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A failure to communicate…

Start Integrated, Stay Integrated

Realize innovation.

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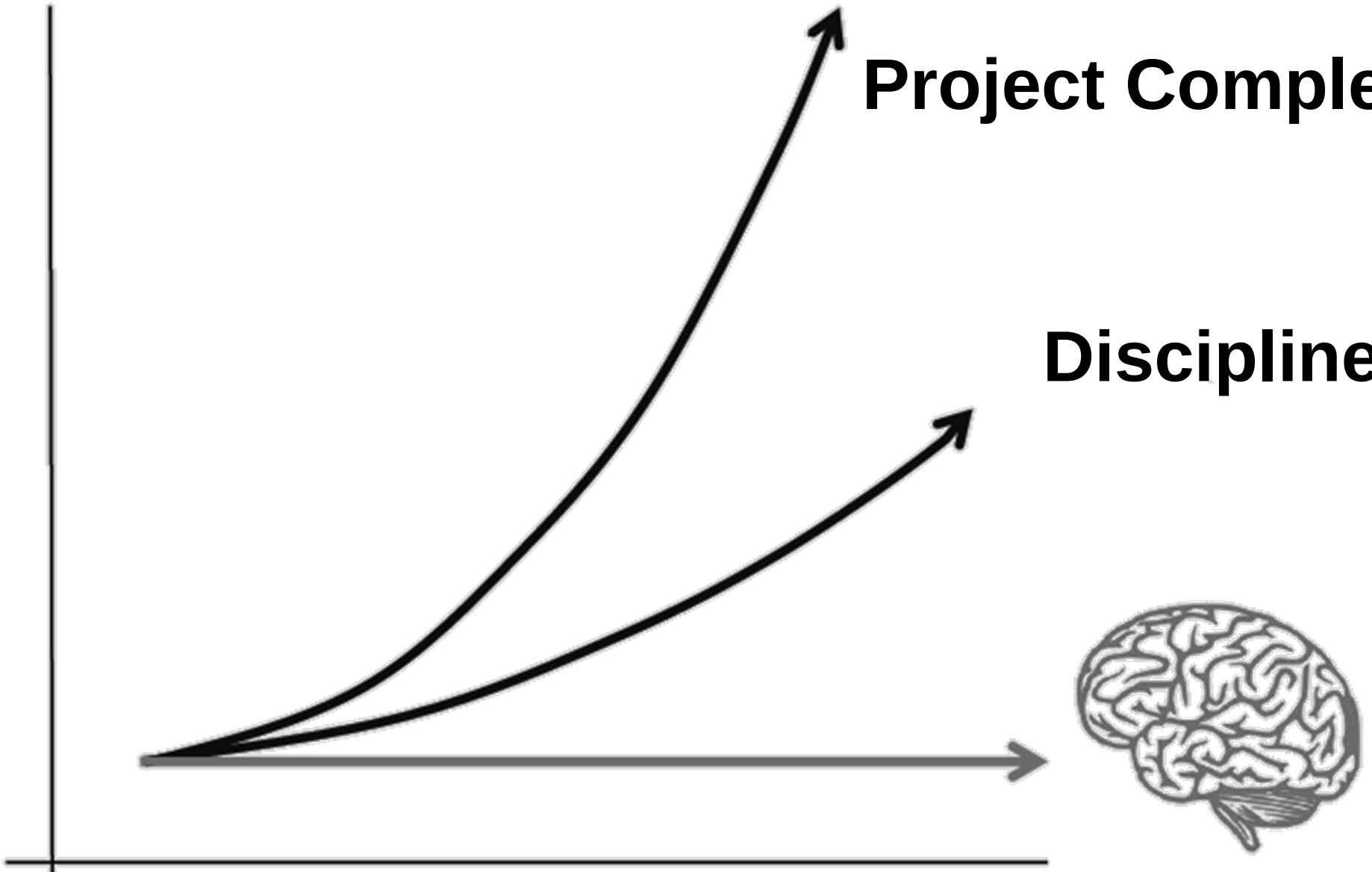
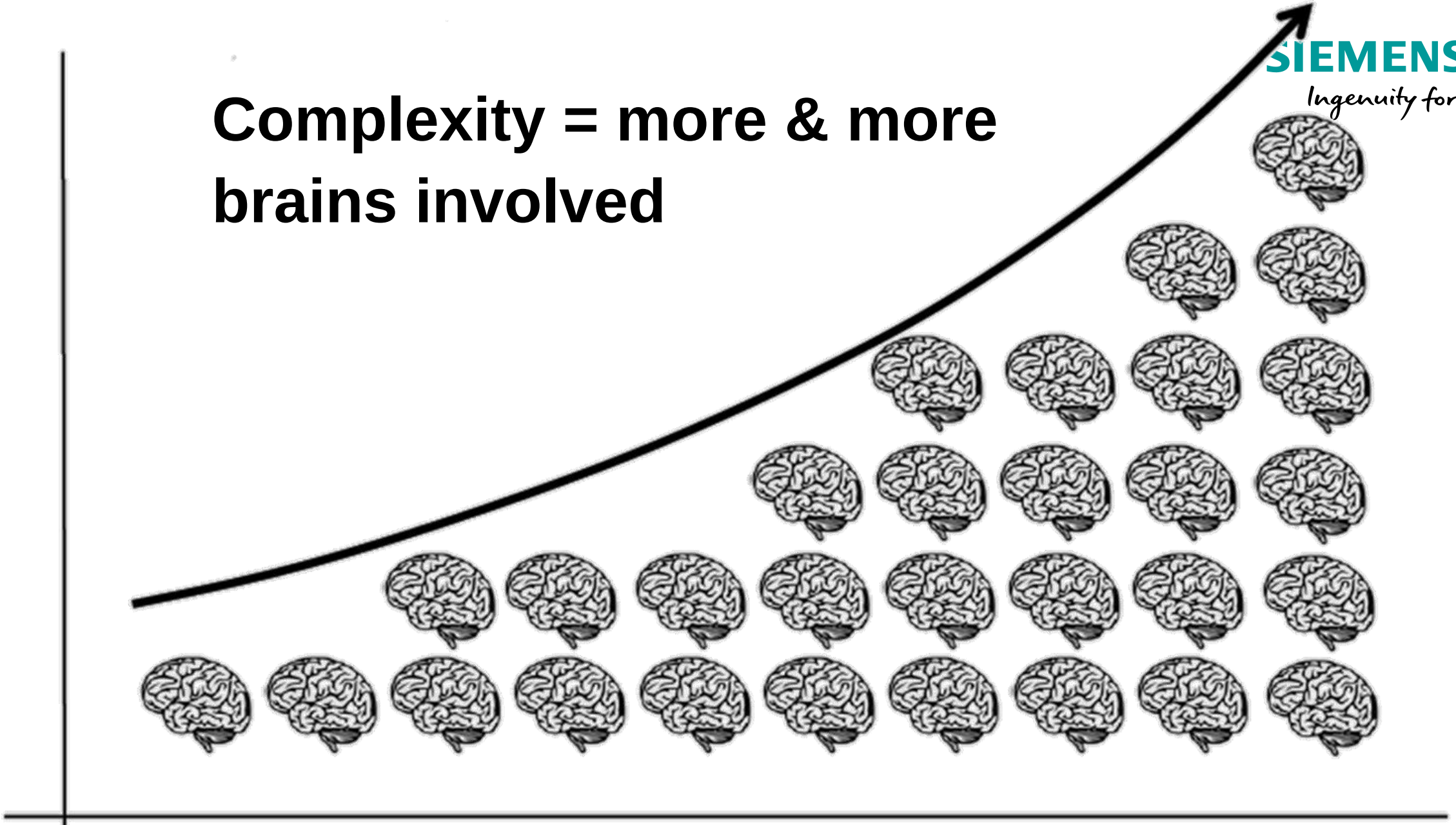


[Fostering MBSE, Bonnet, Navas INCOSE MBSE Workshop 2020]

Complexity = more & more brains involved



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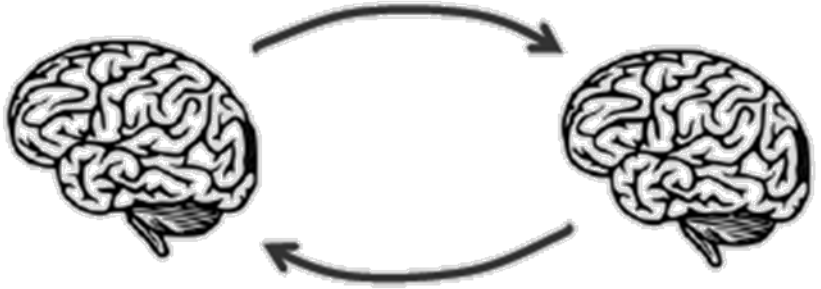
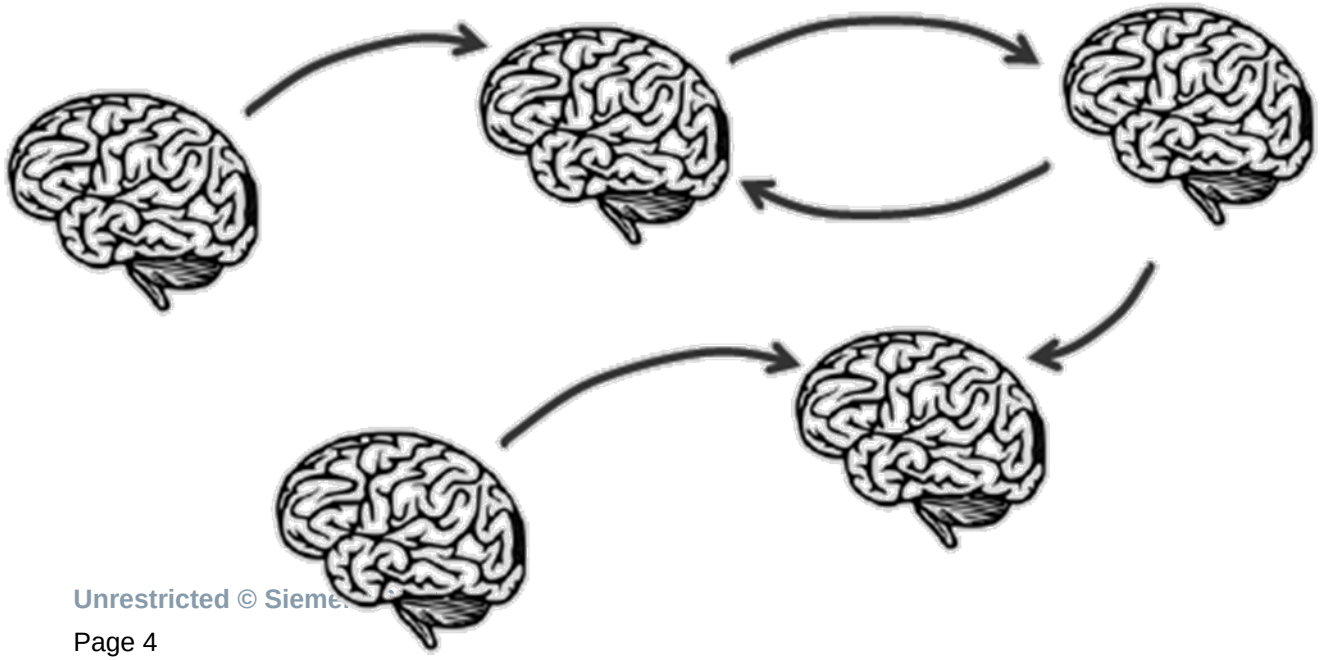
Doing more, with more constraints, less time



Dealing with very demanding customers

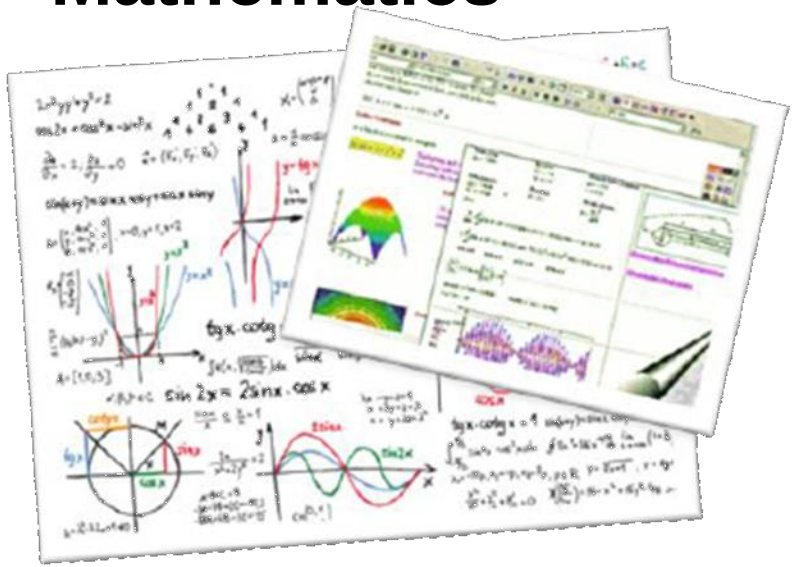
Interacting with more people



Communication & Information Management Problem

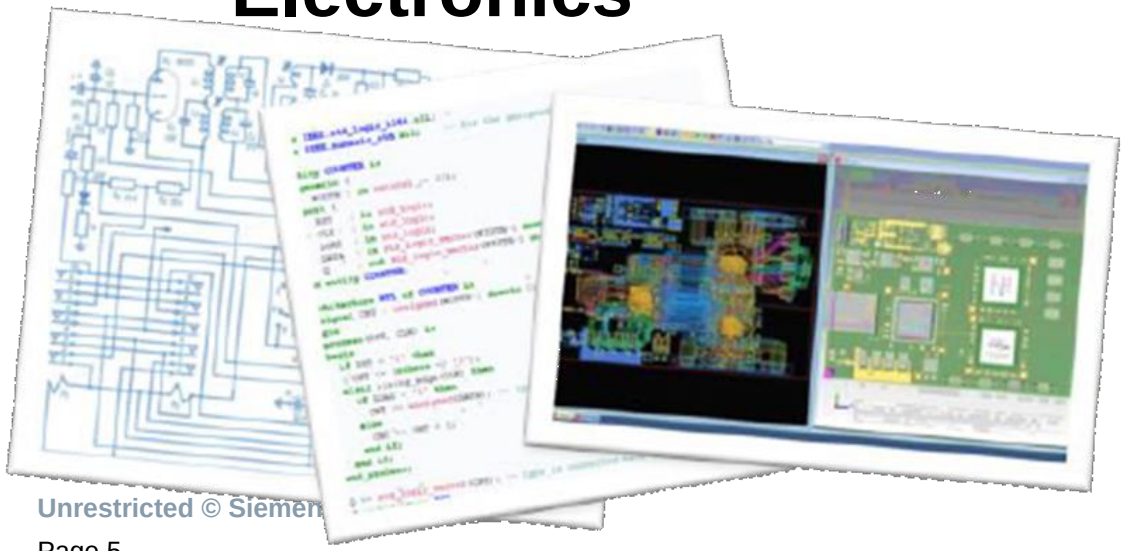
Language

Mathematics

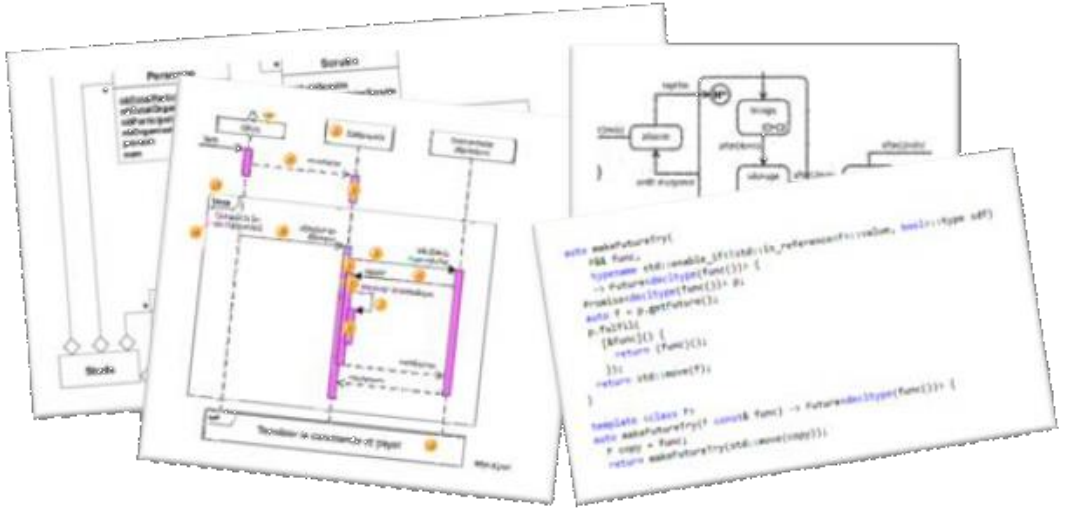


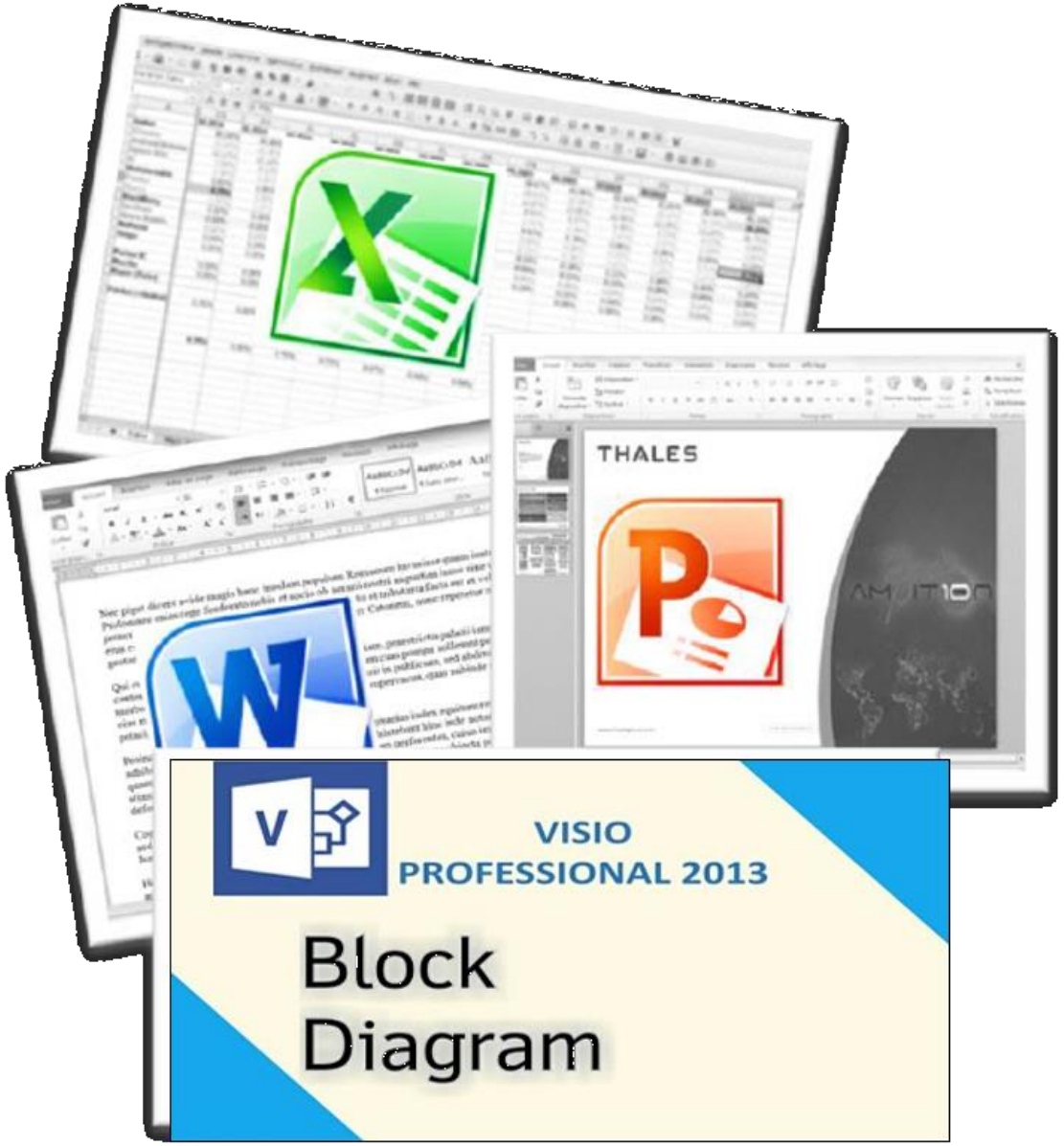
Construction

Electronics



Software





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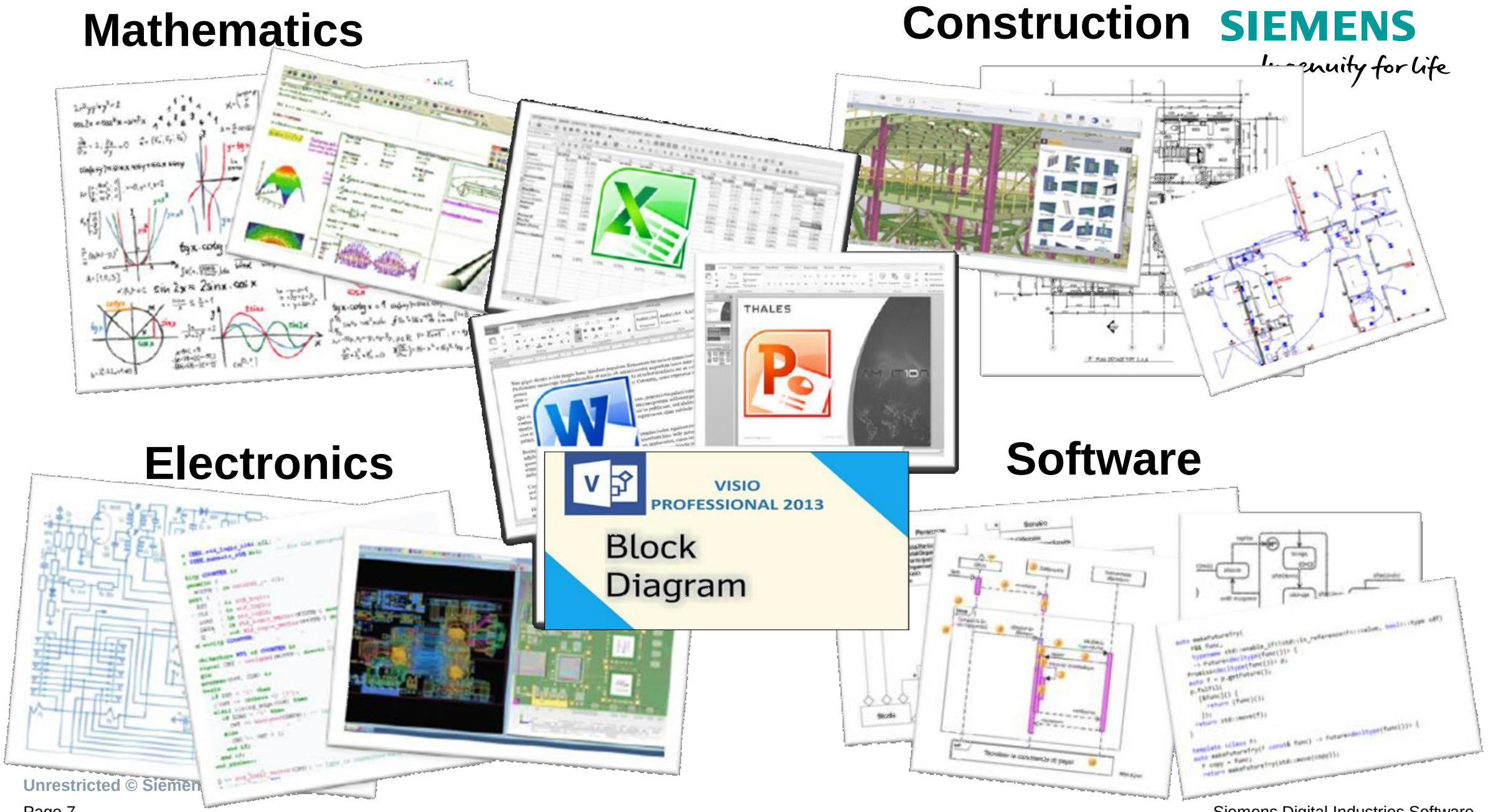
Systems Engineering



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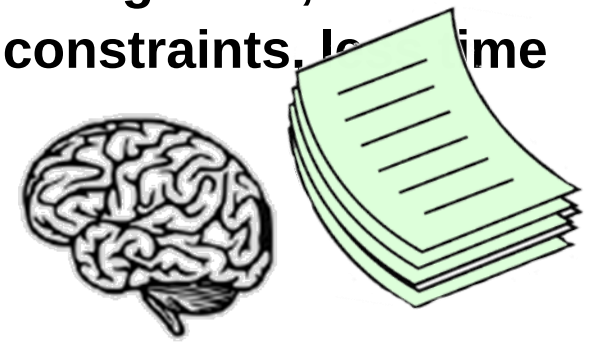
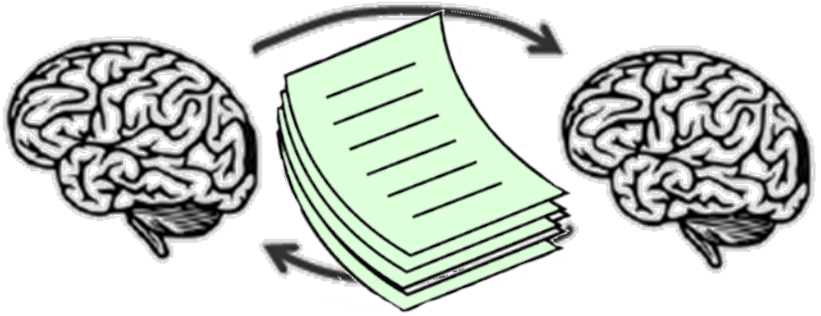
Doing more, with more constraints, less time





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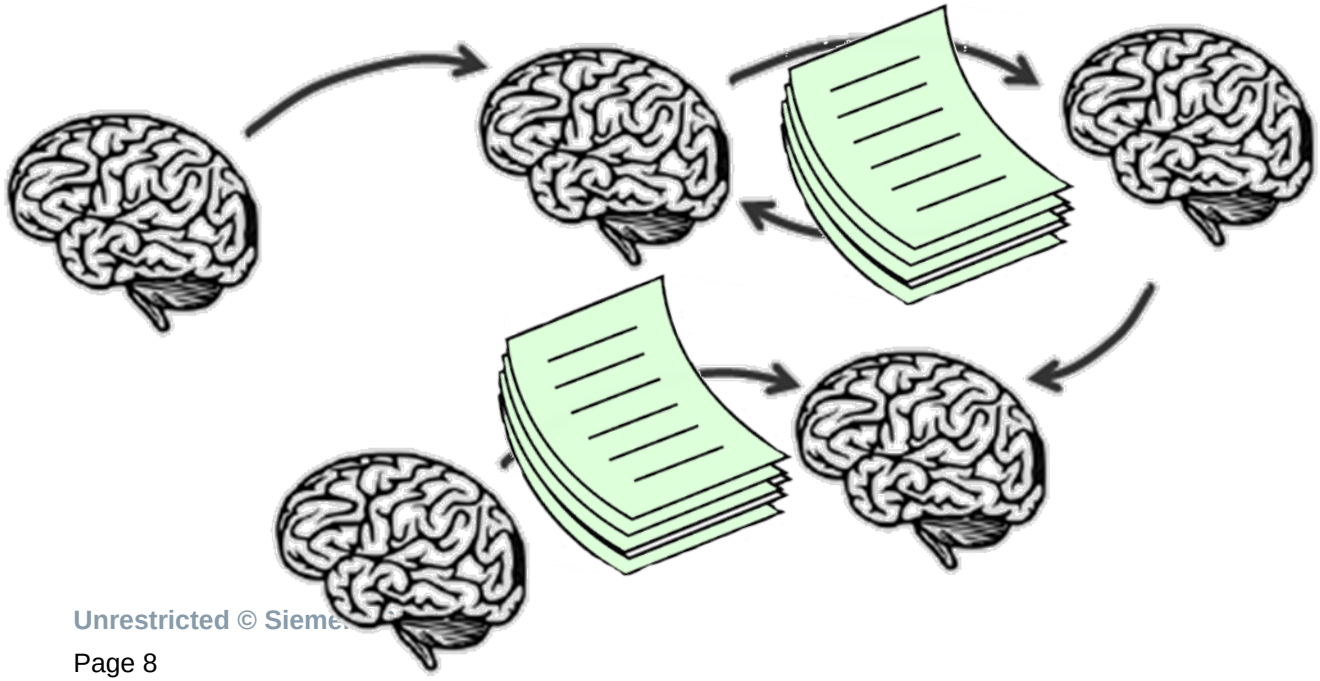
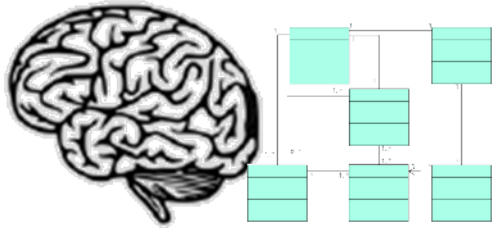
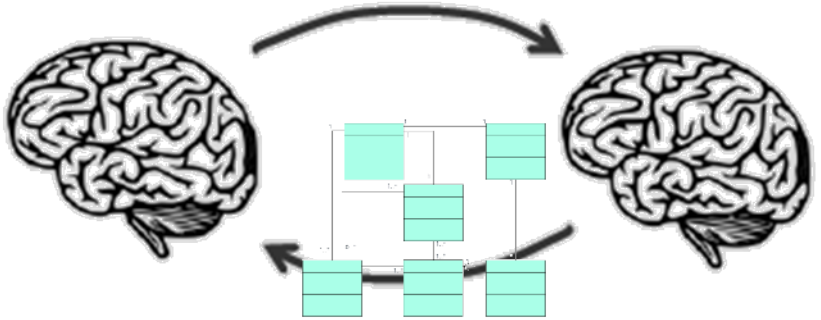
Interacting with more people



Documents don’t scale…

Doing more, with more constraints, less time





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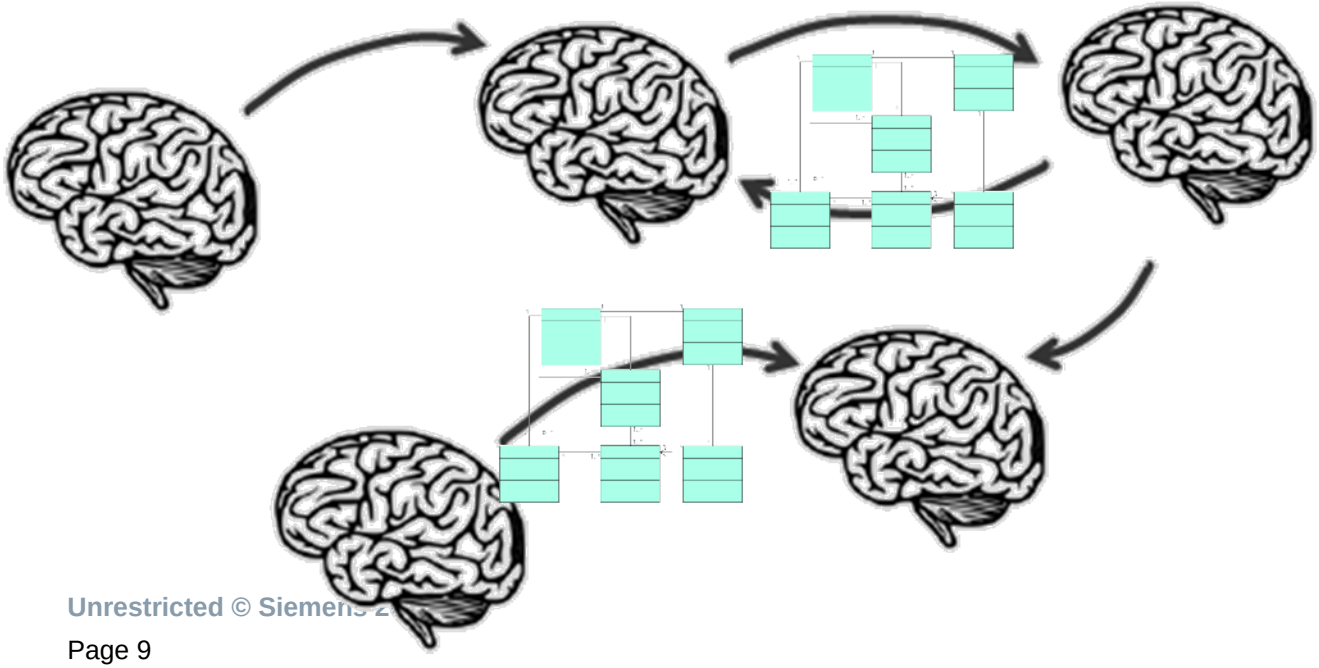
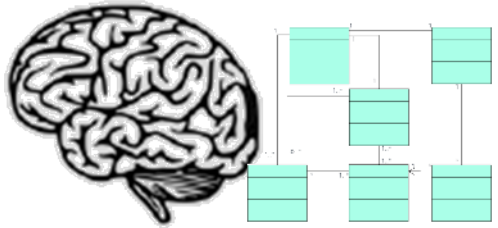
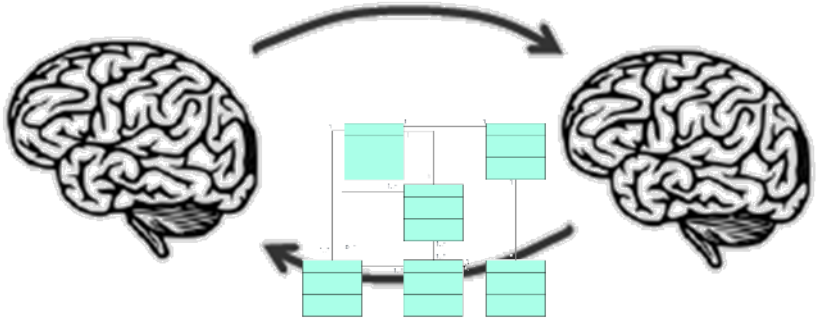


Models without common methods/grammar can't communicate meaning

Doing more, with more constraints, less time





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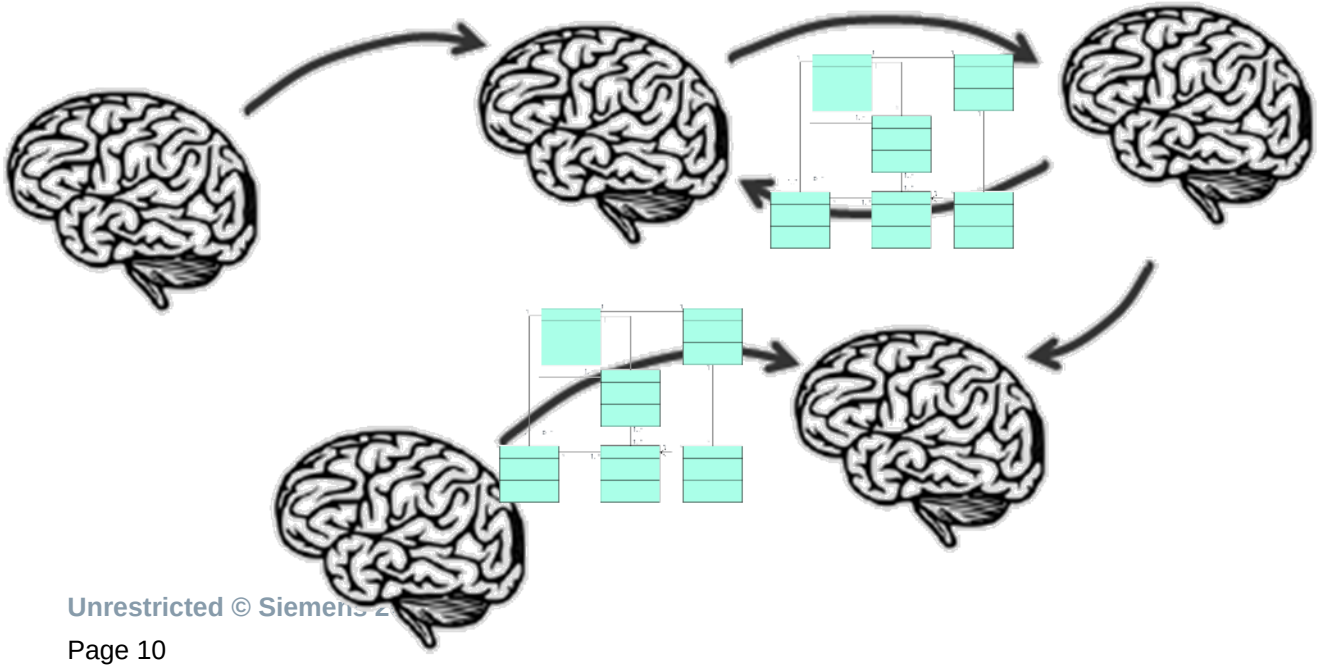

Continuous communication requires:

…architecture/system modeling with embedded standard process/method

- Blueprint with requirements for programs
- integrated with scalable PLM
- with access to standard services
- sharable with suppliers without compromising IP

…enables continuous integration/communication

Integrated MBSE Vision
How integrated MBSE enables communication…

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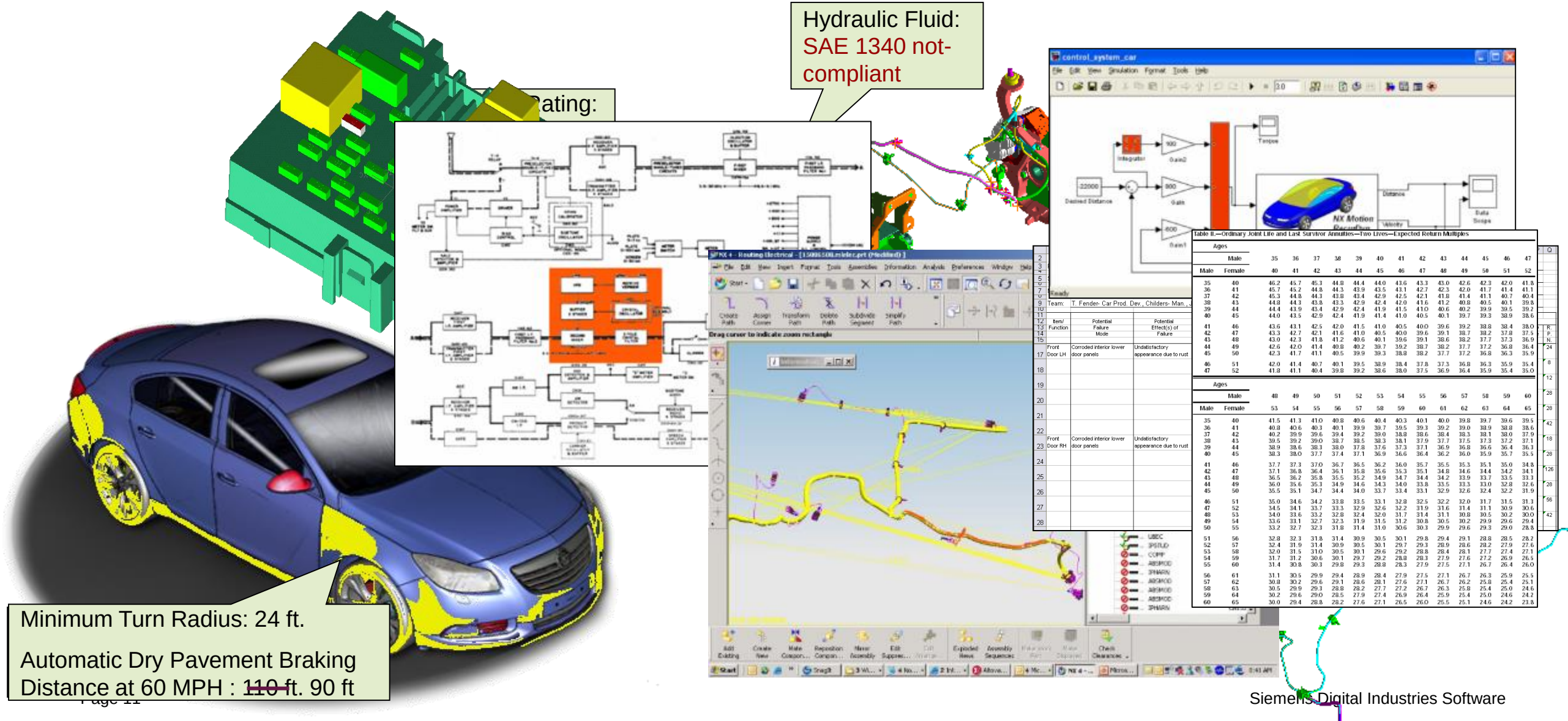

MBSE Process…
Shift left…

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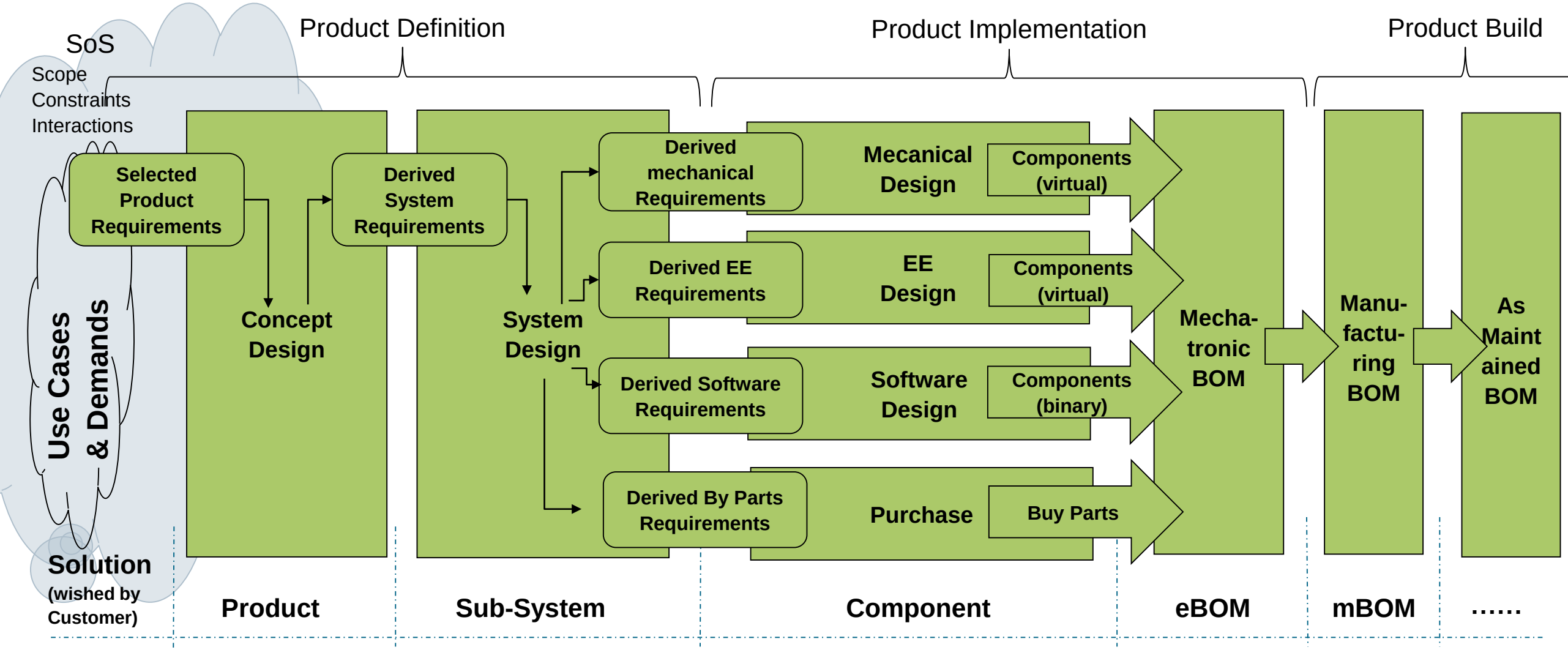
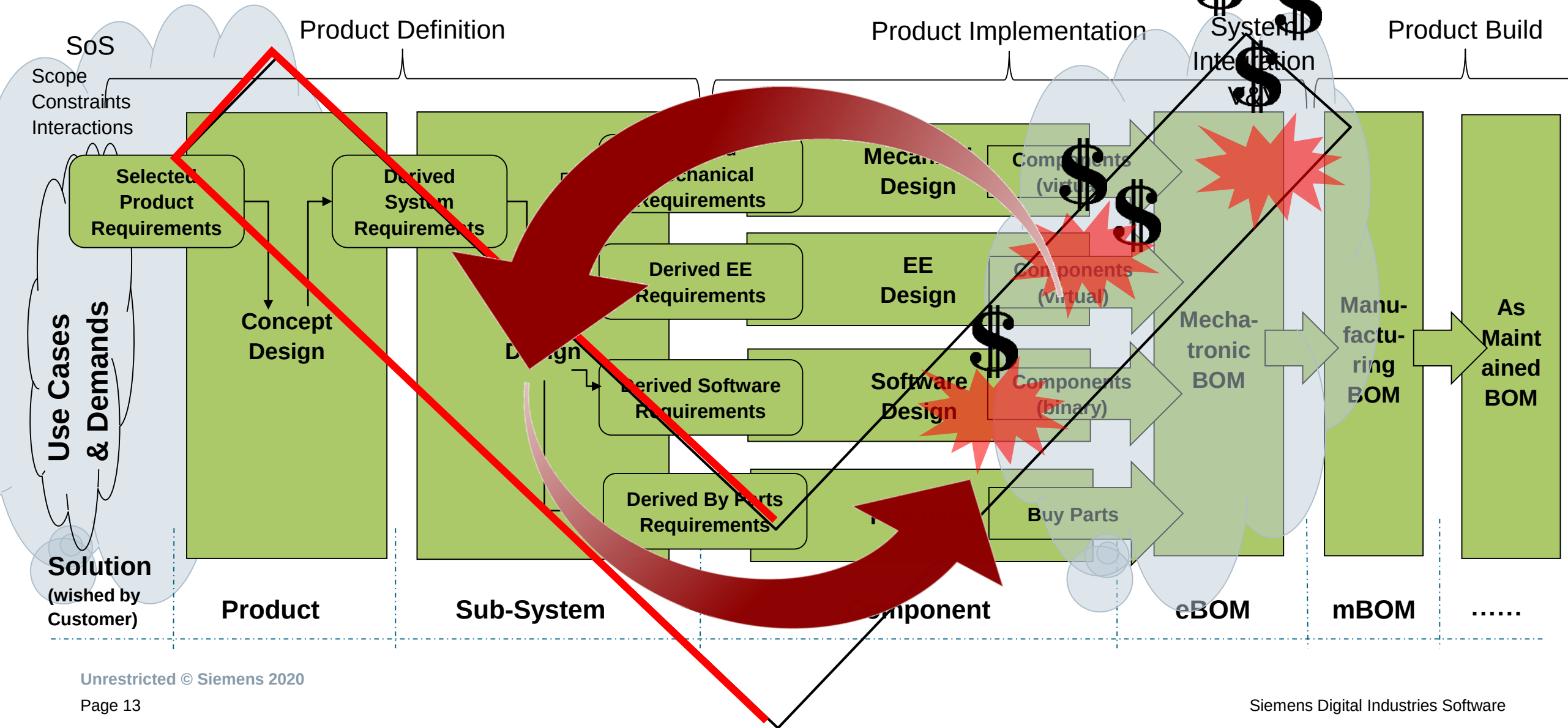
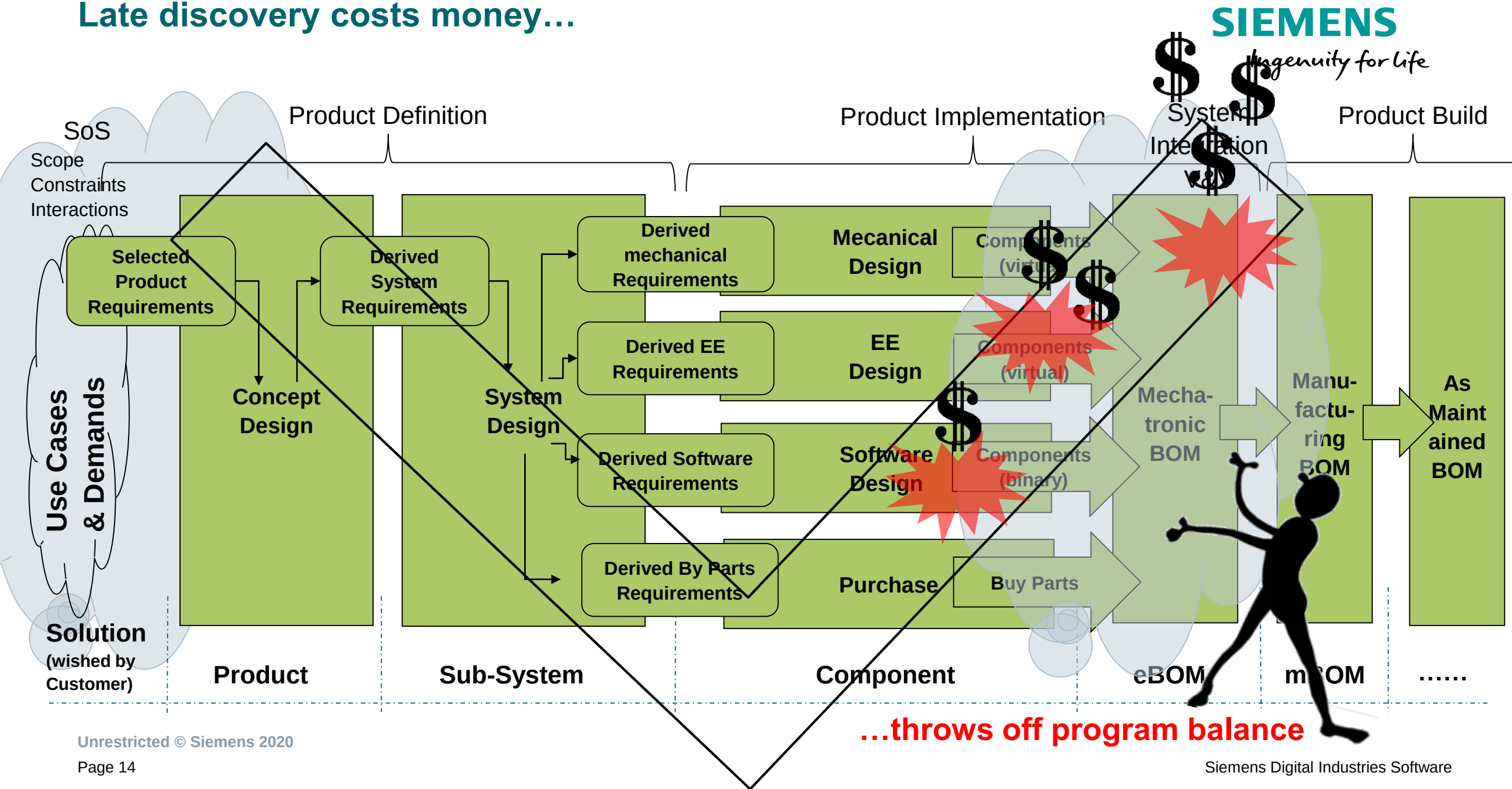


Failure to communicate architecture downstream…

Late discovery of integration problems



Late discovery costs money…



You plan for this communication failure…

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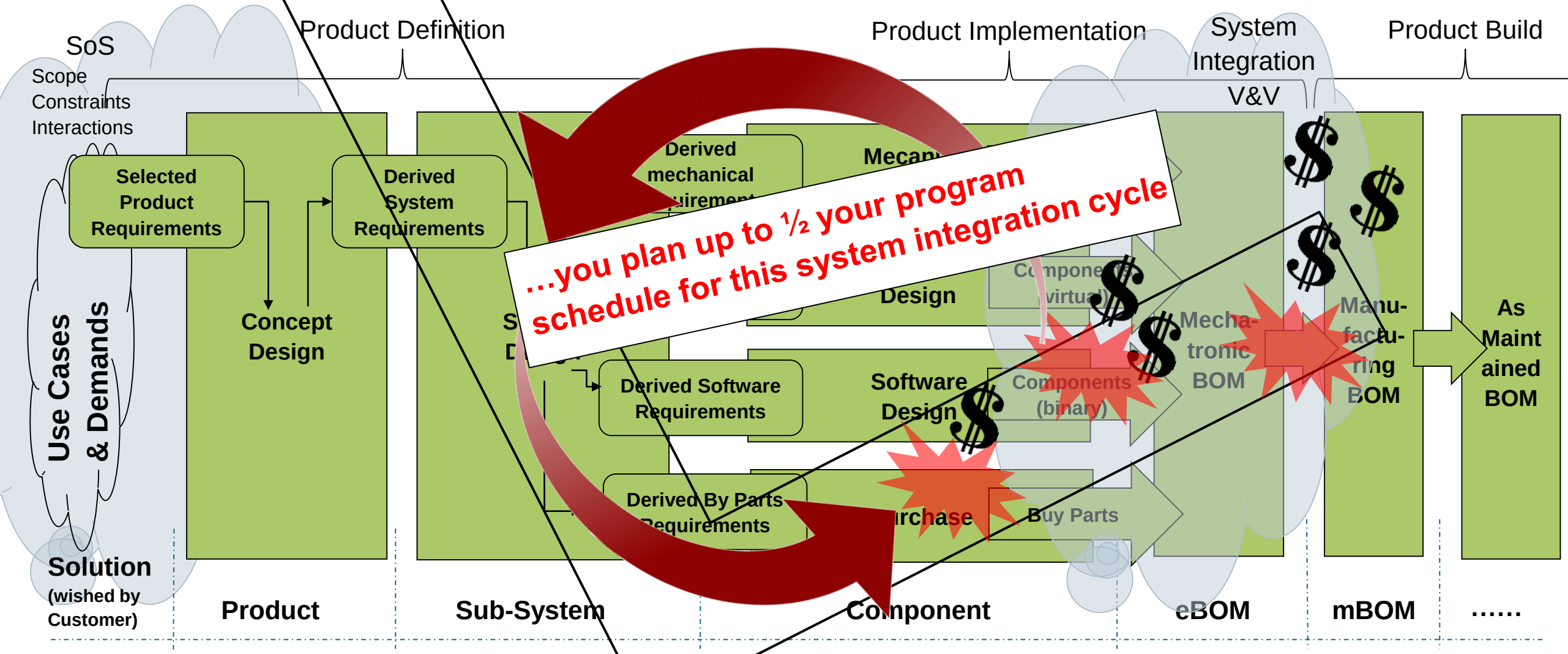

…you plan up to ½ your program schedule for this system integration cycle

A failure to communicate costs money…

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- ~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)

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

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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

"Water on the knee"

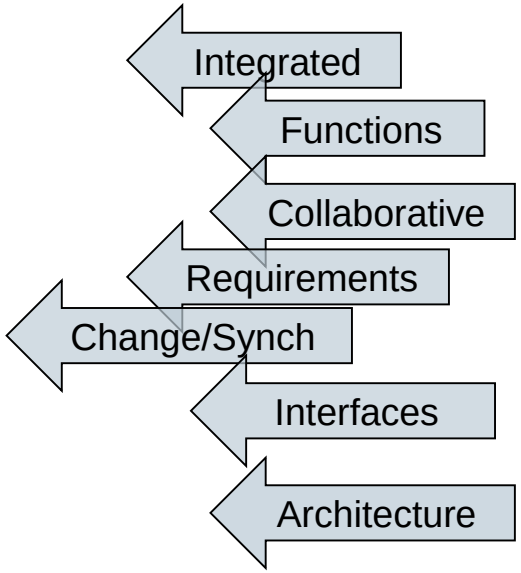
Cross-Domain problems result from:

- 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

How bad is your communication problem?

MBSE Maturity



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

Disconnected Commnication with documents

Communication Continuum

Continuous Communication with models

System Modeling/Architecture	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] models for cross-domain arch/optimize [illegible] built into into architecture decisions
PLE/Configuration (variation)	[illegible]	Variation documents, spreadsheets	Disconnected variation rules	Integrated variation rules	
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**

Where are we?

Everyone has a communication problem

Capability Assessment:	Basic Disintegrated	Low	Medium	High	Advanced 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
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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 ect
Requirement Management	Uncontrolled spreadsheets &	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	th controlled
Verification & Validation	Minimum to no planning	Manually testing everything	Isolated validation simulations	Integrated simulation (HIL,	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**

Avg Organization (best case)

Best Auto (best case)

Best Aero (best case)

PLM Required to solve your communication problem…

- Different tools speak different languages
- Tool specific integrations are not scalable (NxN problem)
- Digital thread between different tools carried by PLM with integrated systems methodology
- Thru infrastructure defined by Product Architecture that is part of PLM

Capability Assessment:	Basic Disintegrated	Low	Medium	High	Advanced Integrated
MBSE Process Maturity Level 4					
System Modeling/Architecture	PPT in docs	Disconnected Visio models	Sys Models with simulations	Multiple model exchange/optimize	Integra for cros
PLE/Configuration (variation)	None	Variation documents, spreadsheets	Disconnected variation rules	Integrated variation rules	PL vari into ar
Technical Risk (RAMS, cost,…)	None	Risk documents, spreadsheets	Integrated Risk Management PI aspects of RAMS (FMEA)	Standalone RAMS with FMEA Dash boards	Integra assess dashbo
MBSE Process Maturity Level 3					
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
MBSE Process Maturity Level 2					
Feature/Functional Modeling	Functional description docs	Function hierarchy	Isolated behavior models	Integrated functional modeling	Functional arch with allocations & Traceability
Characteristic/Target Mgmt	None	Uncontrolled Excel/	Uncontrolled 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
MBSE Process Maturity Level 1					
Requirement Management	Uncontrolled spreadsheets & docs	Managed Docs	Standard-based (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

SysML

RAMS

Word

Excel

RM Tools

Your company here (best case)

PLM

Medical/Healthcare | Semiconductor | Aerospace | Automotive | Government

Discover early vs late…
Shift left…

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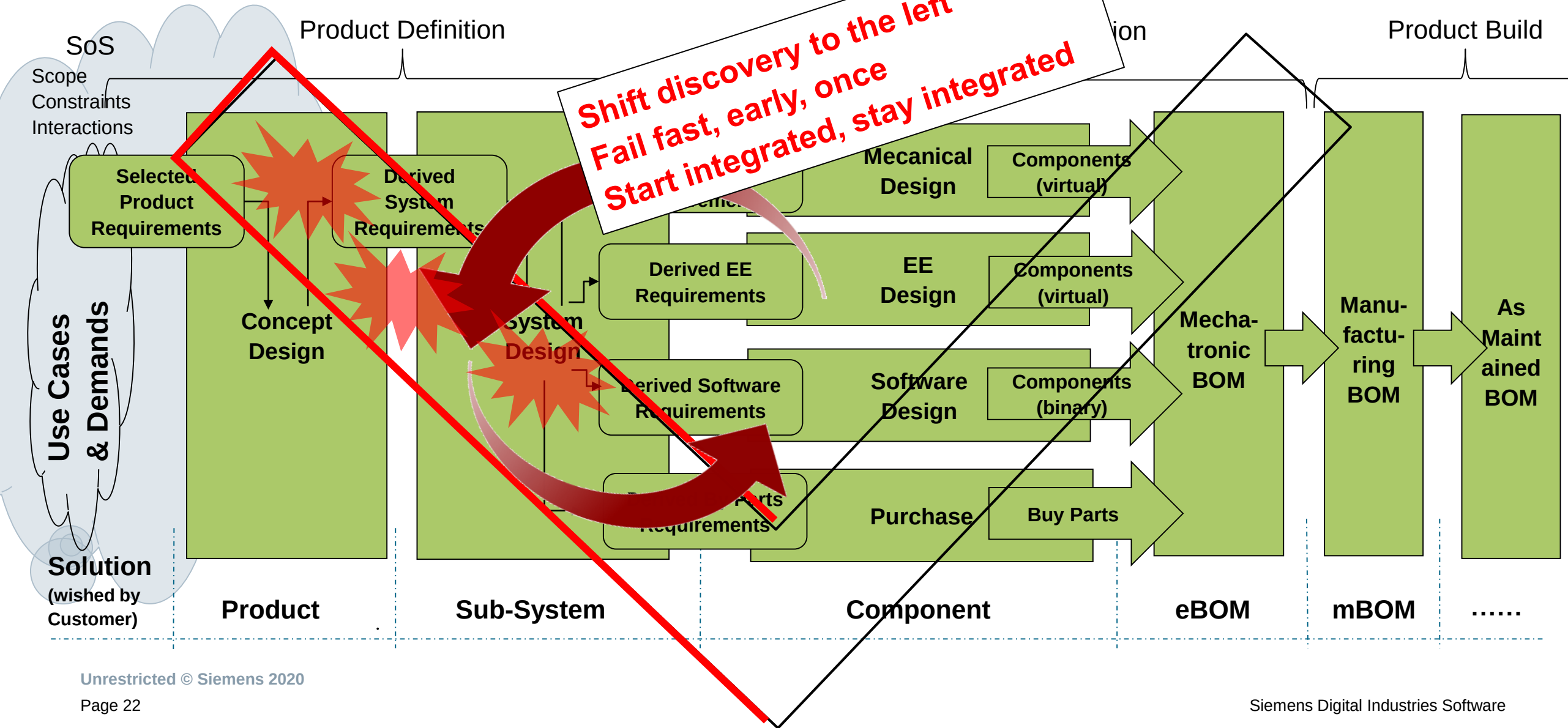

How to shift left?
Disconnected models don't scale…

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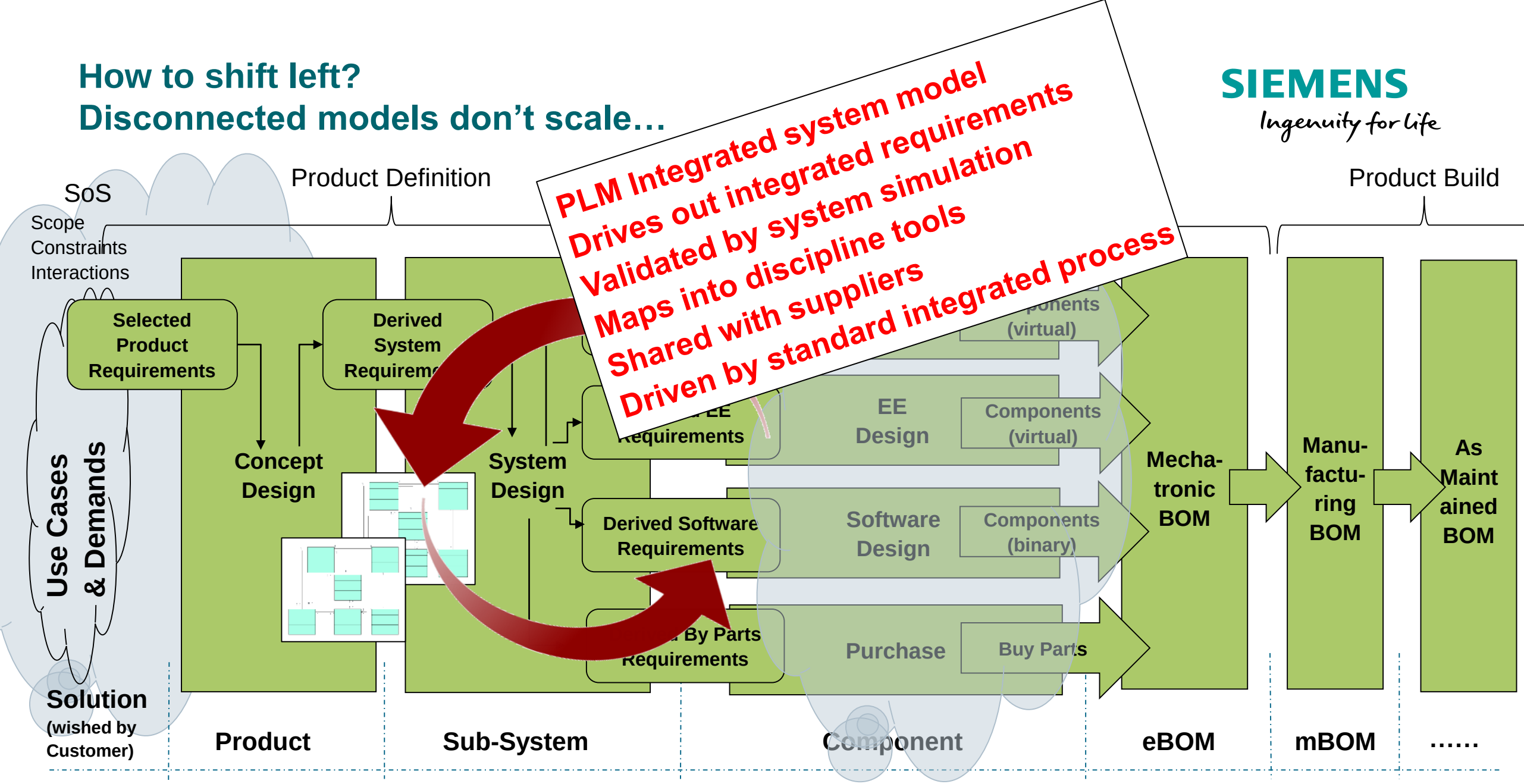

Shrinking the communication V…

Continuous integration

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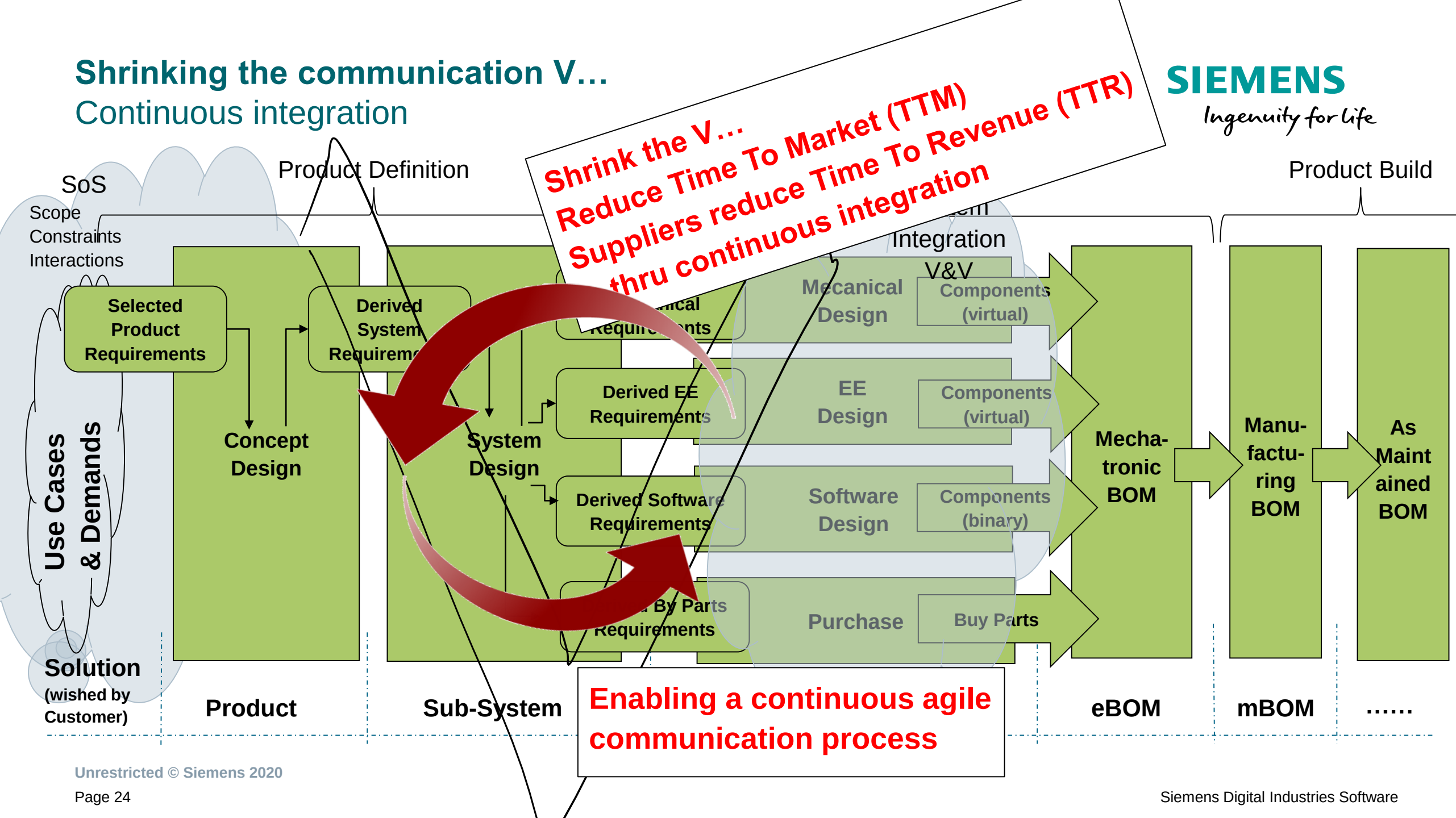

Summary…
You don't have an engineering problem, you have a knowledge <u>communication/management problem</u>

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Today's products are built by everyone/everywhere…

- Documents aren't scalable
- Disconnected models provide knotholes
- *SysML v1 language is missing methods to go with the language & no ability to share IP with suppliers*

Symptoms:

- Half your program schedule is spent on system integration (supplier collaboration?)
- Tedious communication via meetings (inter-team and intra-team)
- Uncommunicated change
- Innocent impact understanding
- …

An integrated product architecture/blueprint with requirements is mandatory

- Delivered thru PLM
- Allocated through suppliers for continuous feedback

…to start integrated, stay integrated

How to start solving your communication problem…

Possible starting spots…
To solving your communication problem

System Modeling/Architecture	PPT in docs	Disconnected Visio models	Sys Models with Simulations	Multiple model exchange/optimize	Integr for cr
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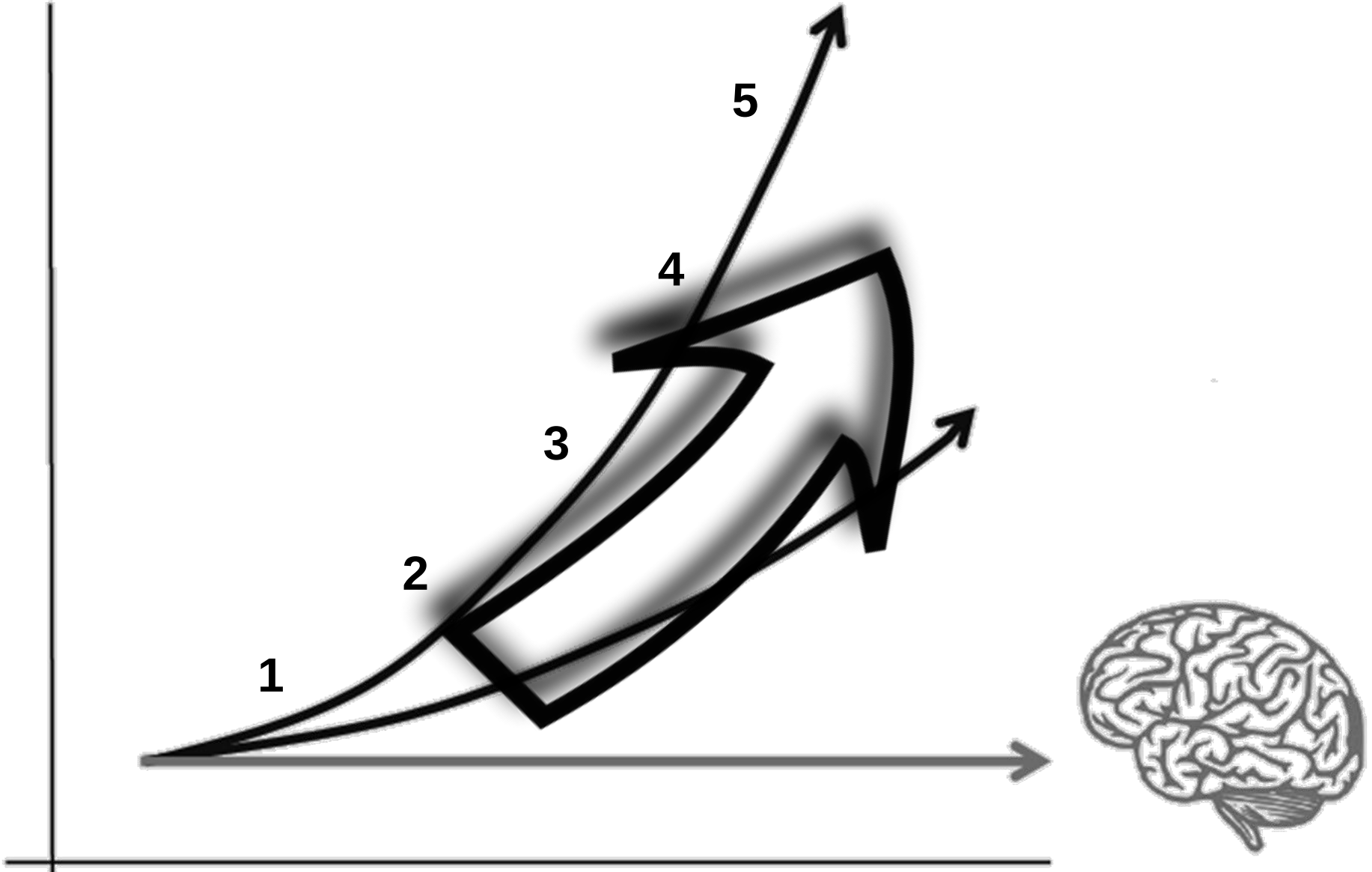
PLM

Medical/Healthcare | Semiconductor | Aerospace | Automotive | Government

…enabling continuous communication



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Thank you