

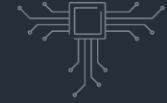


Leonardo Electronics

The Problem Definition-MBSE Capability Gap

Second MDENet Annual Symposium – Kings College London

01-02/12/2022



Electronics



Helicopters



Aircraft



Cyber & Security



Space



Unmanned Systems

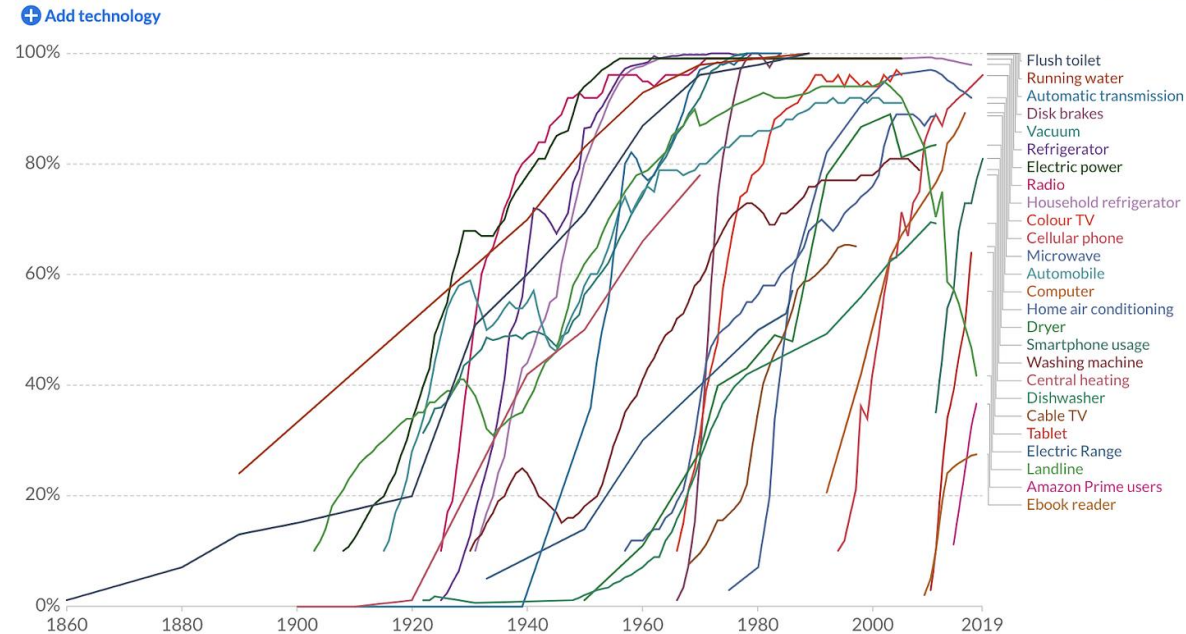


Aerostructures

The Big Picture – Engineering in the 21st Century

- *Problem Definition is a major strategic area of concern*

Share of US households using specific technologies, 1860 to 2019



The world is becoming more Volatile, Uncertain, Complex and Ambiguous (VUCA)

The deployment cycle time is getting faster and being first to market enables you to 'steal a march' on the opposition.

The UK faces STEM shortages - We can not afford our engineers to be working on solutions to the wrong problem

Engineers are pre-disposed to think in solutions



The Big Picture – Problem Definition though the ages

Successful problem solving requires finding the right solution to the right problem. We fail more often because we solve the wrong problem than because we get the wrong solution to the right problem” - Russell Ackoff (1919-2009)

The important and difficult job is never to find the right answer, it is to find the right question. For there are few things as useless – if not dangerous –as the right answer to the wrong question” Peter Drucker (1909-2005)

If I had an hour to solve a problem I'd spend 55 minutes thinking about the problem and five minutes thinking about solutions. Albert Einstein (1879-1955)



The Big Picture – The Challenge

How can we extend the Model-based Engineering paradigm to meet the needs of Problem Definition?

How can we best ensure knowledge is to be improved, challenged and increased constantly before it vanishes¹?

How can we make working in the problem domain more appealing?

Ultimately, how can we take all the fragments of information, experiments, associations and inferences and build a cohesive package of information for downstream exploitation.

Here are our thoughts....

¹Adapted from Drucker



The Problem – the details

Achieving Digital Continuity in Mission Analysis to Stakeholder Needs domains



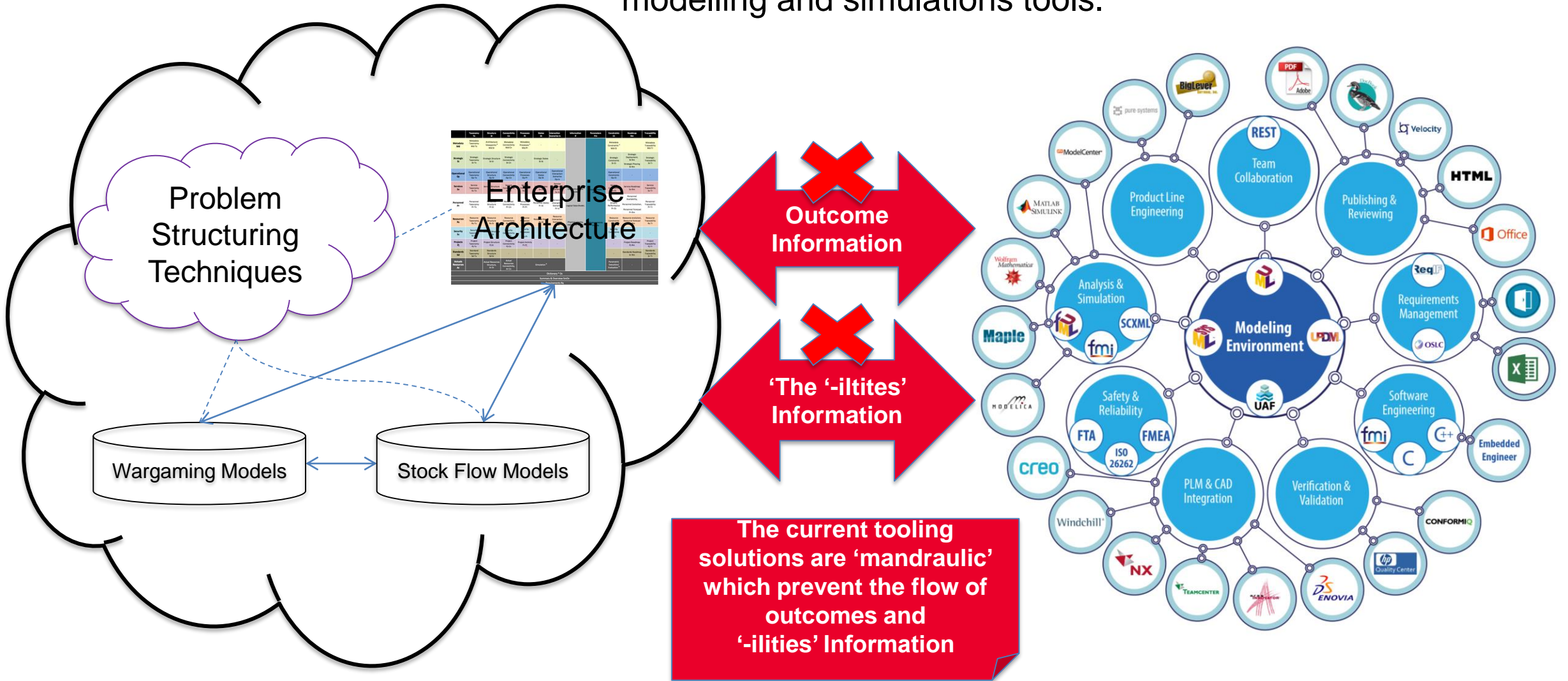
Definitions

Term	Description
Mission Analysis	The purpose of Mission Analysis (MA) is to understand a mission/market problem or opportunity, analyze the solution space, and initiate the life cycle of a potential solution that could address the problem or take advantage of an opportunity. MA is a type of strategic or operations analysis related to needs, capability gaps, or opportunities and solutions that can be applied to any organization that evolves its strategy for its business objectives.
Problem Structuring	A loose collection of group of techniques used to model or map the nature or structure of a situation or state of affairs that some people want to change.
Stock Flow Modeling	The branch of systems dynamics which is concerned with the measure the sufficiency of a certain assets within a given context.
Wargaming	Wargames are analytic games that simulate aspects of warfare at the tactical, operational and/or strategic level. They are used to examine warfighting concepts, train and educate commanders and analysts, explore scenarios, and assess how force planning and posture choices affect campaign outcomes.



The Current State

There is a discontinuity between 'Problem Structuring Techniques', 'Enterprise Architecture', 'Wargaming' and 'Logistics Stock Flow' modelling and simulations tools.



The current situation mapped on to the Boeing MBE Diamond

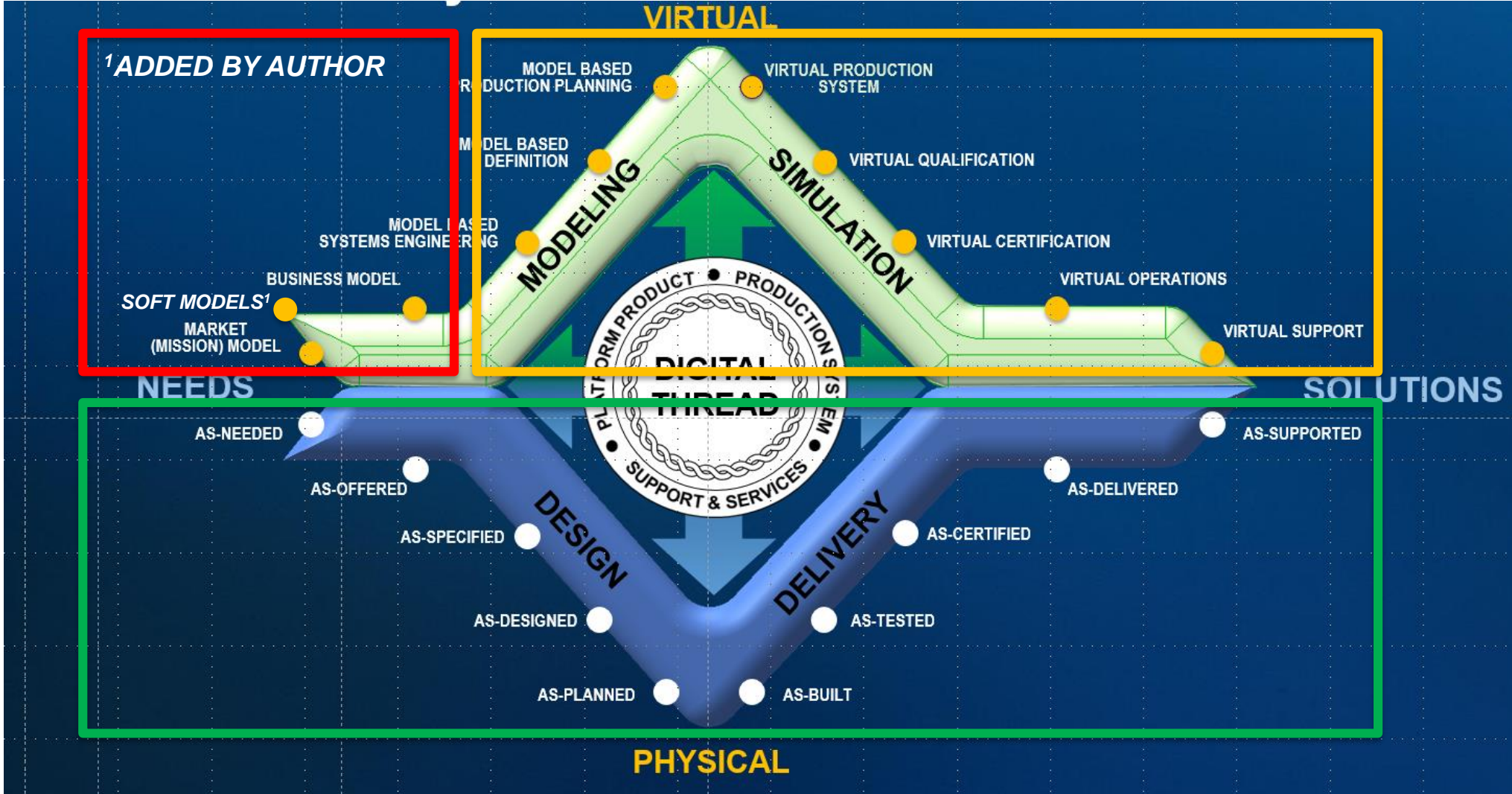
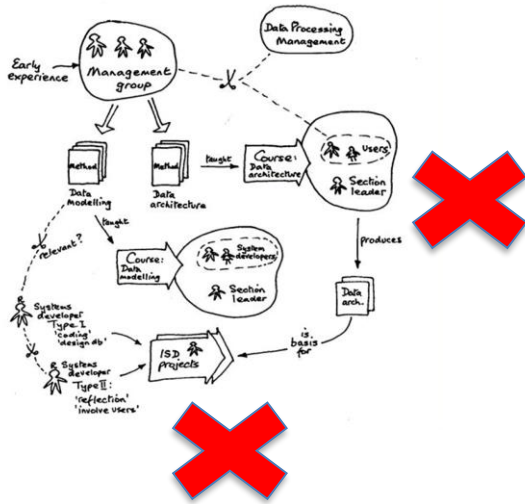


Image Source: Boeing 2020 MBE Diamond



The Bleeding Edge - Tool Elements

Rich Pictures



Category	Structure	Connectivity	Process	Status	Information	Information	Parameters	Contents	Realised	Transparency
Metadeta MI	Metadeta Trasnsmity MI %	Architecture Visions/Mod MI %	Metadeta Connectivity MI %	Metadeta Process MI %				Metadeta Contents MI %	Metadeta Realised MI %	Metadeta Transparency MI %
Strategic St	Strategic Trasnsmity St %	Strategic Structure St %	Strategic Connectivity St %	Strategic Process St %	Strategic Status St %			Strategic Contents St %	Strategic Realised St %	Strategic Transparency St %
Operational Op	Operational Trasnsmity Op %	Operational Structure Op %	Operational Connectivity Op %	Operational Process Op %	Operational Status Op %			Operational Contents Op %	Operational Realised Op %	Operational Transparency Op %
Service Sv	Service Trasnsmity Sv %	Service Structure Sv %	Service Connectivity Sv %	Service Process Sv %	Service Status Sv %			Service Contents Sv %	Service Realised Sv %	Service Transparency Sv %
Personal Pr	Personal Trasnsmity Pr %	Personal Structure Pr %	Personal Connectivity Pr %	Personal Process Pr %	Personal Status Pr %			Personal Contents Pr %	Personal Realised Pr %	Personal Transparency Pr %
Resource Rn	Resource Trasnsmity Rn %	Resource Structure Rn %	Resource Connectivity Rn %	Resource Process Rn %	Resource Status Rn %			Resource Contents Rn %	Resource Realised Rn %	Resource Transparency Rn %
Security Sc	Security Trasnsmity Sc %	Security Structure Sc %	Security Connectivity Sc %	Security Process Sc %	Security Status Sc %			Security Contents Sc %	Security Realised Sc %	Security Transparency Sc %
Project Pj	Project Trasnsmity Pj %	Project Structure Pj %	Project Connectivity Pj %	Project Process Pj %	Project Status Pj %			Project Contents Pj %	Project Realised Pj %	Project Transparency Pj %
Standards Sd	Standards Trasnsmity Sd %	Standards Structure Sd %	Standards Connectivity Sd %	Standards Process Sd %	Standards Status Sd %			Standards Contents Sd %	Standards Realised Sd %	Standards Transparency Sd %
Actual Resource Ar	Actual Resource Trasnsmity Ar %	Actual Resource Structure Ar %	Actual Resource Connectivity Ar %	Actual Resource Process Ar %	Actual Resource Status Ar %			Actual Resource Contents Ar %	Actual Resource Realised Ar %	Actual Resource Transparency Ar %

Weak integration between the Front end tooling which includes:

Enterprise Architecture solutions

Flows down into the MBE tooling but lacks the analytic capabilities.

Problem Structuring solutions

Work shopping tools used to elicit needs from stakeholders and understand the current PESTLE landscape:

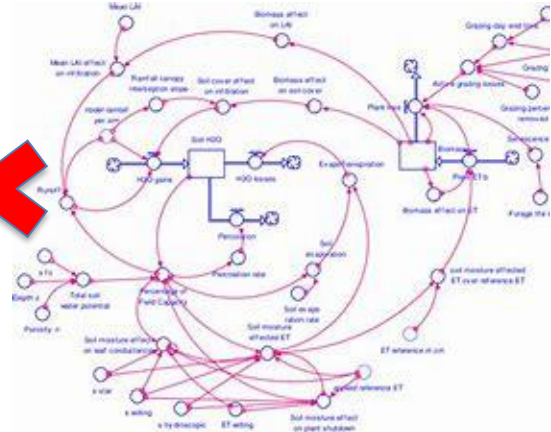
- Includes techniques like: Rich Pictures, Business Canvassing, Affinity Analysis, Mind Mapping, Sensemaking, etc.

War Gammng simulation solutions

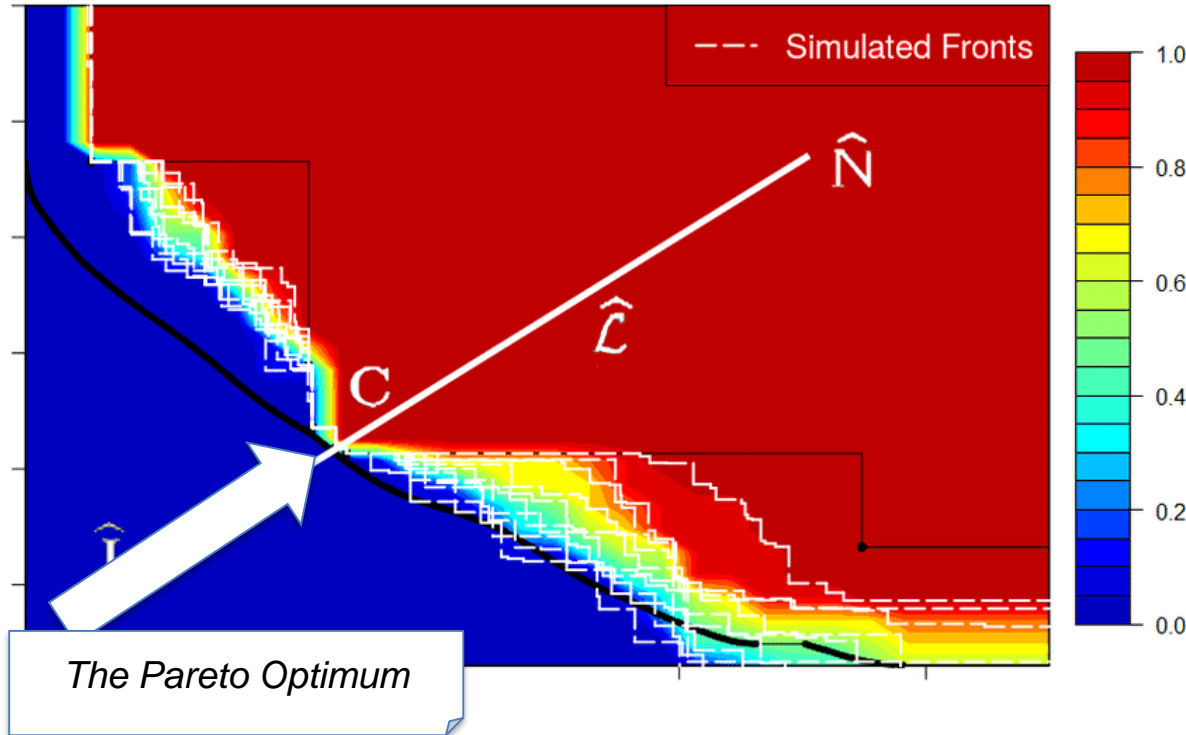
Needed to optimise the users needs specifications for Agents within the problem situation
Is used for setting Measure of Success / Measures of Effectiveness
Very good user ability but operates in its own silo.

Stock Flow simulation solutions

Needed to understand logistical (and attrite) considerations of Problem Space
Operates at an organisational unit level of abstraction



The Bleeding Edge in the Mission Analysis Space



In a early Mission Analysis Systems of Systems simulations, it would be desirable to capture the Measures of Success / Effectives contained with the Operational Analysis tools across a Pareto Optimum solution.

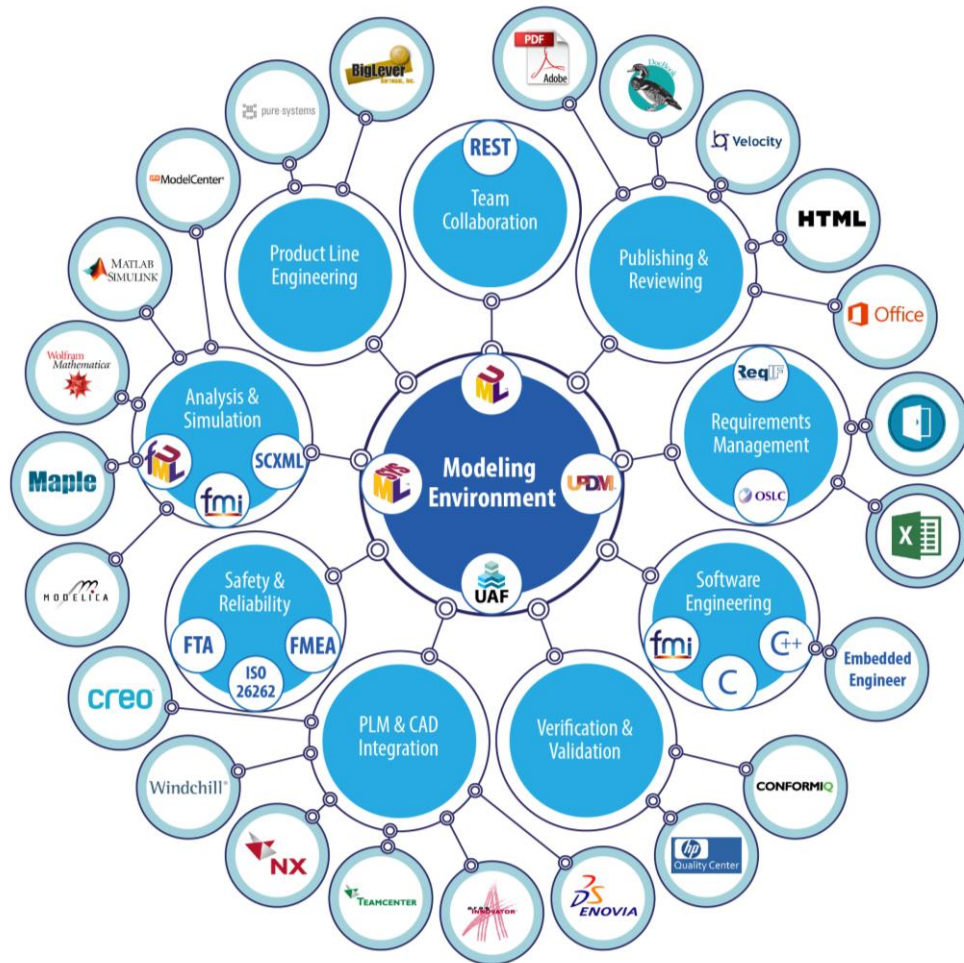
This information is critical for multiple dimension trade-off decision downstream ...
 ... **but** current tooling does not permit the user to readily capture this information.

The Current Digital Environment Solutions

The EA to MBE Digital Thread



State of the Art



A developing ecology of Model based tools with an increase recognition of connectivity.

Adoption issues in this space are largely *Political*, *Economic* and *Social* in nature.

However it is increasingly feasible to envisage an ‘Soup to Nuts’ digitisation with Technologies exist to ensure continuity between the RM MBSE ALM PLM led domains.

Two Solutions Classes are available:

- A middleware-based approach
- A platform-based approach

Source: See end matter for image source



Business As Usual

Agreement Processes	Organizational Project-Enabling Processes	Technical Management Processes	Technical Processes
Acquisition Process	Life Cycle Model Management Process	Project Planning Process	Business or Mission Analysis Process
Supply Process	Infrastructure Management Process	Process Assessment and Control Process	Stakeholder Needs & Requirements Definition Process
	Portfolio Management Process	Decision Management Process	System Requirements Definition Process
	Human resource Management Process	Risk Management Process	Architecture Definition Process
	Quality Management Process	Configuration Management Process	Design Definition Process
	Knowledge Management Process	Information Management Process	System Analysis Process
		Measurement Process	Implementation Process
		Quality Assurance Process	Integration Process
			Verification Process
			Transition Process
			Validation Process
			Operation Process
			Maintenance Process
			Disposal Process
		<i>Life Cycle Cost Management Process</i>	

Reasonable Tooling Ecology

Mature Good Practice based on ISO 15288:2015

- Previous editions in 2002 and 2008
- Based on MIL STD 499A (1974)
- SE as a profession emerged of WW2 and Operational Research

Needs business processes maturity and solid execution of the Stakeholders Needs and Requirements Definition Process

- More easily said than done.
- One of the reasons for Software's Agile Manifesto.
- Agile Process and Toolsets are increasingly favoured for Early Lifecycle Activities and VUCA Type Developments.

However the concurrent engineering has started to strain Document Intensive Systems Engineering (DISE).

Source: Koblen after ISO15288:2015

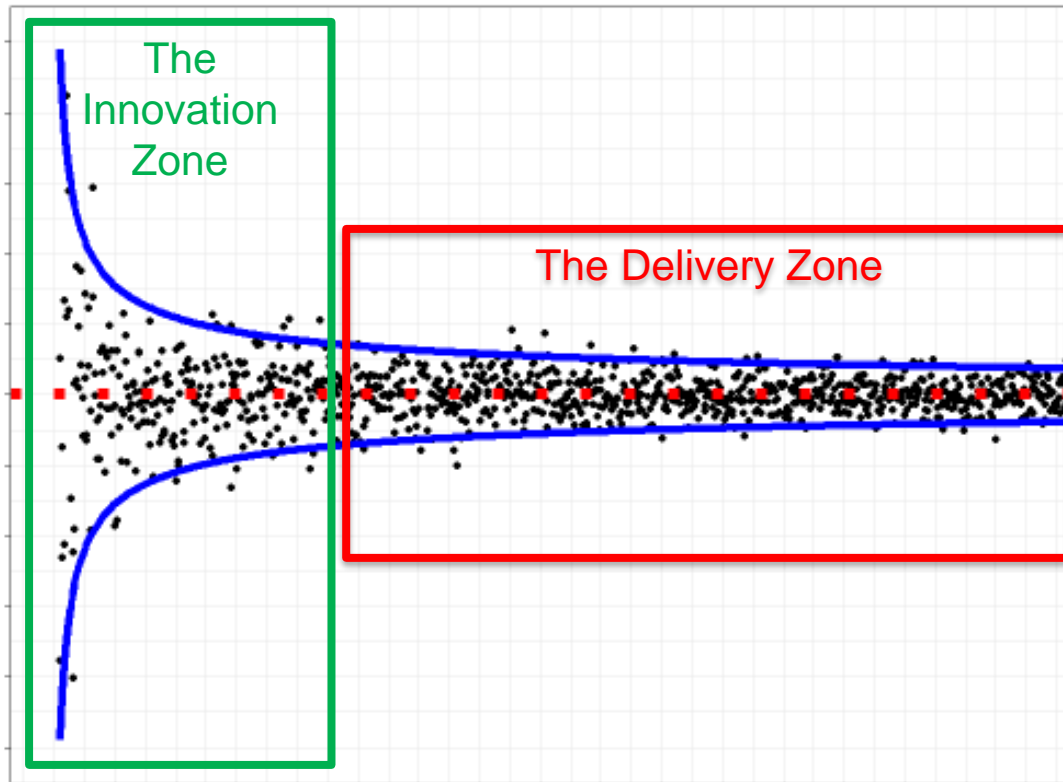


What should be?

The Flow Needs Evidence with the Integrated Set of Needs



The ability to elicit hypotheses and digitally experiment in the mission analysis phase



The acquisition arm on the MoD want reasonably assured Delivery outcomes from a Project or Programme.

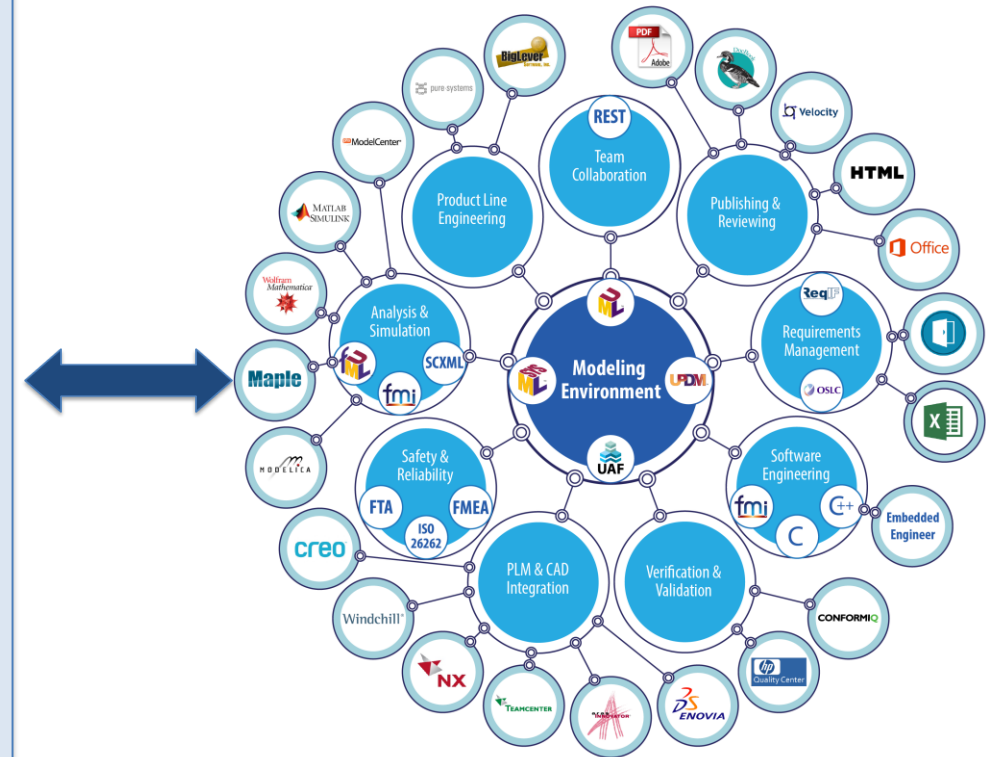
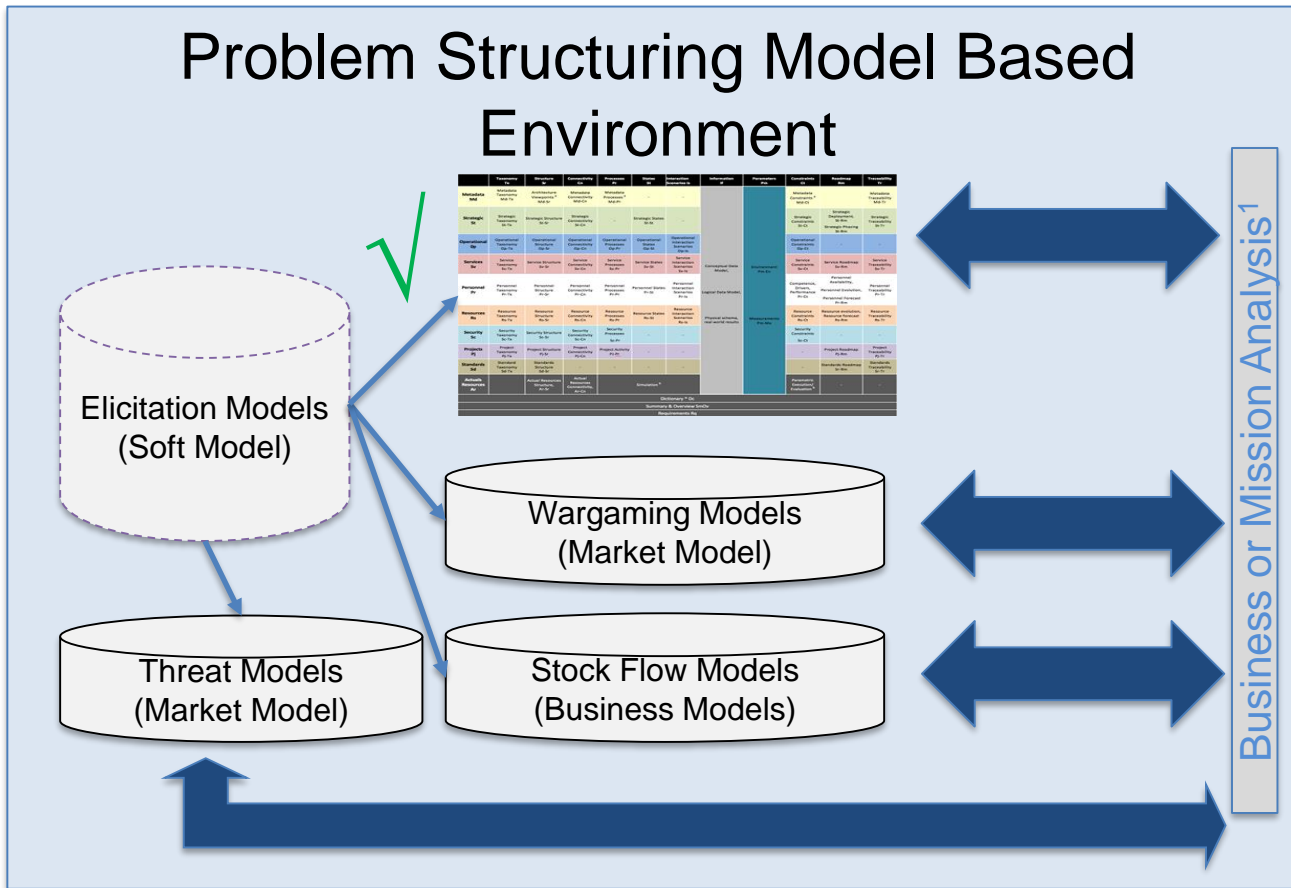
The MoD also need new capabilities and technologies to maintain operational advantage.

To capture new business and drive innovation Leonardo want to be able to capture users hypothesis and conduct experiments in the digital space.

Current vendor offerings do support this work **but** operate within their silos making it difficult to construct the beginnings of the 'digital thread'.

The Desirable Situation

The ability to manage Mission related Information¹ between a notional Problem Structuring Model Based Environment and the downstream MBE Environment.



¹ Things like: *Integrated Set of Needs, Use Case MetaData, Simulation Runs (including Parameters for Measures of Success and Effectiveness plus Utility Curves).*

To conclude ... what do we think we need?

Elicitation Models

- The ability to empower with **non-technical stakeholders** to sketch stakeholders, needs, processes and entities associated with the problem situation.
- The ability to conduct ethnographic surveys with non-technical stakeholders to identify unarticulated needs associated with PESTLE concerns
- The ability to cluster and 'affinitise' stakeholders, needs, processes and entities.
- The ability to take the clusters of stakeholders, needs, processes and entities and develop corresponding **source elements** for future downstream exploitation.
- Where ethical to do so, the ability to answer the Kipling Questions associated with the **source elements**.

Cross Cutting

- The ability to aggregate the model and results into a digital thread with good configuration management
- The ability to execute the modeling in an agile workflow
- The ability to chain together facts to support business cases and establish defensible arguments



To conclude ... what do we think we need?

Enterprise Architecture

- The ability to on-board critical user defined design parameters to represent measure of success and effectiveness
- The ability to on-board critical supplier parameters to represent requisite stock levels and associated rate of consumption and supply.

War Gaming

- The ability to off-board critical user defined design parameters into the model-based systems engineering environment for the parametrisation of those stakeholder needs.
- The ability to transform war gaming outcomes into utility curves for downstream optimisation.
- The ability to ensure traceability to the war gaming simulation sets and, if necessary, re- run the same simulations with further variations

Stock Flow Simulation

- A playbook and/or MBSE Profile to enable stock flow modeling within an MBSE Environment.
- The ability to off-board critical supplier parameters into the model-based systems engineering environment for the parametrisation of stakeholder requirements.
- The ability to transform stock flow simulation outcomes into volumetric supply chain focused requirements
- The ability to ensure traceability to the stock flow models and modeling outcomes and, if necessary, re run the same simulations with further variations

Cross Cutting

- The ability to aggregate the model and results data into a digital thread with good configuration management
- The ability to execute the modeling in an agile workflow
- The ability to chain together facts to support business cases and establish defensible arguments



SUMMARY

The purpose of these slides was to introduce to the MDE Network Community to some of the emerging issues with the Digital Thread.

Leonardo would like the facility to **experiment** with different techniques in the **problem domain** and then take that experimentation data and convert it into useful information within the Model Based Engineering (MBE) environment.



What is the impact?

Problem Definition as a Service



What is the Impact of not having a Problem Structuring Model Based Environment?



The 'energy costs' or working directly with stakeholders

Needs and Requirements are developed independently leading to a loss of information and traceability.

There is a significant 'energy costs' of doing downstream trade-off analysis.

- This cost is set to increase with the increased importance of System of Systems.

The 'energy costs' of feeding back solution specifications to validate architectural solutions in the originating simulations is also high.

Slower turn around times for customer queries.

So why are Leonardo at this Symposium?

After looking at multiple vendor's offerings Leonardo remains unconvinced that there are engineering tooling solutions that assist the user work in at 'fuzzy front end' of the Life Cycle.

We believe there are opportunities to work with Academia and Industry to develop solutions which can support the activities associated with Problems Definition.

- Leonardo would like to initiate a conversation Academia to with a view to establish a Knowledge Transfer Partnership which would assist Leonardo in building its Problem Definition capability
- Leonardo would like to work with Industry to develop Problem Definition solutions, perhaps in conjunction with Knowledge Transfer Partnership, to ensure that developed solutions remain compatible with the more delivery focused and existing Model-based tool chain.



Any Questions?



End Matter

Logos and images used under fair provisions namely criticism, review and reporting of current events

- Share of US Households using specific technologies 1860 to 2019
 - [Distribute the Future - by Tomas Pueyo](#)
- The Digital Diamond is the a Trademark of The Boeing Corporation.
- The ISO15288:2015 processes have been issued by the International Standards Organisation
- The Modelling Environment image comes from No Magic documentation prior to the Dassault Systemes
- The COMMAND PROFESSIONAL EDITION image is from Matrix Games LLC
- The MagicGrid / 15288:2015 overlay image is from Dassault Systemes CATIA
- The Pareto Frontier images is from the following open source paper:
 - [\(PDF\) Budgeted Multi-Objective Optimization with a Focus on the Central Part of the Pareto Front - Extended Version \(researchgate.net\)](#)
- The Impact graphic comes from iStock by Getty Images.



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