Mark Sampson)
13:20	13:50	SysML v2 Update (Sandy Friedenthal)
13:50	15:00	MBSE Standards Update (Troy Peterson)
15:00	15:30	Break
15:30	16:10	Working Group Round Robin (Troy Peterson)
16:10	16:30	SE Tools Lab Update (Barclay Brown)
16:30	17:00	Wrap up, Q&A (Troy Peterson/Mark Sampson)

Day 2:

10:30	17:00	SE AI/Machine Learning Lightning Round (Barclay Brown, Thomas McDermott)
10:30	17:00	MBSE-System Safety Integration Workshop (Troy Peterson, Mark Sampson)
18:00	19:00	MBSE Social with annual MBSE Propeller Hat Awards