IDEAS IN CONJUNCTION

ANTAGONISTIC SYSTEMS ENGINEERING AND DIGITAL TRANSFORMATION.

ARNO GRANADOS

PAST PRESIDENT INCOSE ENCHANTMENT CHAPTER

THE ROADMAP FOR THIS TALK…

Some Definitions

A little Background

What is this Antagonistic concept?

Antagonistic Engineering

Parting Thoughts

Our meander today

BUT FIRST…DEFINITIONS!

Model-Based Systems Engineering (MBSE)

The formalized application of modeling in performance of or in support of understanding, requirements capture and validation, design, verification and validation activities, application beginning with early problem definition, continuing through solution development and remaining through later system life cycle phases.

https://www.ppi-int.com/articles-systems-engineering/reflections-on-the-incose-iw2021/

MBSE = Formalized Systems Engineering using Full life-cycle modeling

BUT FIRST…DEFINITIONS!

Digital engineering

An integrated digital approach that uses authoritative sources of systems' data as a continuum across disciplines and organizational boundaries to support system life cycle activities from concept through to disposal.

https://www.ppi-int.com/articles-systems-engineering/reflections-on-the-incose-iw2021/

DE = integrated *digital* approach

…AN IMPORTANT CONSIDERATION

DE is concerned with the digitization, exchange of, and access to engineering data as a single source of truth on a lifecycle basis. MBSE, if used, *creates* a subset of the data, i.e. models, that *may* be subject to DE.

https://www.ppi-int.com/articles-systems-engineering/reflections-on-the-incose-iw2021/

MBSE *may be* part of DE

…AN IMPORTANT CONSIDERATION

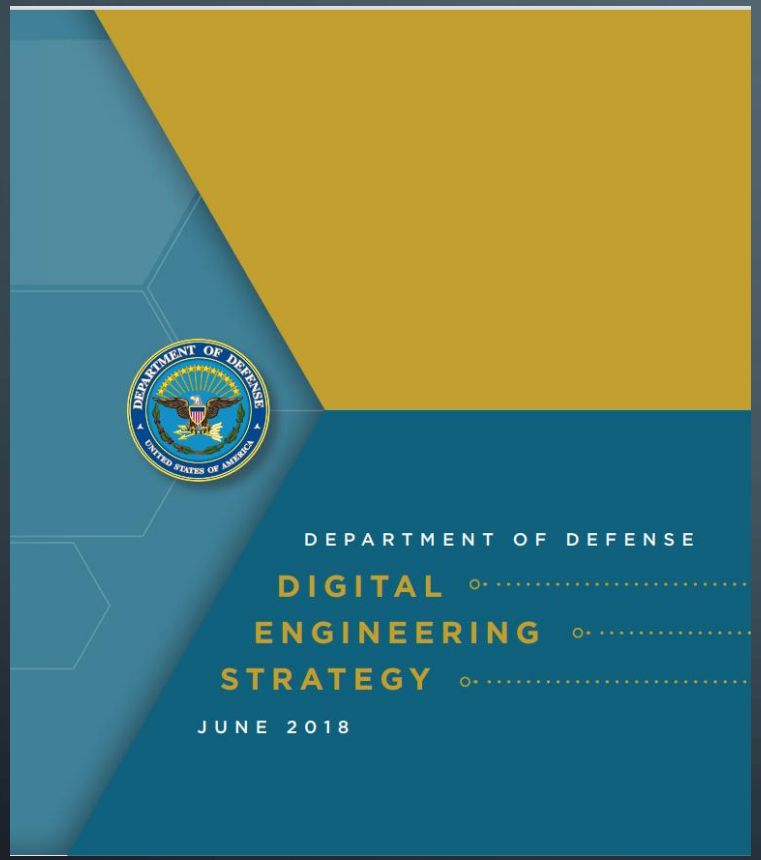
MBSE can be practiced without DE

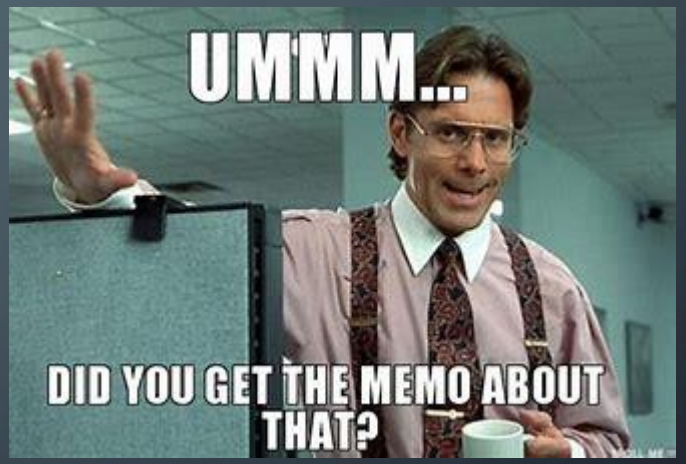
Yes, the models in 2021 are almost always in digital format, but the models may not be integrated, may not be shared across discipline or organizational boundaries, and may not support the product or system on a lifecycle basis

https://www.ppi-int.com/articles-systems-engineering/reflections-on-the-incose-iw2021/

MBSE doesn't *have to be* DE

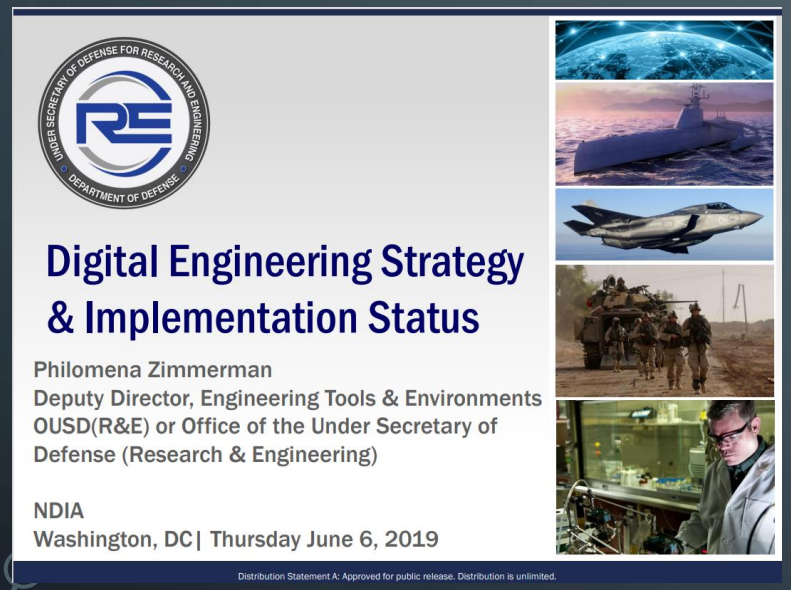
DOD DIGITAL ENGINEERING MEMO





"Digital Transformation" is being driven by the marketplace

CLARIFYING GUIDANCE FROM OSD



☐ What is Digital Engineering? – Combines model-based techniques, digital practices, and computing infrastructure – Enables delivery of high pay off solutions to the warfighter at the speed of relevance

☐ Reforms Business Practices – Digital enterprise connects people, processes, data, and capabilities – Improves technical, contract, and business practices through an authoritative source of truth and digital artifacts

Digital Engineering happens within a Digital Enterprise

CLARIFYING GUIDANCE FROM OSD

M&S

- Modeling and simulation (M&S) is an enabler of warfighting capabilities. It helps to save lives, to save taxpayer dollars, and to improve operational readiness.
- Defense Modeling and Simulation Coordination Office
- Modeling and Simulation Enterprise – Technical Leadership

Model: A physical, mathematical, or otherwise logical representation of a system, entity, phenomenon, or process; i.e. "a representation of reality"

All usable in digital engineering; what do you need to do?....

Digital Eng

"The goals (of the Digital Engineering Strategy) promote the **use** of digital representations and components and the **use** of digital artifacts as a technical means of communication across a diverse set of stakeholders."
"Advancements in computing, modeling, data management, and analytical capabilities offer great opportunities for the engineering practice. **Applying** these tools and methods, we are shifting toward a dynamic digital engineering ecosystem."

Dig Eng
May 2021
Distribution Statement A: Approved for public release. Distribution is unlimited.
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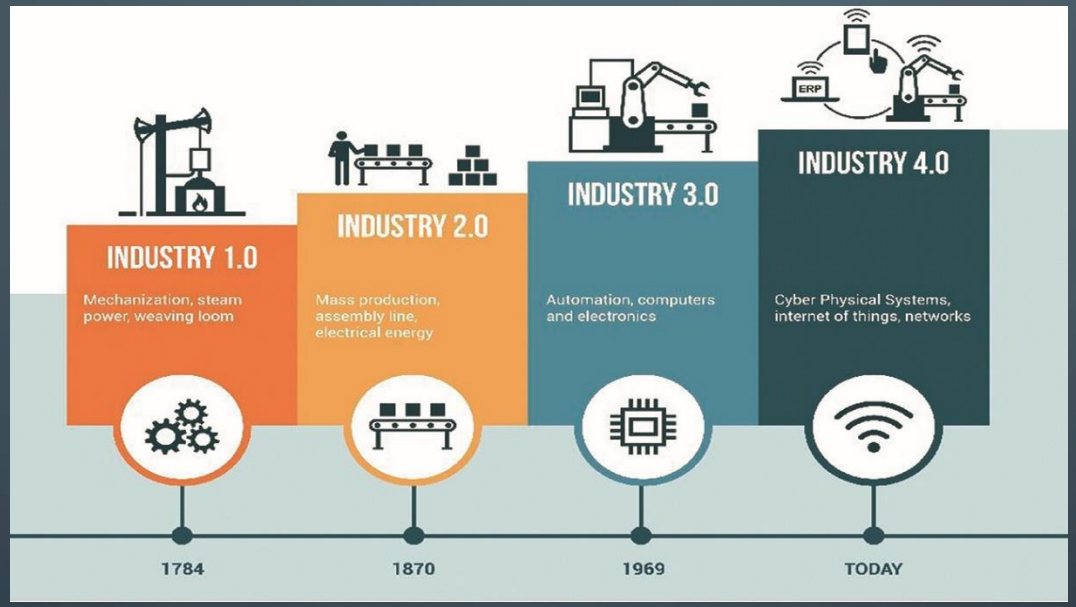
Digital Engineering is NOT Simply Mod & Sim. It is A *Digital Ecosystem*

DIGITAL ENGINEERING

The DE Revolution is NOT only DoD

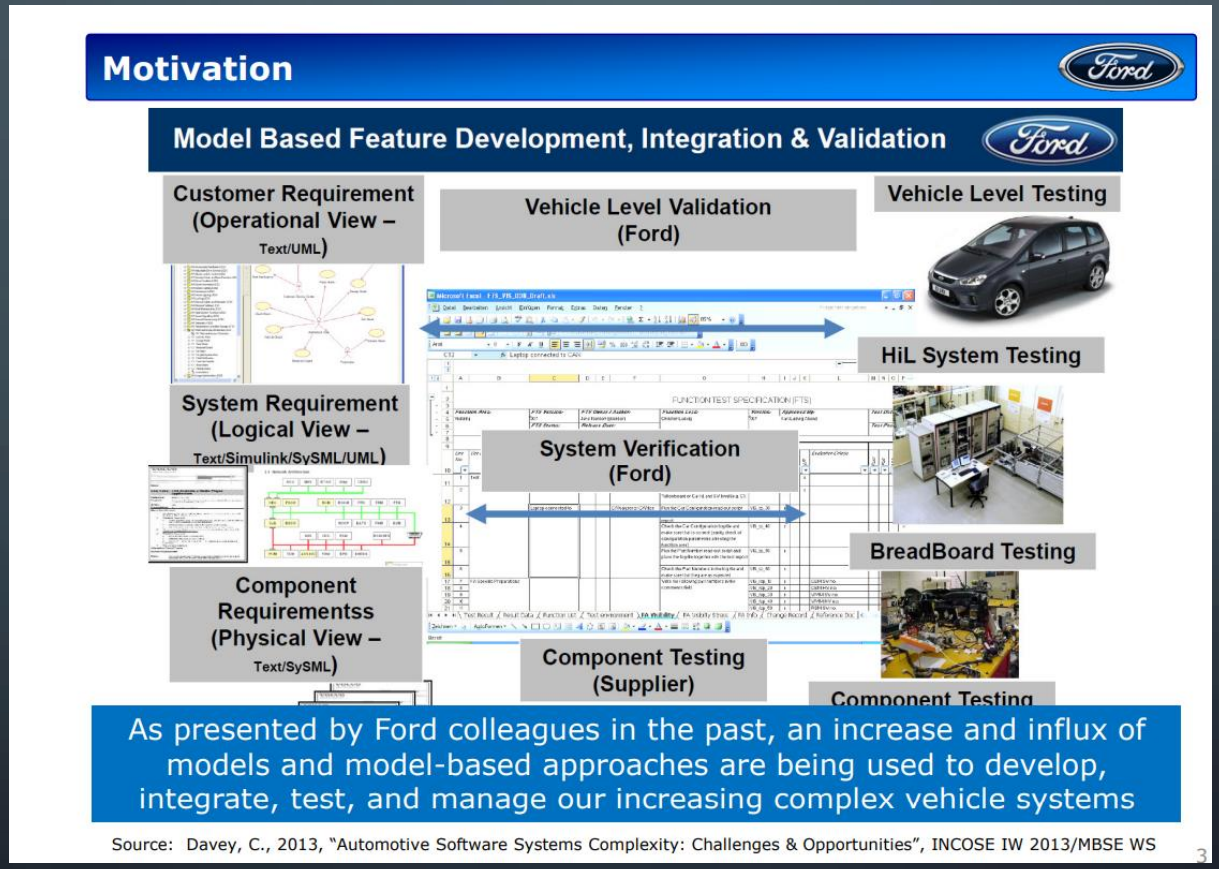
4TH INDUSTRIAL REVOLUTION



The Fourth Industrial Revolution (4IR or Industry 4.0) is the ongoing automation of traditional manufacturing and industrial practices, using modern smart technology. Large-scale machine-to-machine communication (M2M) and the internet of things (IoT) are integrated for increased automation, improved communication and self-monitoring, and production of smart machines that can analyze and diagnose issues without the need for human intervention -- Wikipedia

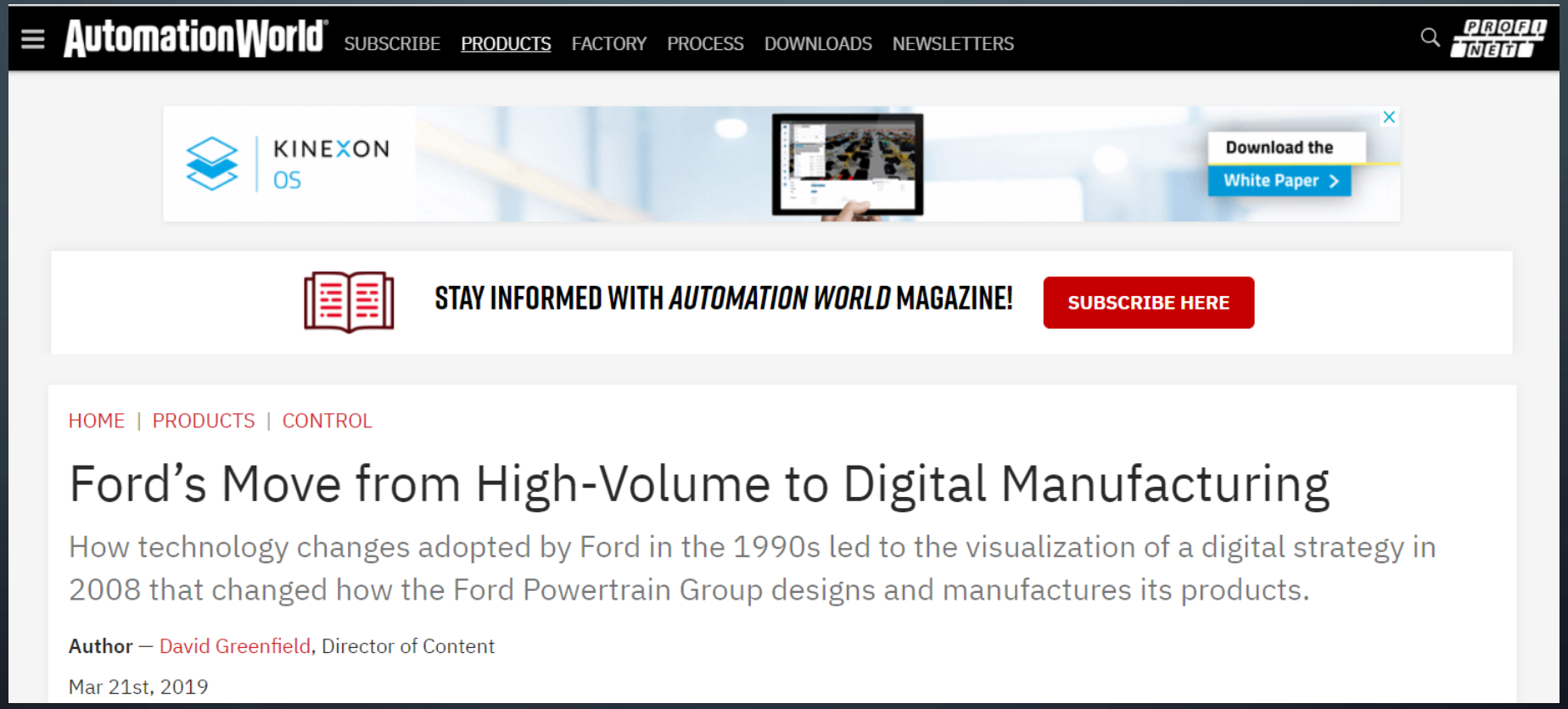
"Digital Transformation" is widespread

INDUSTRY EXAMPLE



Ford Motor Company is showing industry leading progress at INCOSE events

DIGITAL MANUFACTURING

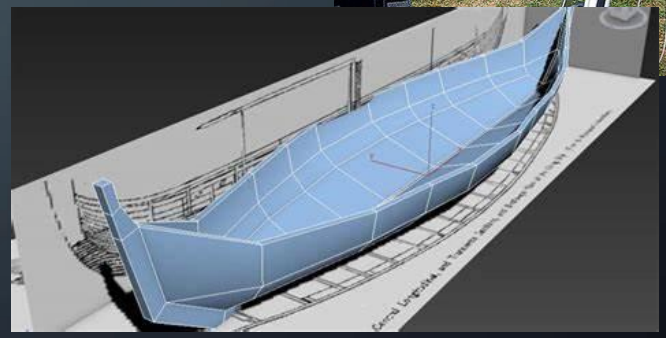


Ford Motor Company is one example…from 2008!

DIGITAL ARCHAEOLOGY

Digital archaeology is the application of information technology and digital media to archaeology. It includes the use of digital photography, 3D reconstruction, virtual reality, and geographical information systems, among other techniques.

Computational archaeology, which covers computer-based analytical methods, can be considered a subfield of digital archaeology, as can virtual archaeology.



https://en.wikipedia.org/wiki/Digital_archaeology

“Digital Transformation” isn’t just “tech markets”

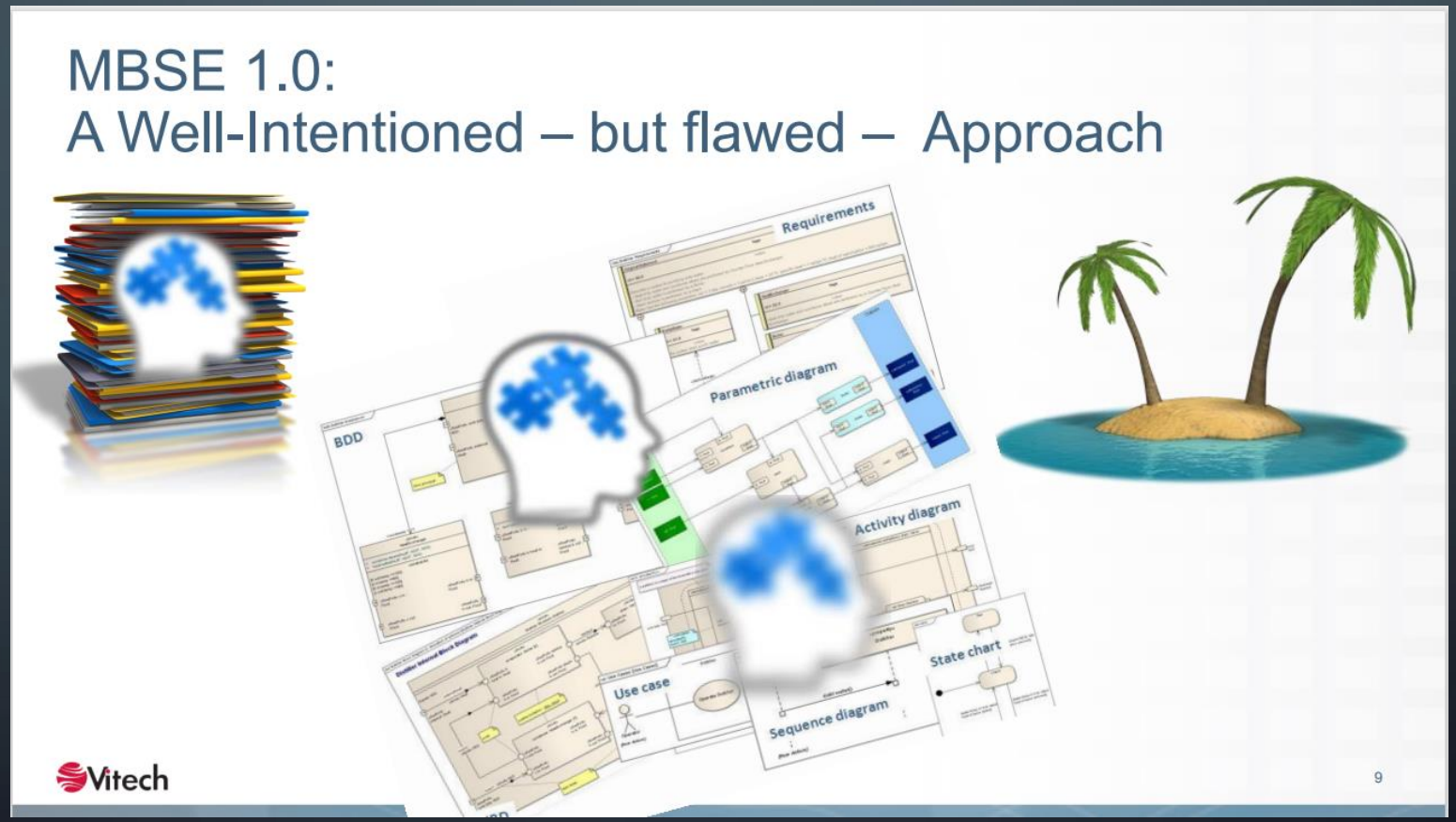
MBSE ADOPTED ACROSS INDUSTRIES!!

Uh…not exactly…

Film at 11!!

A BIT MORE BACKGROUND

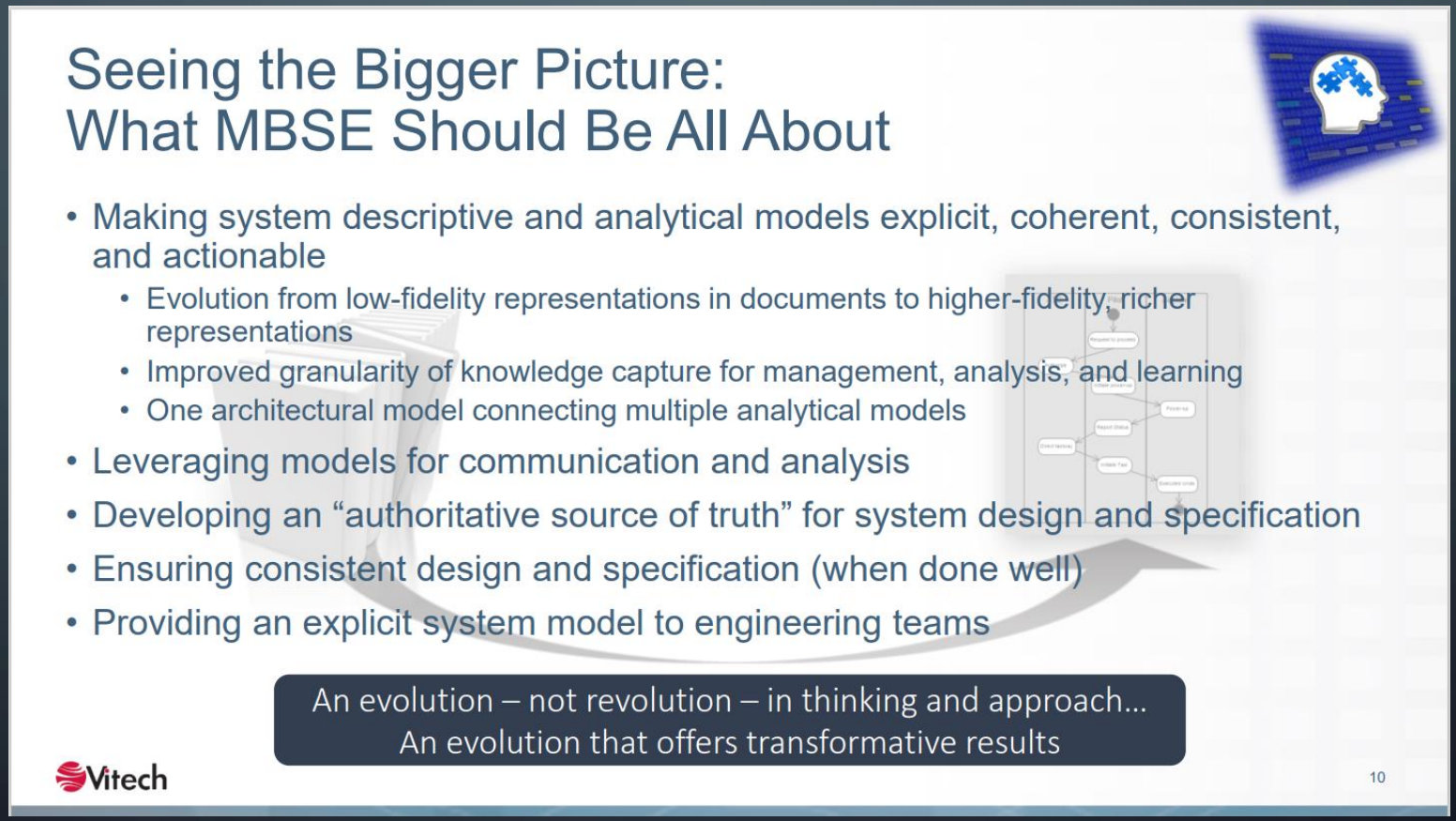
November 2019 Enchantment Speaker:
David Long : MBSE 2.0



Most are *still* not doing *MB*SE

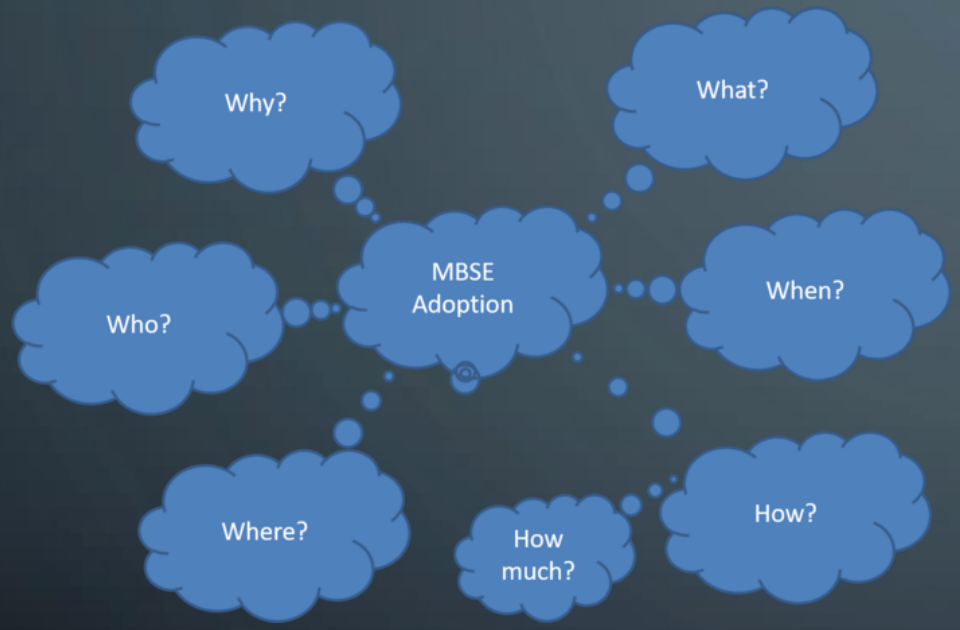
A BIT MORE BACKGROUND

November 2019 Enchantment Speaker: David Long : MBSE 2.0

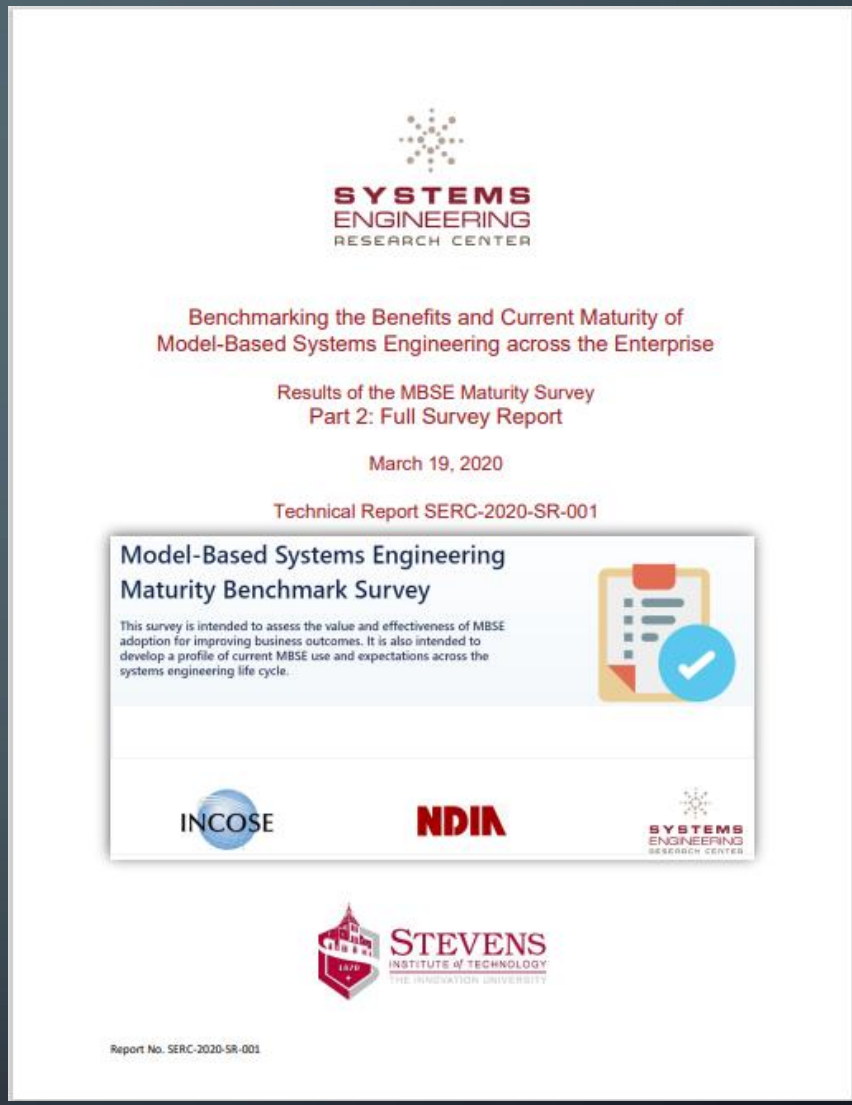


MBSE = DE??

MBSE ADOPTION



https://www.incosewiki.info/Model_Based_Systems_Engineering/index.php?title=MBSE_Adoption_Guide_-_v0.5



https://sercuarc.org/wp-content/uploads/2020/03/SERC-SR-2020-001-Benchmarking-the-Benefits-and-Current-Maturity-of-MBSE-3-2020.pdf

SERC Study: MBSE use is low / immature

OBSTACLES TO MBSE ADOPTION

Table 17. Analysis of Responses to Questions on Obstacles to MBSE Adoption

Code Category	Code	Code label	# Comments Obstacles
Organizational Environment	Organizational culture**	CULTURE	44
Workforce	Workforce knowledge/skills**	SKILLS	30
Leadership	Leadership support/commitment**	LDR CMT	25
Communication	Awareness of MBSE benefits/value**	AWR BEN	18
Change Processes	Change management process design	CHANGE PROC	13
MBSE Processes	Integration to support MBSE implementation	INTEGRATION	13
MBSE Processes	MBSE methods/processes*	MBSE PROC	13
MBSE Processes	MBSE tools*	TOOLS	13
Change Processes	Competing priorities	COMP PRIOR	11
Change Processes	Demonstrating benefits/results	DEMON RES	11
Resources	General resources for MBSE implementation	RESOURCES	11
Workforce	Training*	TRAINING	11

https://sercuarc.org/wp-content/uploads/2020/03/SERC-SR-2020-001-Benchmarking-the-Benefits-and-Current-Maturity-of-MBSE-3-2020.pdf

SERC Study: "Culture" leads the list of obstacles to MBSE

ISSUES ADOPTING MBSE

"Most of these issues appear to be related to workforce, culture, and change management concerns…In fact, responses from smaller organizations reflect more agreement than larger organizations on mature capabilities across these areas, likely because they are able to realize the necessary cultural changes more quickly."

https://sercuarc.org/wp-content/uploads/2020/03/SERC-SR-2020-001-Benchmarking-the-Benefits-and-Current-Maturity-of-MBSE-3-2020.pdf

Adoption issues…related to workforce, culture, and change management

PLM TO THE RESCUE(?)

- DE can be practiced without MBSE.
- Use of MBSE is low (SERC survey)
- Proliferation of Product Lifecycle Management (PLM) tools
  - Siemens Teamcenter
  - Dassault Systèmes family of tools
  - PTC's Windchill

If MBSE practice is low but products are being engineered, ipso facto the product data must be mostly non-MBSE. Such data is in digital form, is being shared as a single source of truth, and is being managed and used on a lifecycle basis.

https://www.ppi-int.com/articles-systems-engineering/reflections-on-the-incose-iw2021/

PLM = DE ???

MBSE REDUX: THE DIGITAL REVOLUTION

What does it Mean to Digitally Transform when we can't yet claim credit for full-on MBSE?

Is Digital Transformation MBSE Redux? MBSE+Mod/SiM? PLE and PLM tools?

It feels like we've been here before…

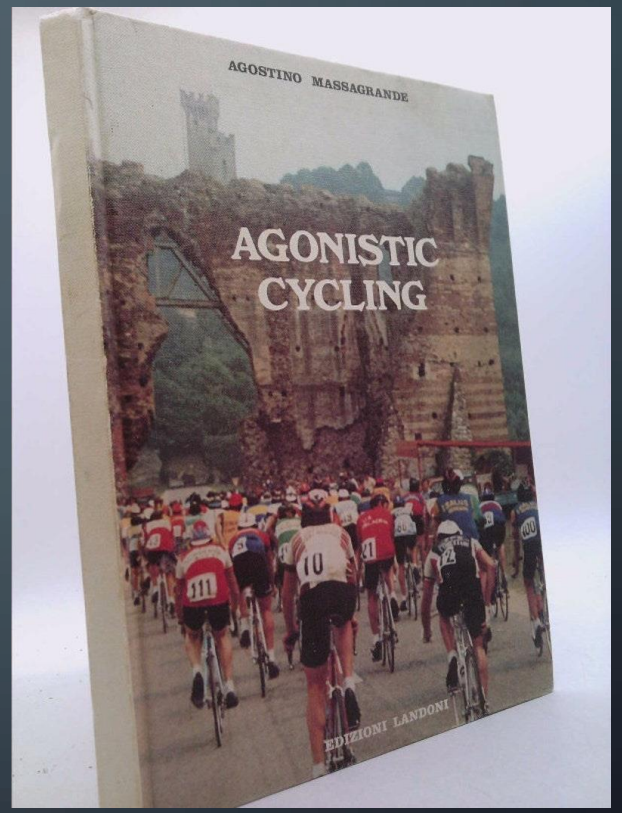
The battle for tomorrow has begun…

SO….

What is the perspective of "Antagonistic Engineering".

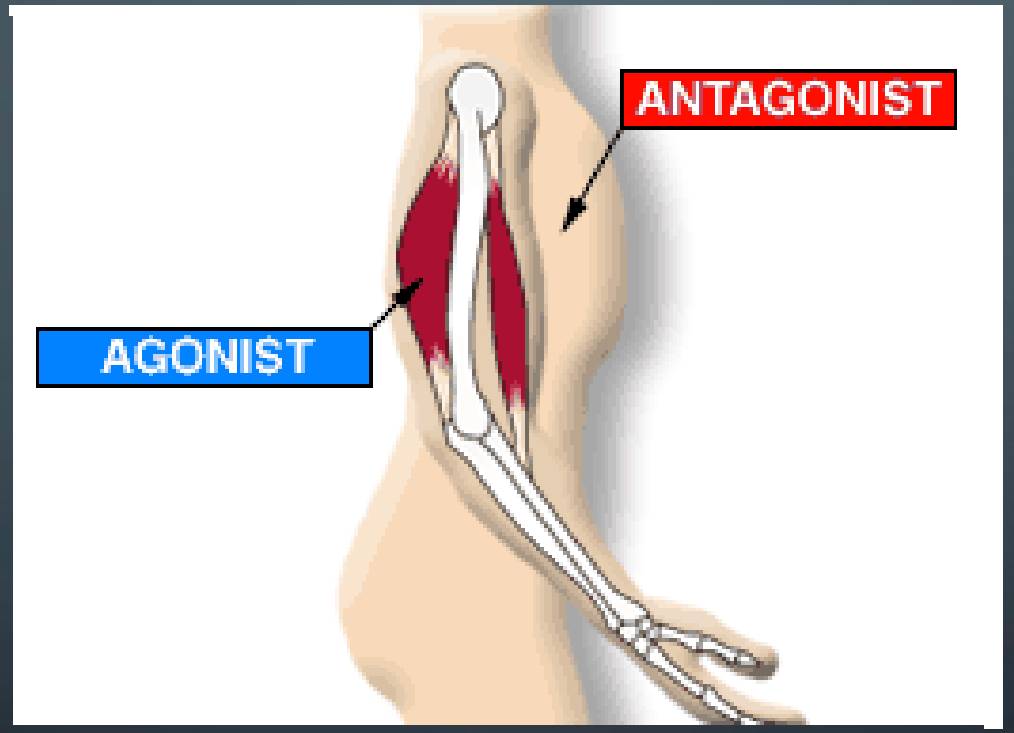
How do we impact engineering processes, attitudes, and culture to not only enable MBSE but further the Digital Revolution?

…let's talk about agonists and antagonists…



Agonistic "cycling" (pardon the pun)

BIO-MECHANICAL ANALOG



Working against…or working together?

AGONIST MUSCLE

Prime Mover. A muscle that causes a particular movement to occur, creating a normal range of movement in a joint by contracting; a muscle which moves in one general direction.

Agonist = prime mover

ANTAGONIST MUSCLE

A muscle that opposes the movement of agonist muscles and returns a limb to its initial position.

Antagonist = opposing (balancing??) force

WHY ANTAGONIST ENGINEERING?

It's really about the dualism of Agonist and Antagonist muscles, trading roles, enabling active motion, balance, and progress. It's about changing culture and soft skills.

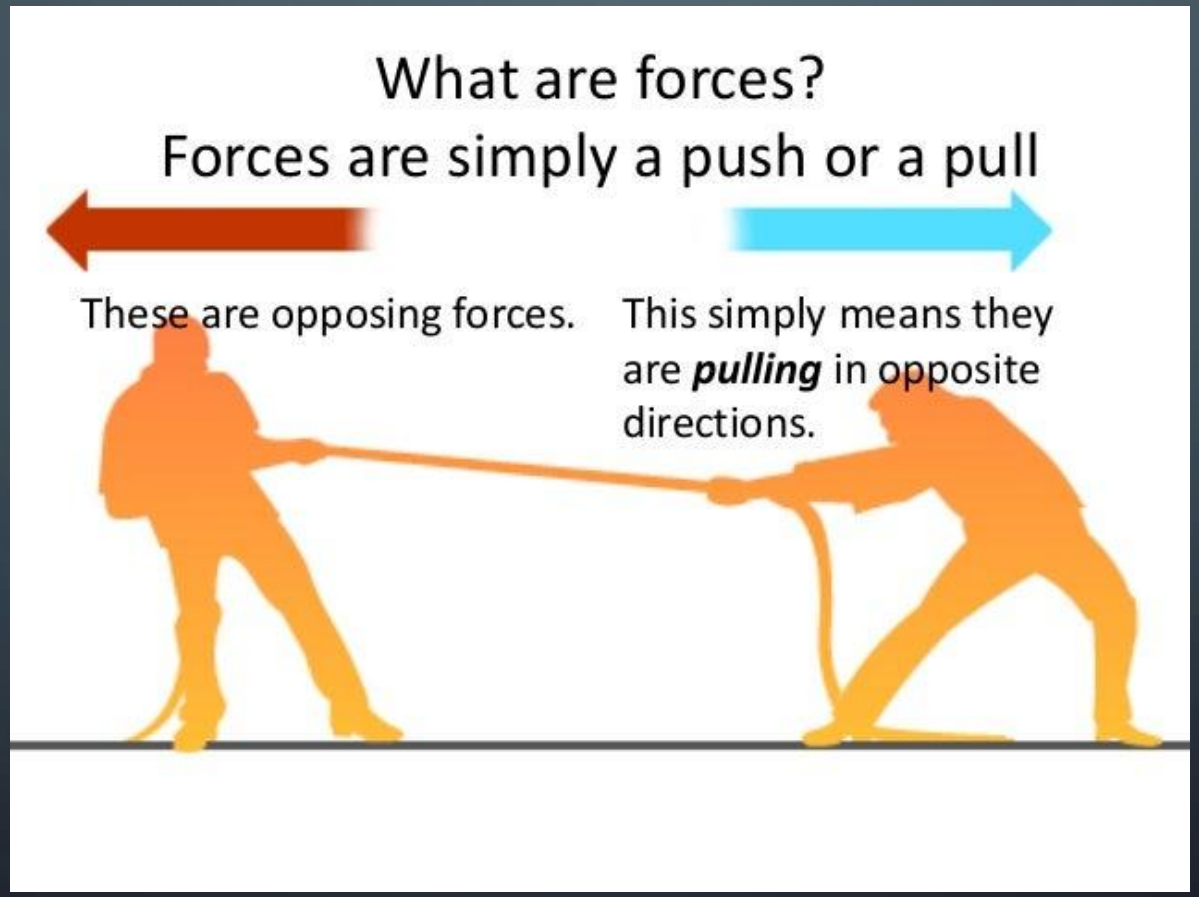
(antagonist was a catchier title)

Antagonist muscles enable BALANCE

WHY ANTAGONIST ENGINEERING?

Antagonist muscles enable BALANCE

ANTAGONIST ENGINEERING IS NOT…

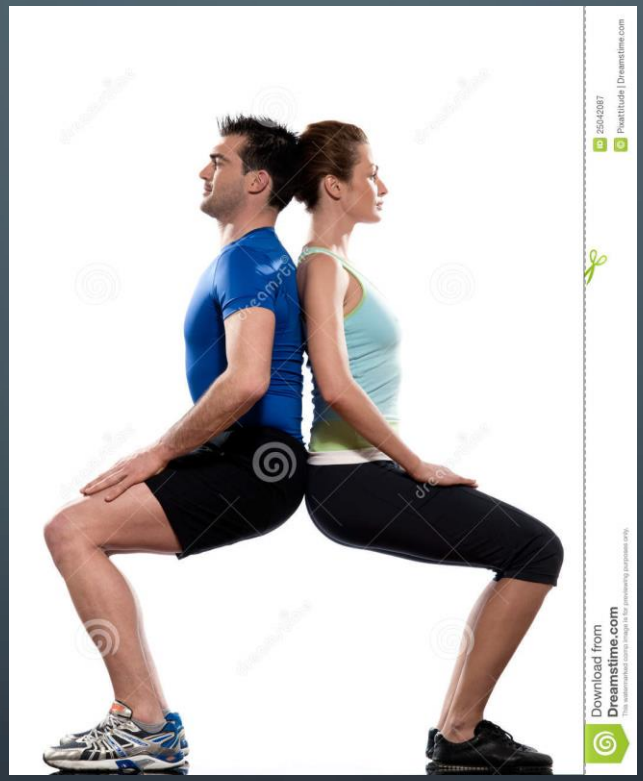


Not a tug-of-war in Opposition

NOT OPPOSITION

Not opposition

IT IS TEAMWORK



Supporting each other / working together

DYNAMIC BALANCE!

Maintaining BALANCE while Moving!!

CHANGE AND BALANCE

Two forces at work: constant change and movement toward balance.

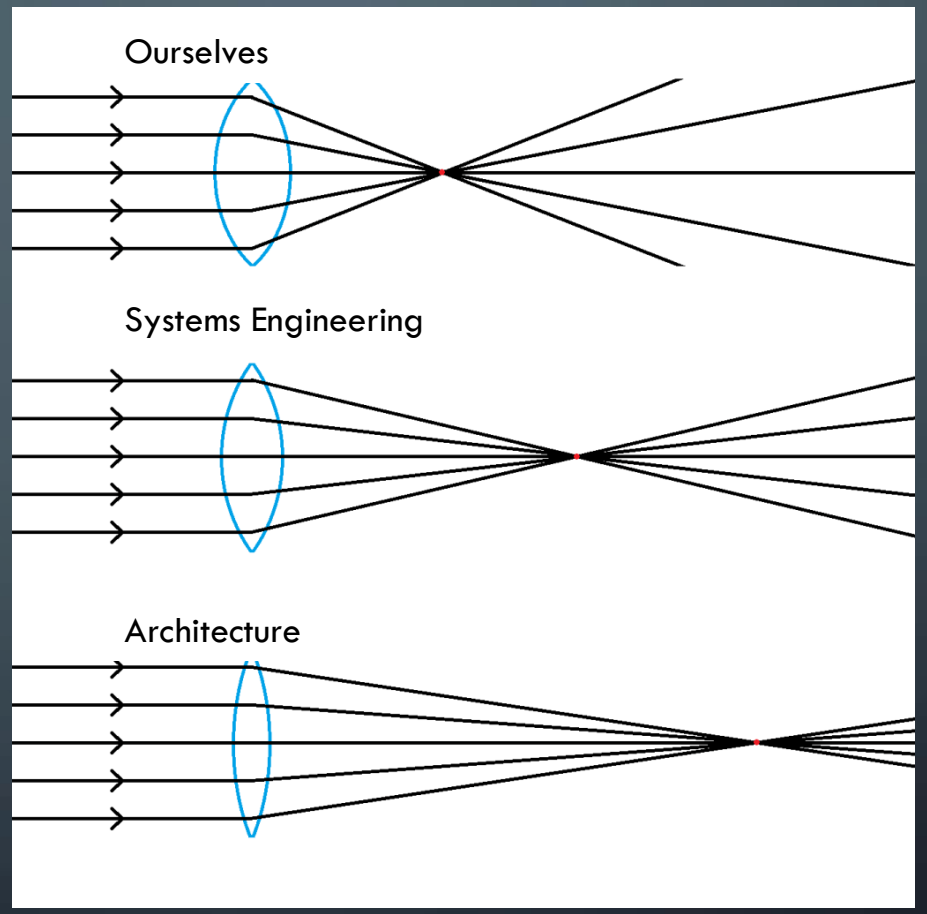
The change comes from exerting effort as you move into new positions.

The movement toward balance occurs as you adjust to each new position.

Change is stressful, whereas balance is comfortable. Efficient movement, essentially, is skillful blending of these two forces, moving in a balanced way through change.

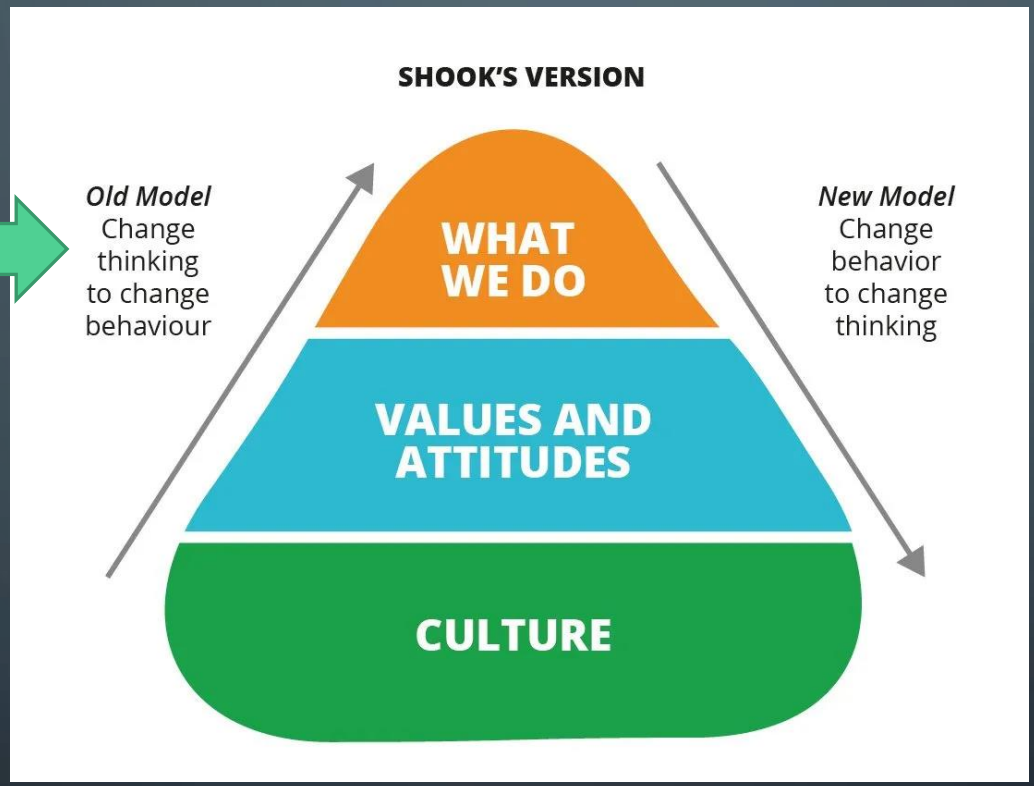
Dynamic balance is a KEY concept

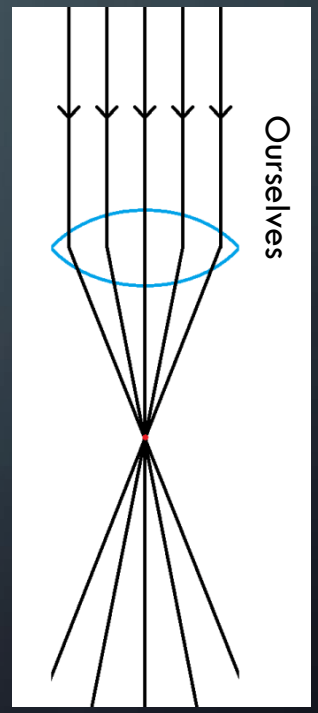
THREE FOCI



It is really about “soft skills”

OURSELVES





John Shook's Change Model, www.lean.org

Start with understanding yourself

OURSELVES

"Culture is our behaviors. It is the actions we perform. The way we talk, and treat one another. The way we behave reflects the values and expectations we have of ourselves, and of one another."

https://barryoreilly.com/explore/blog/leading-culture-change-means-changing-yourself-before-others/

Cultural change begins with Us

KNOW YOURSELF

Do you like Change?
Do you want to Lead?
Do you want to Follow?
Do you want to Get out of the way?

Empathize!
Emotional Intelligence!
Quiet! (Susan Cain)

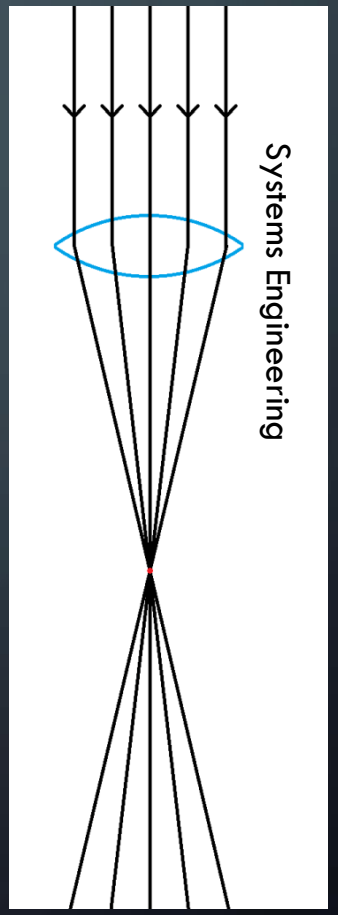
Yes. Soft Skills.

FIRST DO NO HARM

Three Reasons why Document-based SE (usually) works better than (most of) MBSE -Jean Phillipe Lerat

Under this provocative title, this paper warns the reader against a common belief: MBSE is the key to success. This statement is not wrong but terribly reductionist since the success of MBSE requires good SE practices to begin with. However in real life, most of MBSE efforts are just reflecting the bad SE practices that it pretends to correct. This mirroring does not help to solve the problems nor to implement better SE practices. In general, it just bastardizes what was already hardly working, based on document exchanges.

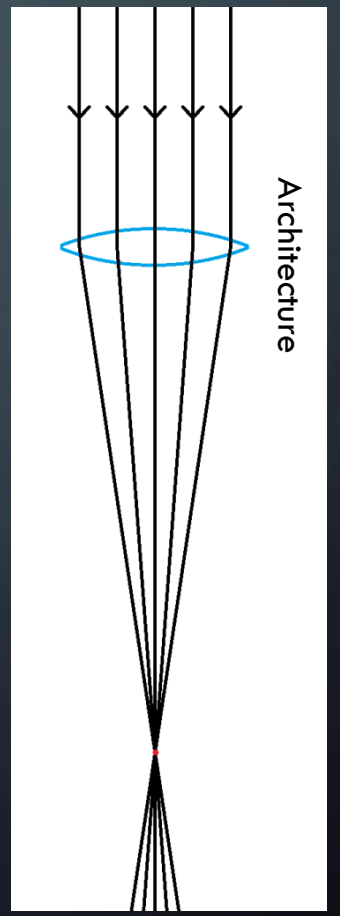
INCOSE 2010



First, do GOOD Systems Engineering

ARCHITECTURE AS A KEY TO BALANCE

SE needs to be involved in the *Architecture* of the change, the transformation to DE. Otherwise it's just like a traditional design effort where the SMEs in the room are already picking LRUs and writing SW in their head before the requirements are written down!!! Except in the Digital Revolution, they're picking PLM tools, MBSE tools and databases (oh my)



Enterprise Architecture!!!!!!!!

“ENTERPRISE” ARCHITECTURE

Use SE concepts and MBSE to Architect and Implement the DE transformation, MBSE Systems, and Enterprise DE integrations

Remember, MBSE, and by extension DE, is not so much about doing MBSE, as it is about doing SE, or Analysis, or other ENGINEERING within a Business ($$) using Model Based and Digital tools.

It is about Engineering, Business and People

EXAMPLE IE ARCHITECTURE

Who needs what information, when do they need it, from whom do they get it, in what format, with what provenance, at what frequency…

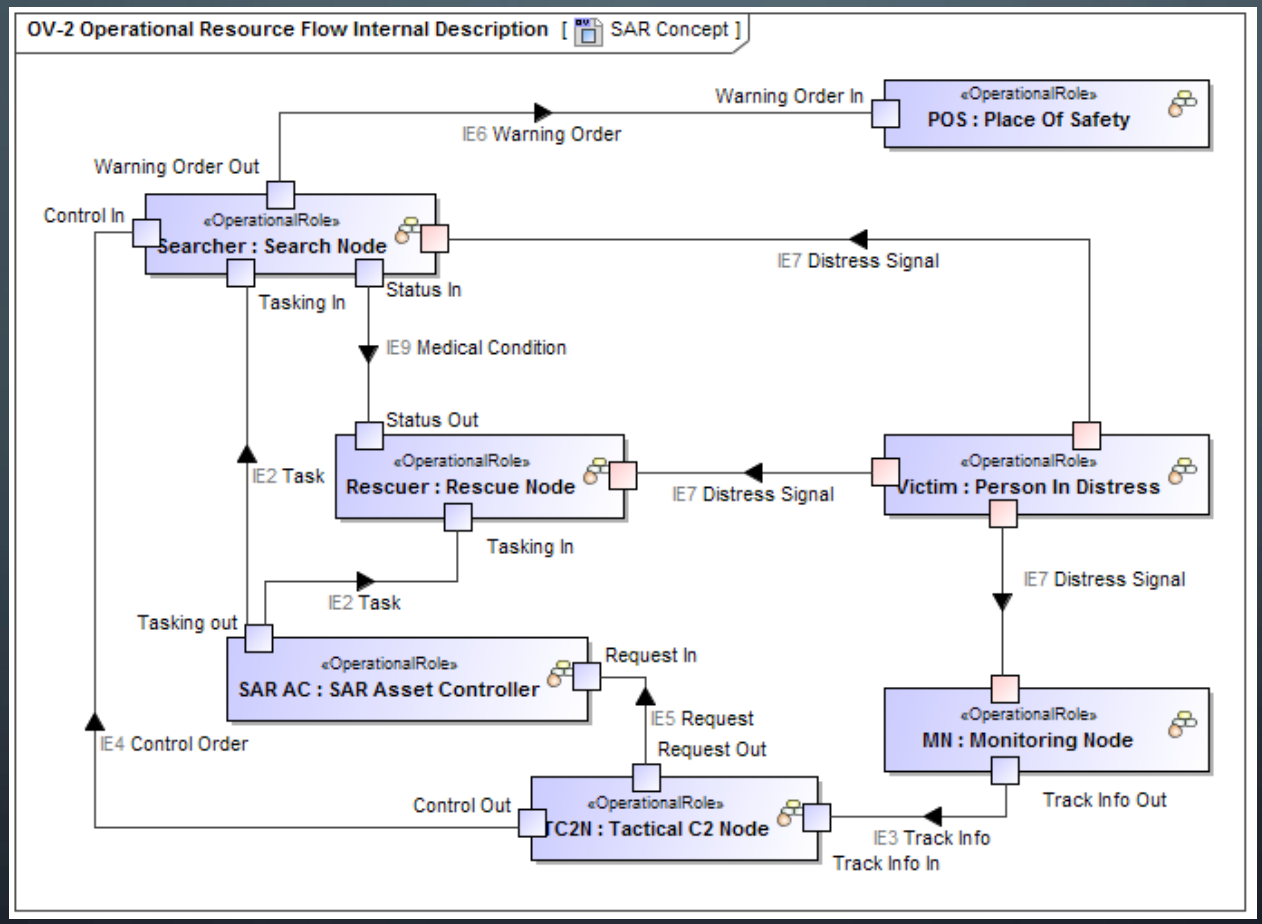
For those who are familiar, this is a bit like DoDAF…

The OV-2 depicts Operational Needlines that indicate a need to exchange resources. The Operational Activities shown in an OV-2 may be internal to the architecture, or may be external activities that communicate with those internal activities. Use of OV-2 is intended to be logical. It is to describe who or what, not how.

OV-3: Operational Resource Flow Matrix
A description of the resources exchanged and the relevant attributes of the exchanges.

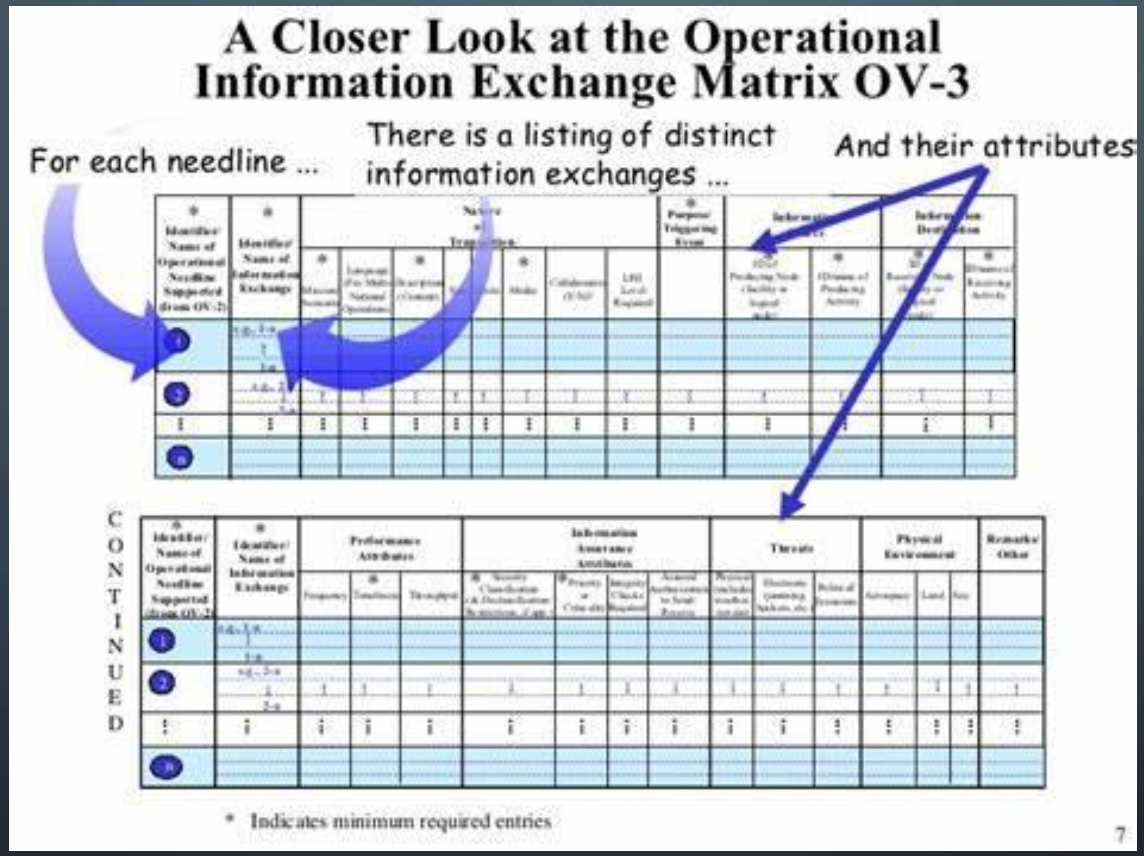
Information Exchange (IE) Architecture

OV-2 AS AN EXAMPLE



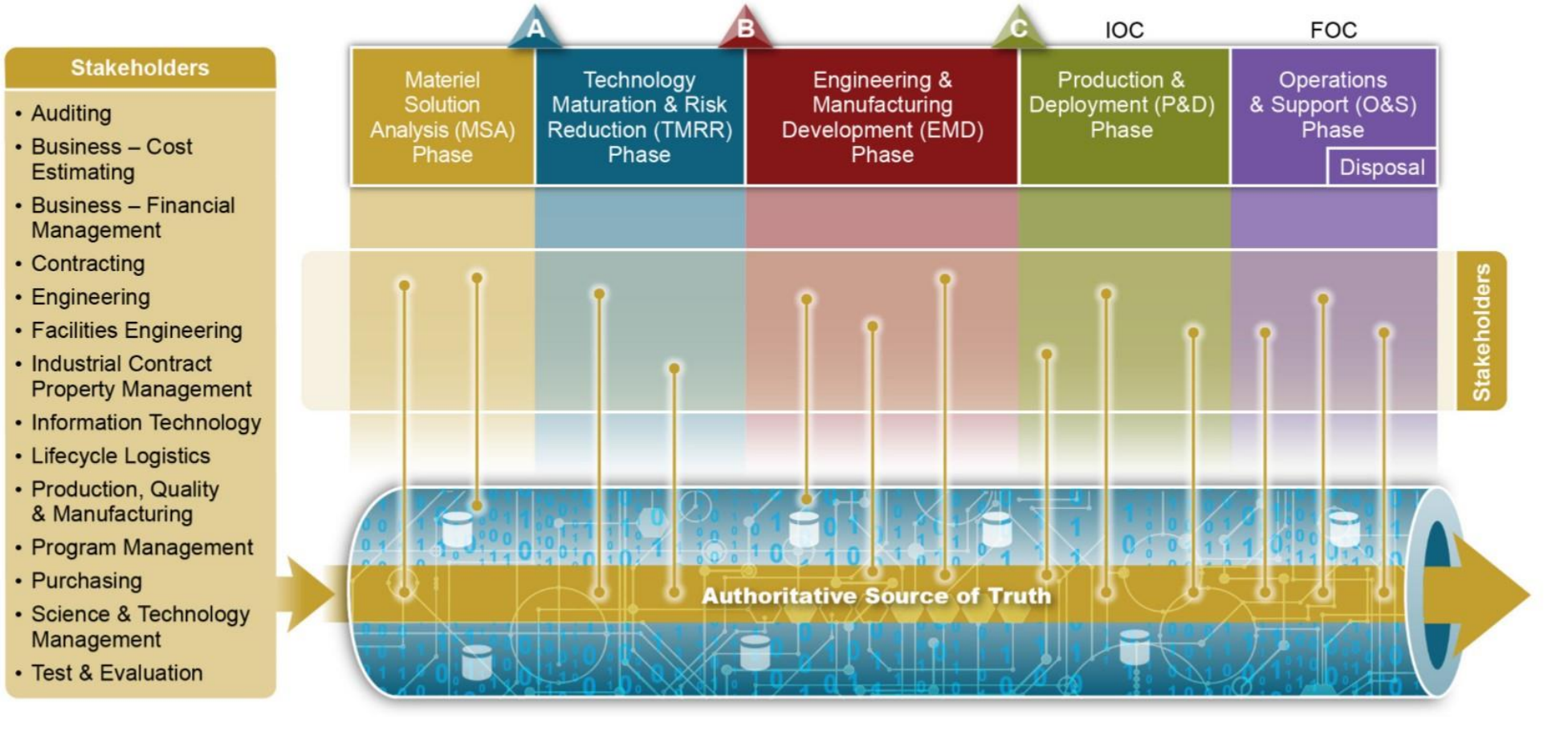
Needlines…who needs what and where does it come from

OV-3 METADATA FOR OV-2



Metadata for the Information Exchange

AUTHORITATIVE SOURCE OF TRUTH



Think of the OV-2 example in the context of an authoritative source of truth in a digital ecosystem

Not only the technical baseline, but the central reference point and map to needlines for models and data across the Entire Digital Enterprise.

All stakeholders…across disciplines…concept to disposal

DASHBOARDS, VIEWS, AND VIEWPOINTS

Bring information into “human readable” views and viewpoints. Enable deciders to decide without requiring them to be Tool Experts.

Information brought to the Decider Level (not buried in tools that require six pages of training classes)

OV-3 METADATA FOR OV-2

Avoid circular connections. Derive data from the MINIMUM number of connections.

A common issue with new MBSE/DE efforts is people connecting A to B and A to C, even though B to C exists and allows A to C to be derived.

Gets MORE complicated if implemented across disparate tools/repositories!!

Remember this is Architecture of the Ecosystem

DEIX – AIR GAP

Digital Engineering Information Exchange (DEIX) challenges occur in exchanges over Air Gaps.

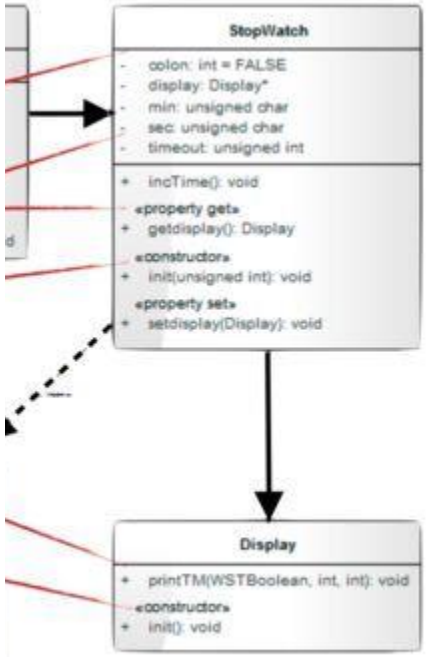
AN integrated *Tool-Suite* e.g. PLM won't have this problem to the same degree. IT is when there are gaps (tool format, file format, underlying meta-model) that we have DEIX PROBLEMS!!!

"Document Centric approaches are inherently based on air-gaps!"
--Eran Gery

Exchange over Gaps will drive Exchange Ontology & Architecture

TRACEABILITY

Within and across *DOMAINS* using tool Integrations



Traceability and Tool Integration(s) enable "Authoritative Source of Truth"

FIVE GOALS OF DIGITAL TRANSFORMATION

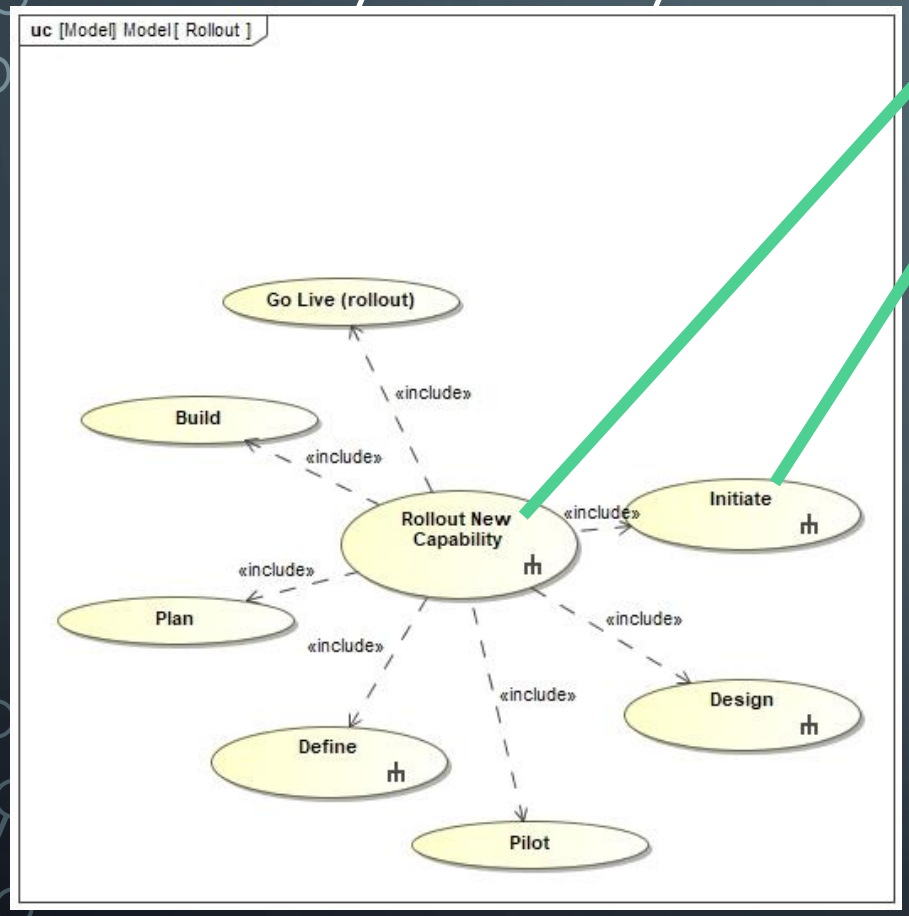
The OSD Strategy asked each of the services to develop corresponding digital engineering implementation plans during 2018 "*to ensure the Department advances this timely and imperative effort*".

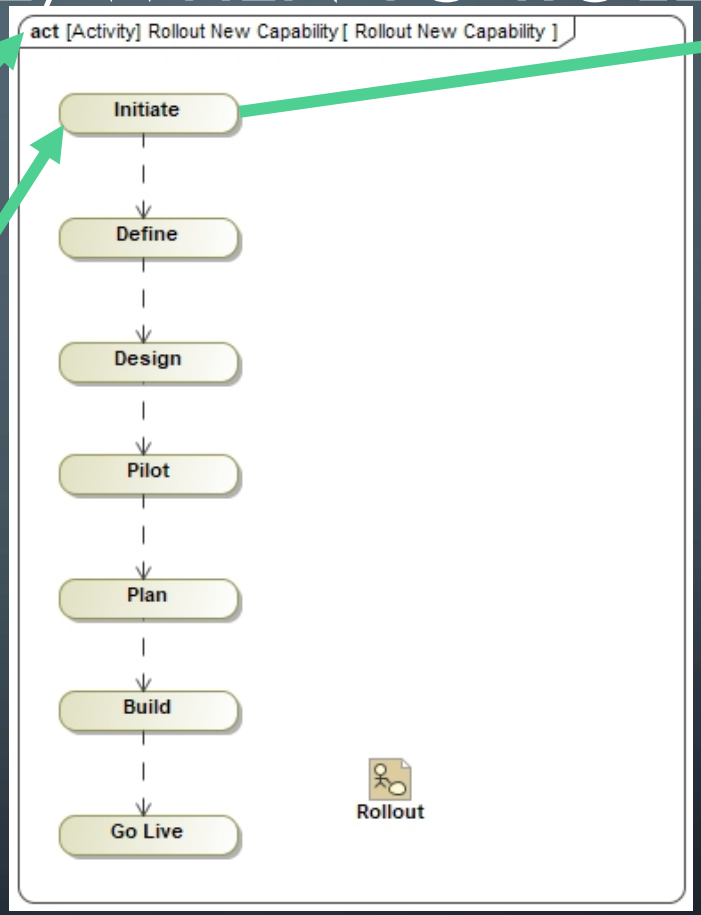
Per the strategy, these efforts are aligned around Five Goals:

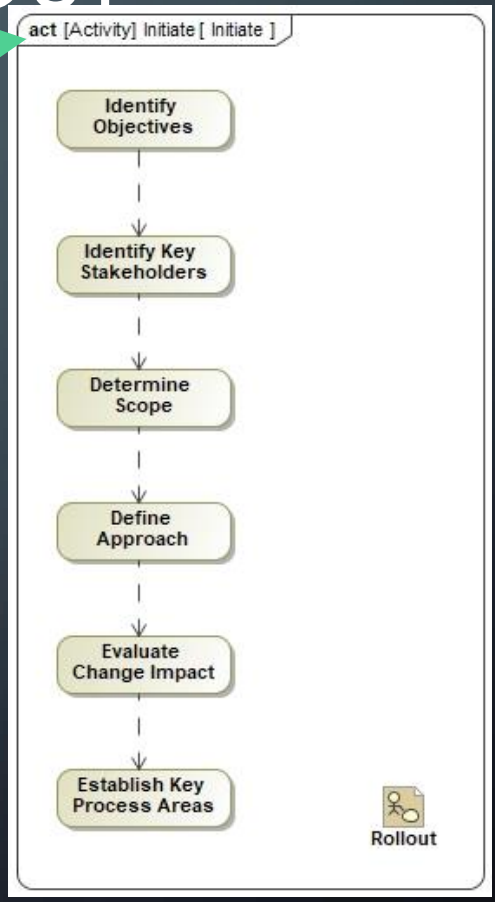
1. Formalize the development, integration, and use of models to inform enterprise and program decision-making.
2. Provide an enduring, authoritative source of truth.
3. Incorporate technological innovation to improve the engineering practice.
4. Establish a supporting infrastructure and environments to perform activities, collaborate, and communicate across stakeholders.
5. Transform the culture and workforce to adopt and support digital engineering across the lifecycle. The final goal incorporates

Transform the Culture

WHO/WHAT/WHERE/WHEN TO ROLL OUT

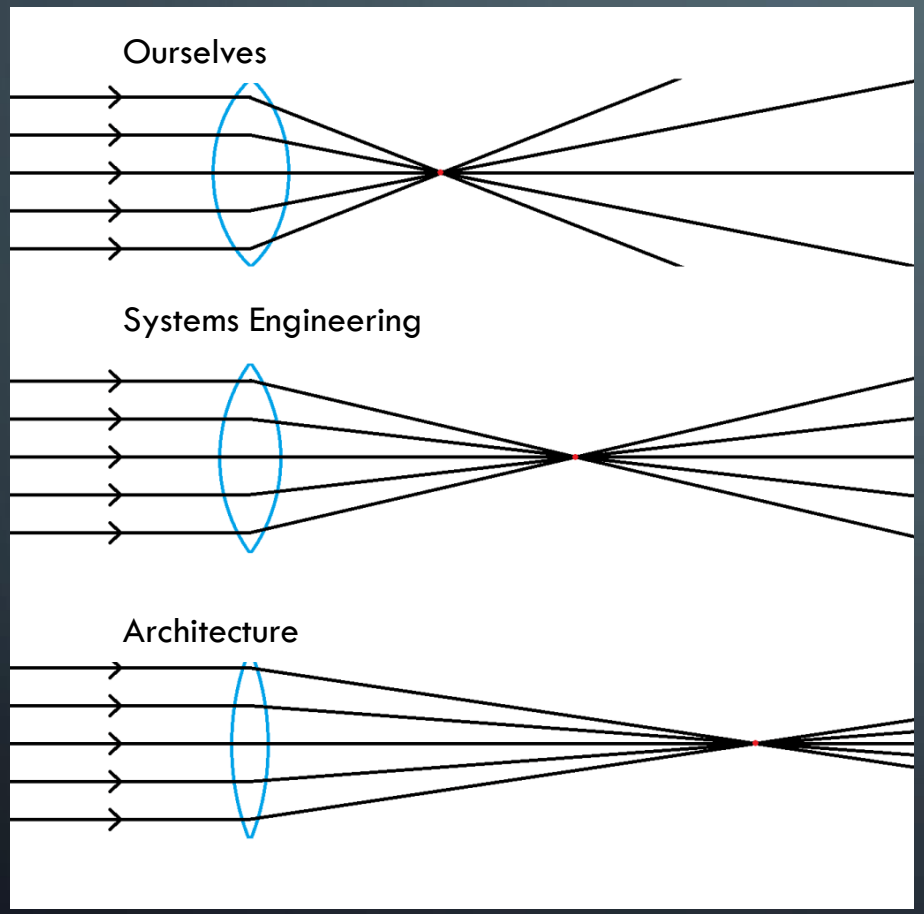


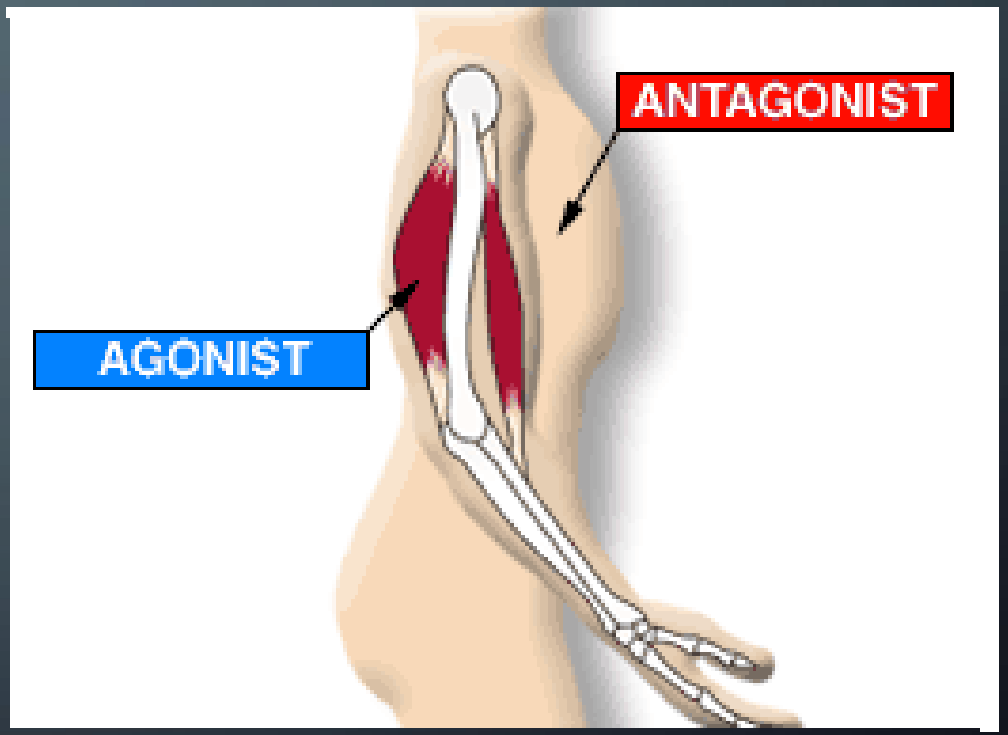




Have a Plan for yourself and your role as a Change Agent

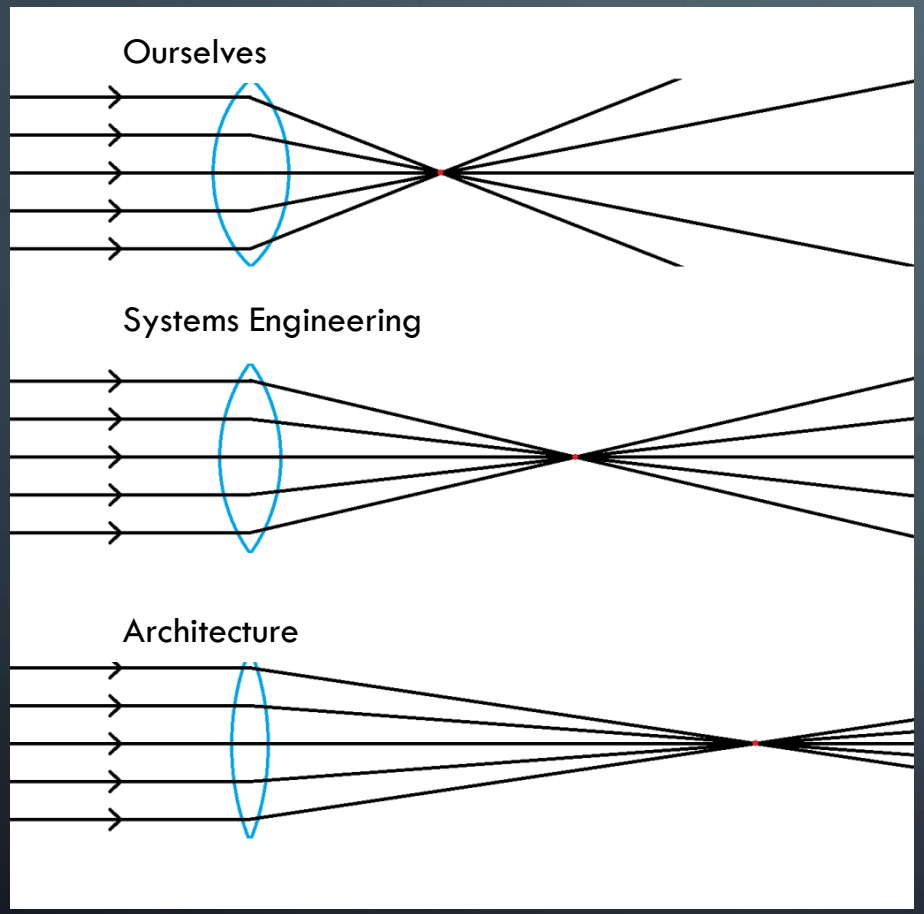
TAKE AWAY





Dynamic Balance

TAKE AWAY



- Lead. Follow. Get out of the way.
- Empathize
- Emotional Intelligence
- Quiet! (Susan Cain)

- First, do good SE
- It's about Engineering not just Tools
- Model with Intent

- Mind the Gap
- Needlines (who/what/where/when/why)

Dynamic Balance

Thank You!