2021
Annual INCOSE
international workshop
Virtual Event
January 29 - 31, 2021

Start Integrated, Stay Integrated…

Solving our cross-domain engineering domain communication problem

Mark E Sampson MBSE Initiative Chair

MBSE Workshop Kickoff…

“There’s a difference between jogging and being chased by a bear”

Grandma Sampson

Some sample bears…

- ~47 million automotive recalls in the US last year
- NHTSA est. $100/recall per vehicle; that's $4.7 billion in direct costs fixing the problem
- …many of these are failures to comply with requirements & regulations

March 2, 2020: Ford & Volvo Door latch [1.4m, $140m)

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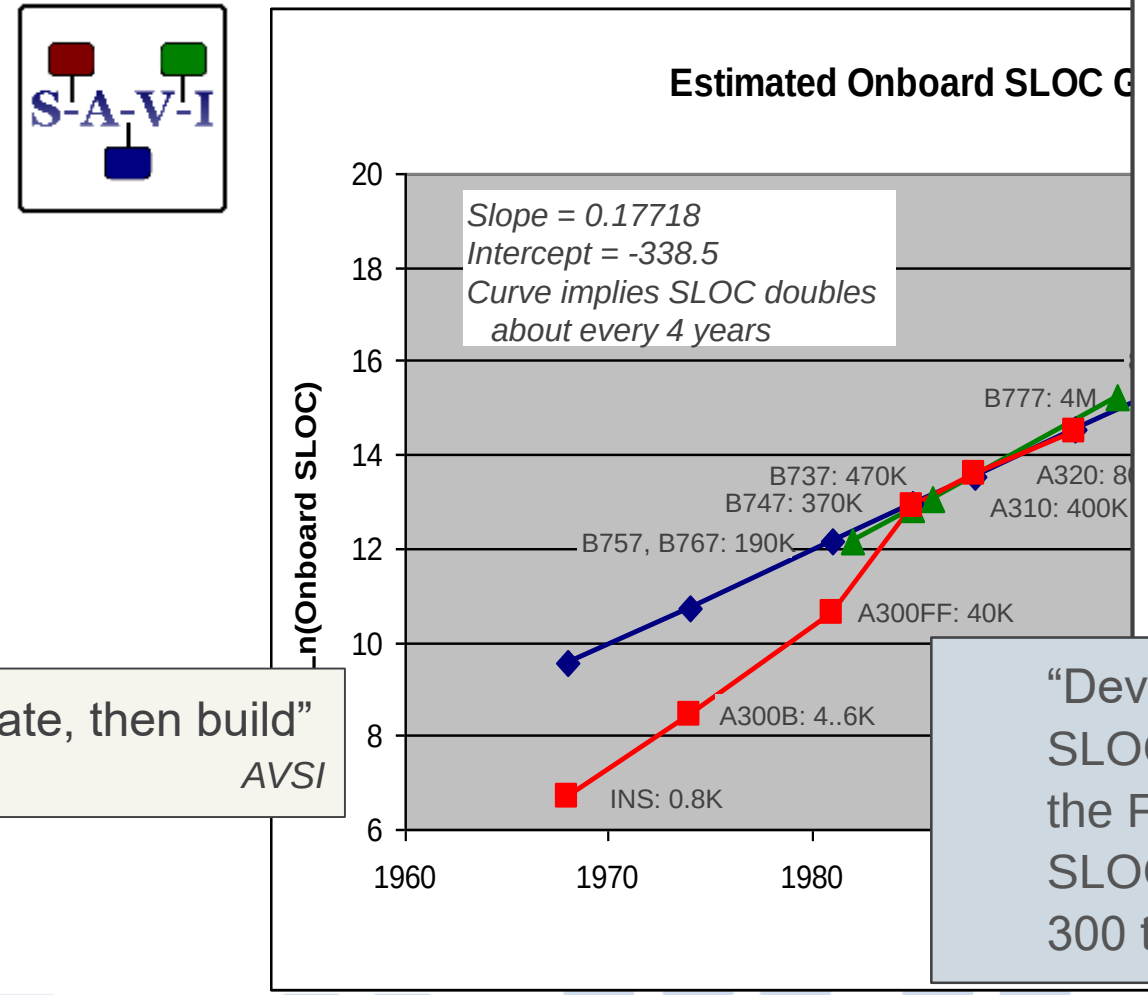
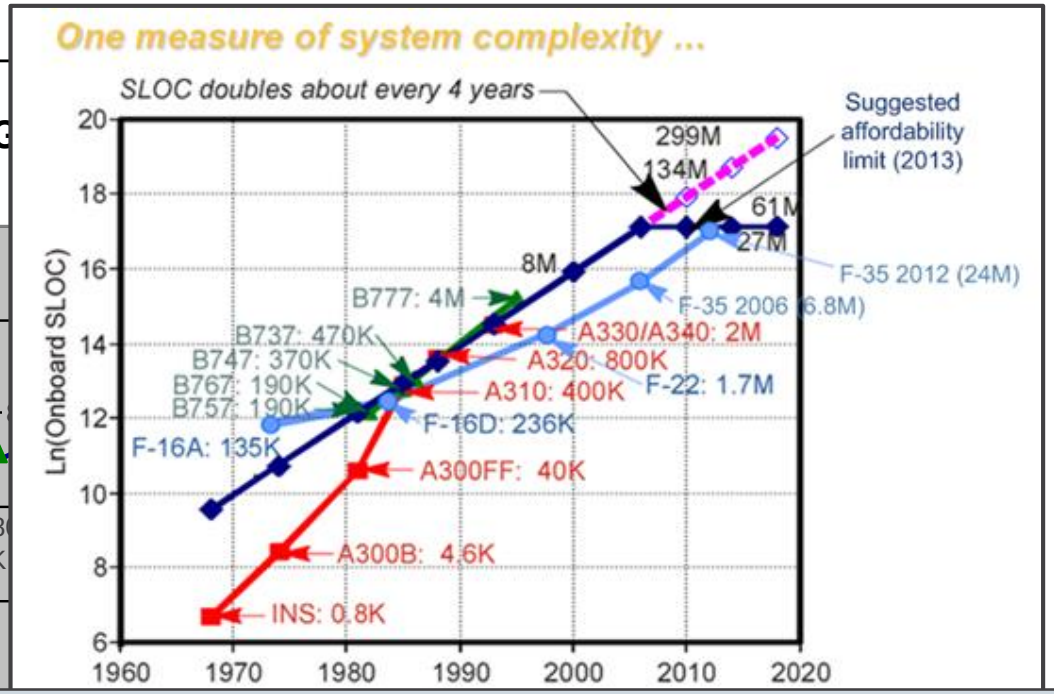
Unprecedented Product Complexity: Unaffordable Norm was right (Augustine's Law #16)





"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"

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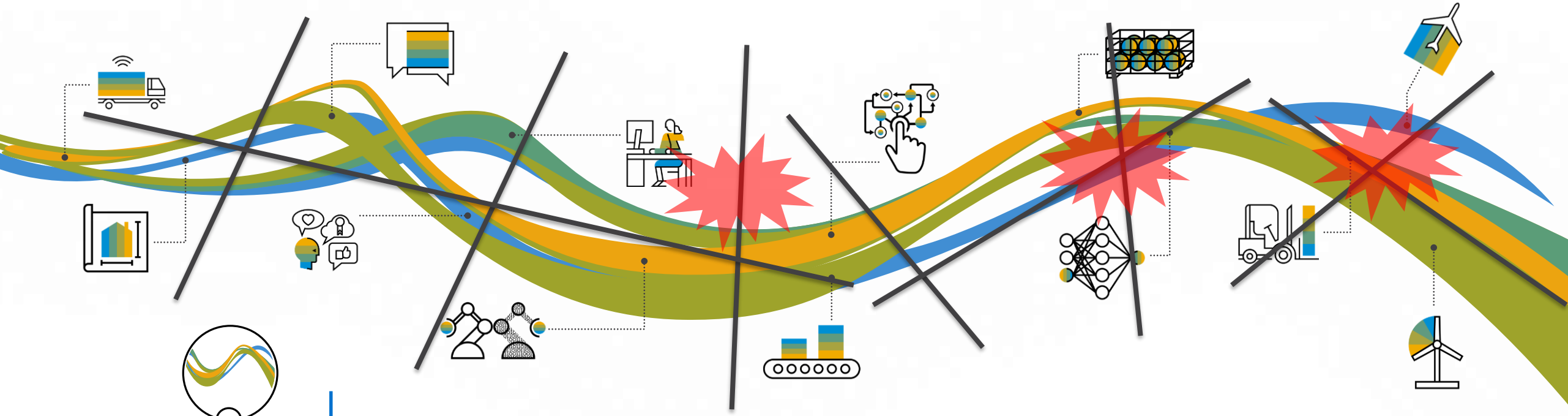
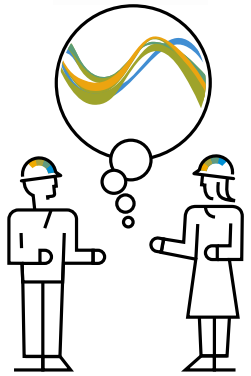
Without the digital thread…





Many different organizations & disciplines interact to create today's complex products

It's at these organization/discipline boundaries where integration problems happen

You already know this and plan to spend half your program schedule/resources for integration problems

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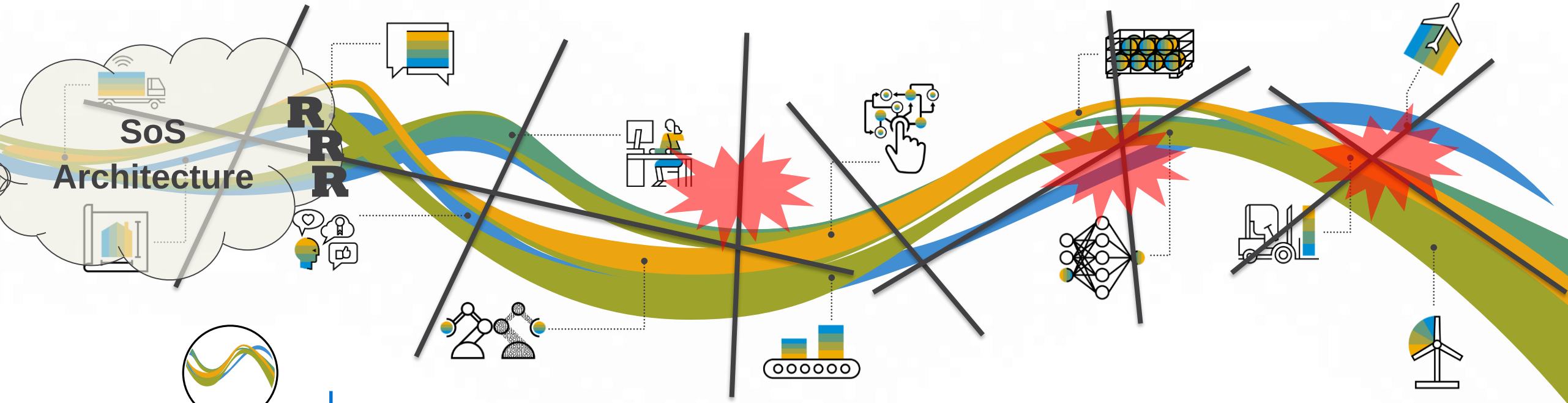
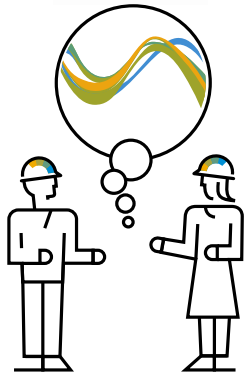
The digital thread starts with an integrated product architecture & requirements…





An integrated product architecture with requirement provides the scaffolding for the digital thread & drives the downstream development process for continuous integration

Requirements, Functions, et al. flow through the threads for continuous/closed-loop V&V

Guided by standard integrated process, participating in standard services, delivered thru PLM to everyone (including suppliers) for closed-loop development—continuous integration

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This isn’t an engineering problem, you have a knowledge communication/management problem

Today’s products are built by everyone/everywhere…

- Documents aren’t scalable
- Disconnected models provide knotholes
- You can’t hire enough brains

Symptoms:

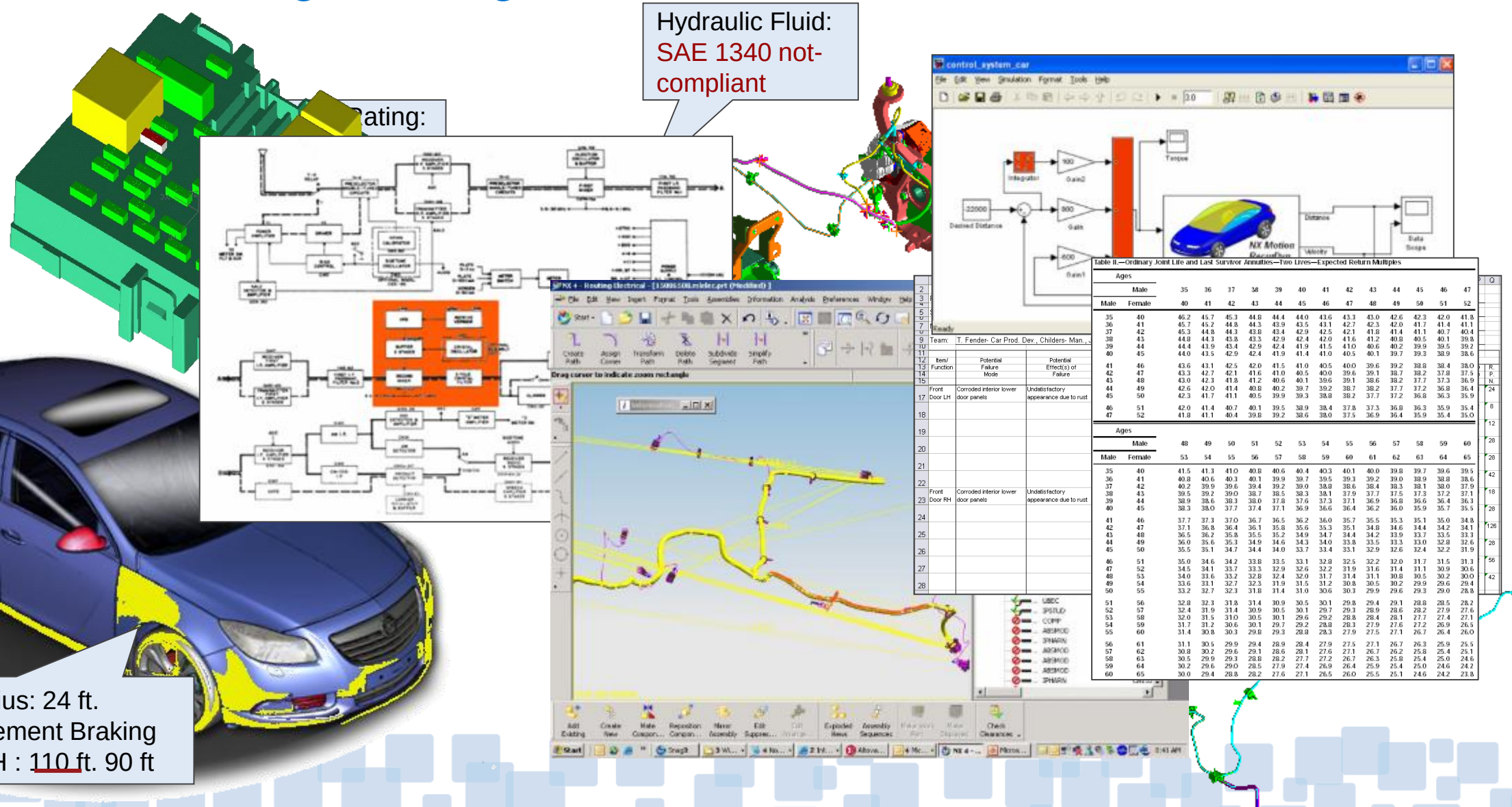
- Half your program schedule spent on system integrat (supplier coordination)
- Tedious communication via meetings
- Uncommunicated change
- Innocent impact understanding

An integrated product architecture/blueprint is required

- Delivered thru PLM
- Allocated through suppliers for continuous feedback

…to start integrated, stay integrated

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



Hidden costs from communication failures…
Solving the same problems over & over

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

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

“Water on the knee”

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

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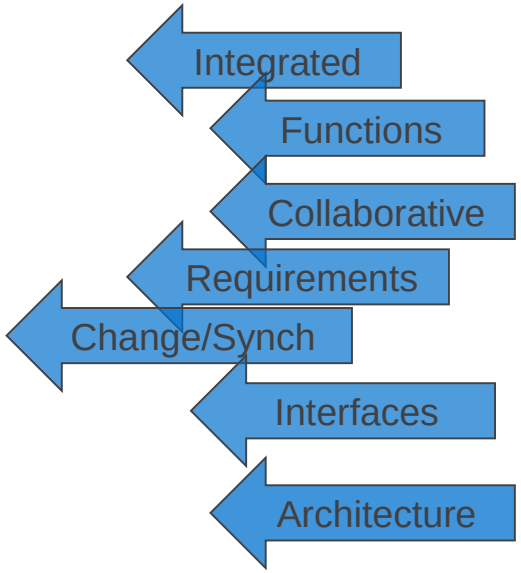
How bad is our communication problem?

MBSE Maturity



Disintegrated----------Integrated

Disconnected Commnication with documents

Communication Continuum

Continuous Communication with models

System Modeling/Architecture					
PLE/Configuration (variation)		documents, spreadsheets	Disconnected variation rules	Integrated variation rules	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/alarms 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 modeles	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, 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
CMMI Staged Levels:	**(1) Initial**	**(2) Managed**	**(3) Defined**	**(4) Qualitative**	**(5) Optimizing**

How bad is our communication problem?

Avg MBSE Maturity

Capability Assessment:	Basic	Low	Medium	High	Advanced
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Avg Organization (best case)

Where are we?

Everyone has a communication problem

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Avg Organization (best case)

Best Auto (best case)

Best Aero (best case)

Is SE education helping our communication problem?

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Avg University (best case)

Avg Organization (best case)

Process Dishonesty/Meta-Dishonesty

“Semmelweis Reflex”

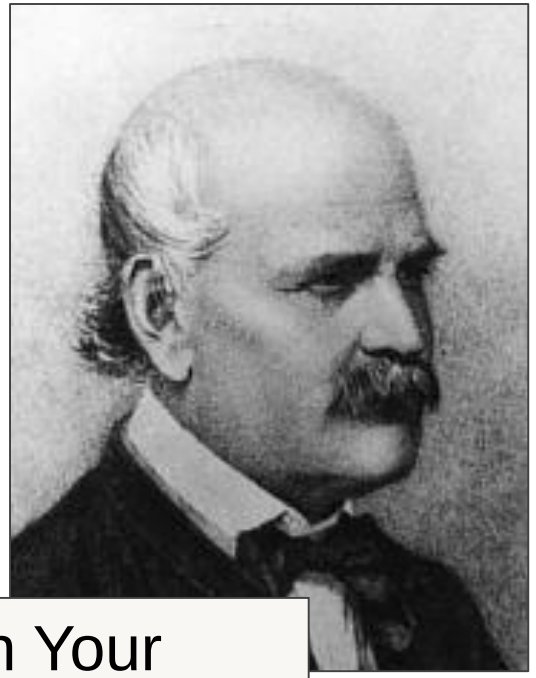
> “…to dismiss/reject out of hand any information, automatically without thought, inspection, or experiment”

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



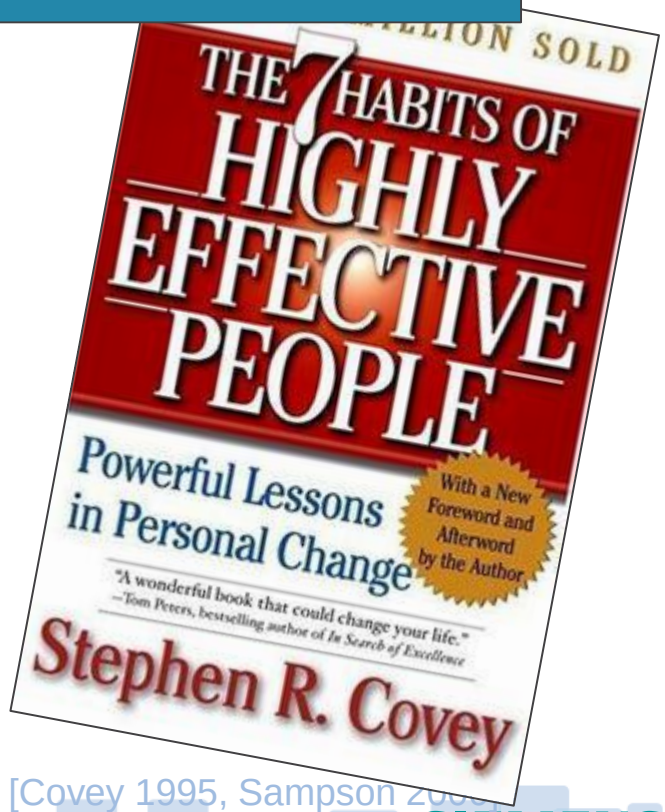
Wash Your Damn Hands

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

Organization SDB's (Self-Defeating Behaviors)…

- 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 process for the tools to work within
- 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



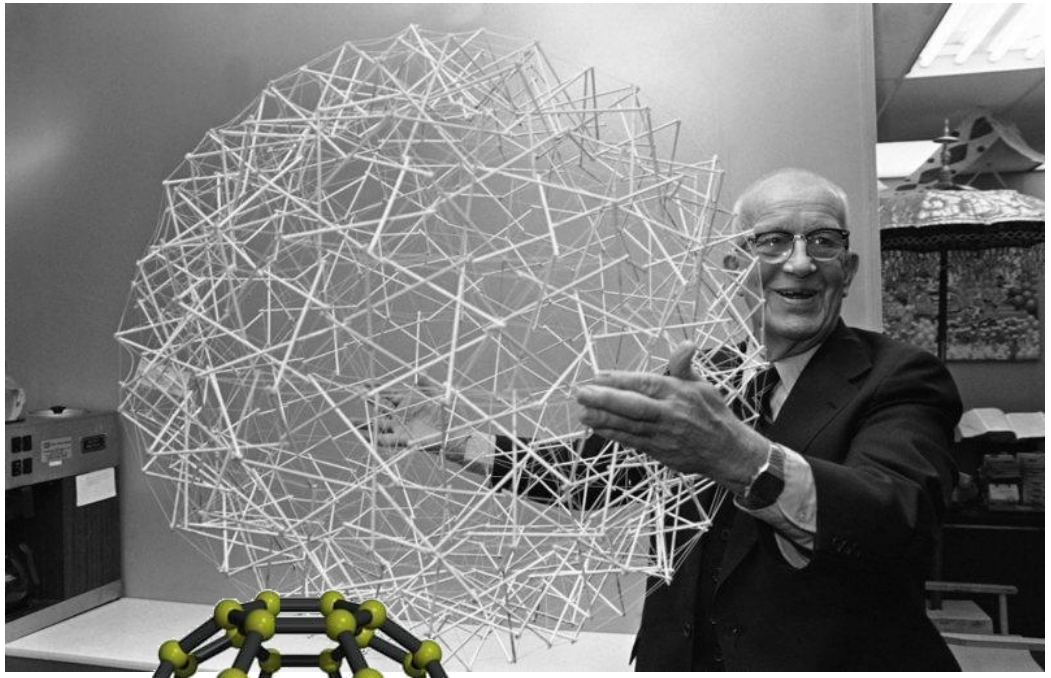
[Covey 1995, Sampson 200

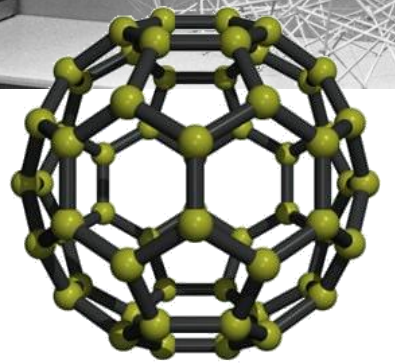
Organizational SDB's cont…

How prepared is your organization?

Culture change vs. getting lucky…

Buckminster Fuller's Magic Log





Buckyballs (Carbo Fullerenum)

[Sampson, 2000, Von Wodtke, 1993]

Cows drink…

You don’t have an engineering problem, you have a knowledge communication/management problem

Today’s products are built by everyone/everywhere…

- Documents aren’t scalable
- Disconnected models provide knotholes
- You can’t put enough brains on the job

Symptoms:

- Half your program schedule/resources spent on system integration
- Arm’s-length supplier collaboration
- Tedious communication via meetings (inter-team & intra-team)
- Uncommunicated change
- Innocent impact understanding
- …

Integrated product architecture with requirements is mandatory

- Delivered thru PLM services
- Integrated standards-based process/methodology
- Allocated through to suppliers for continuous feedback

…to start integrated, stay integrated

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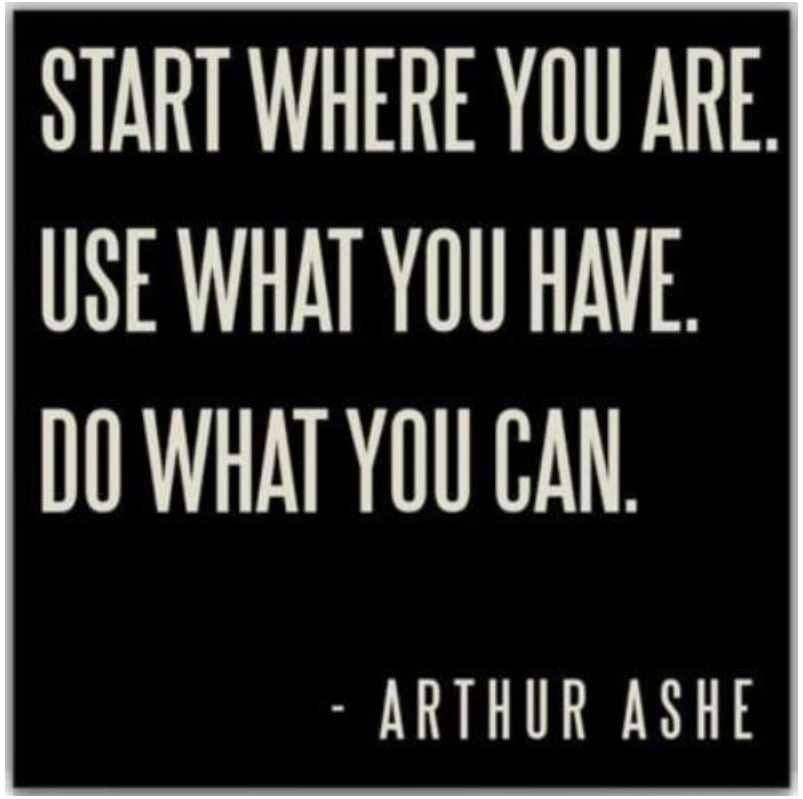
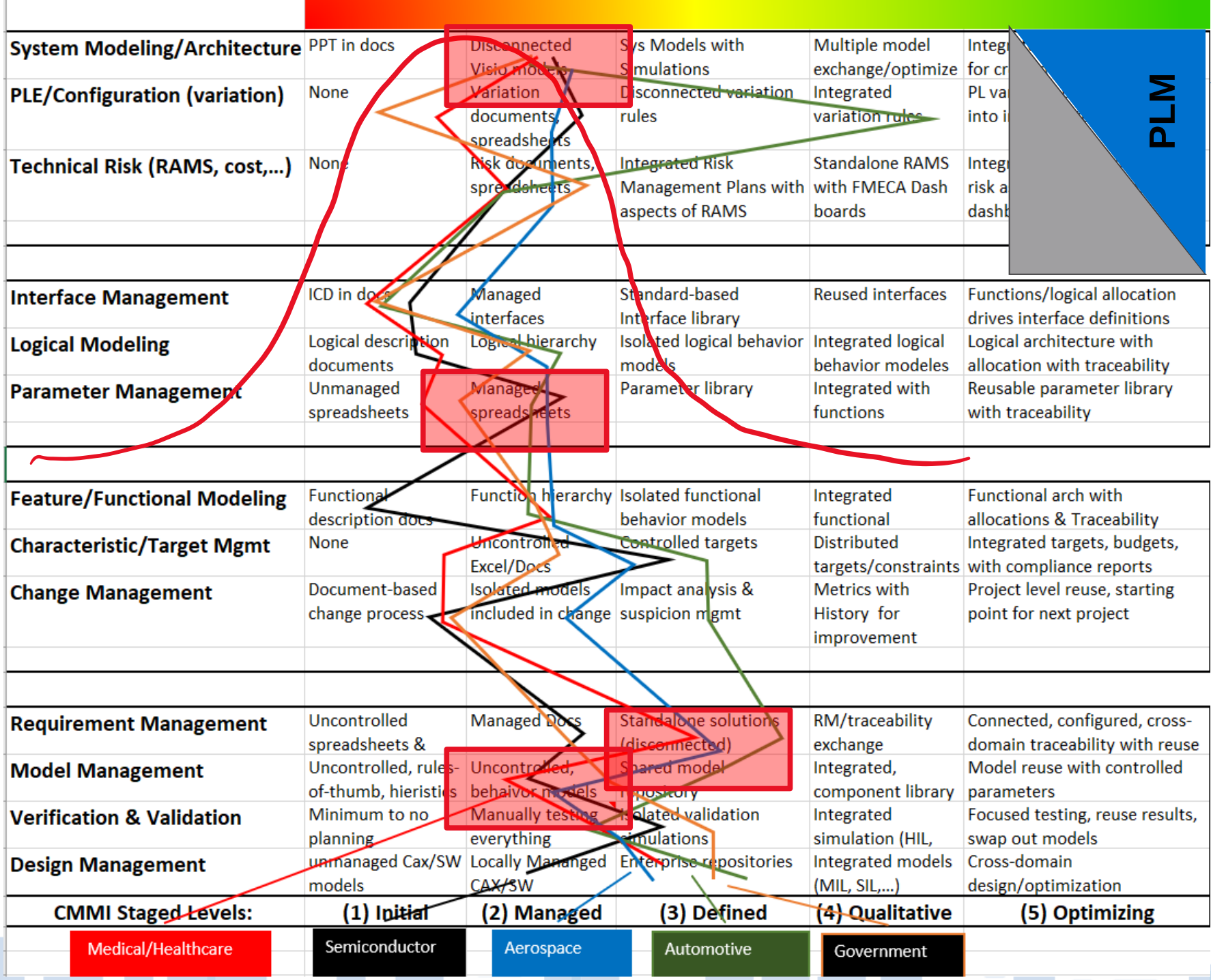
Where do we start?



How to start solving your communication problem…

Possible starting points to solving your communication problem



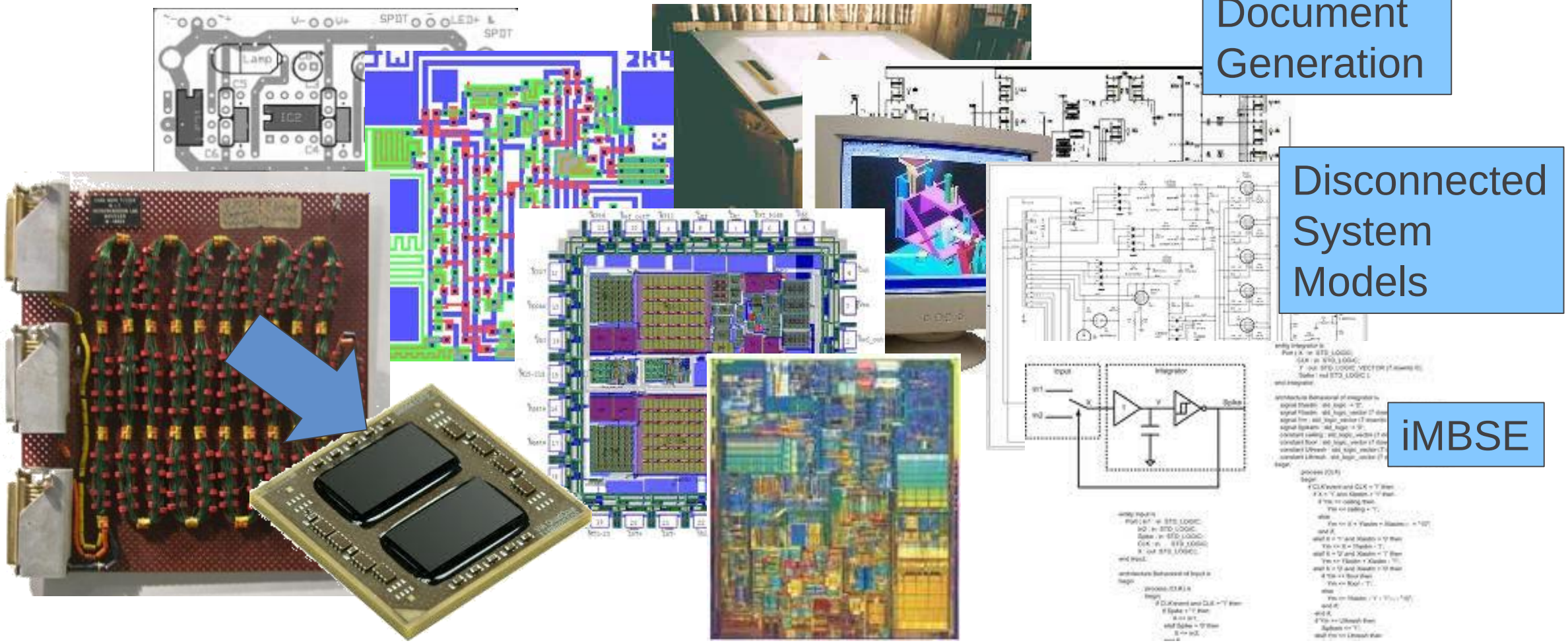
High-tech Experience
This requires change…

Documents

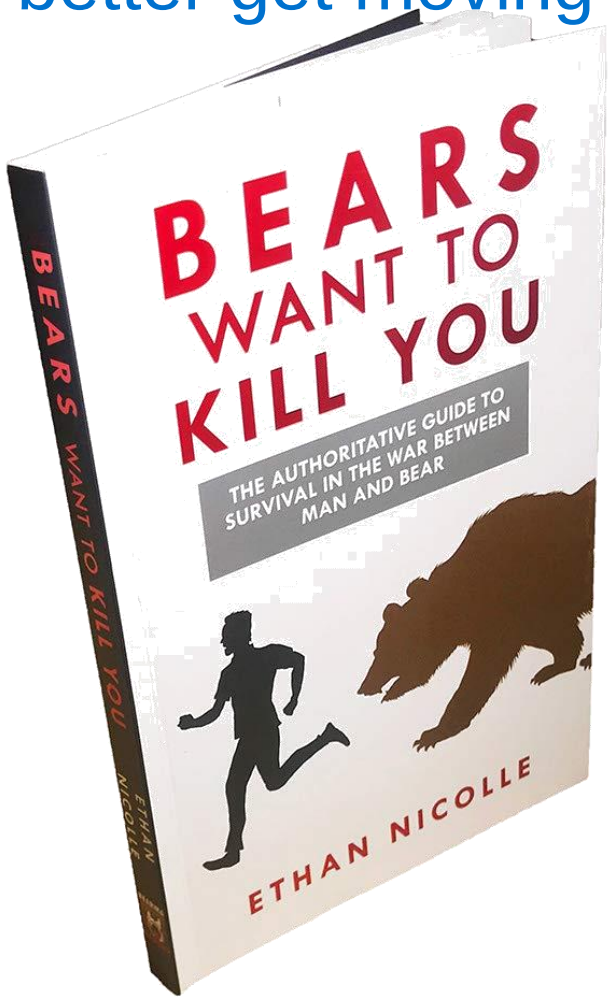
Document Generation

Disconnected System Models

iMBSE



Some additional parting motivation…
You better get moving



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www.incose.org/IW2021

MBSE Workshop

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