International Council on Systems Engineering
A better world through a systems approach

From Systems Engineering to Engineering Systems: The Power of Framing

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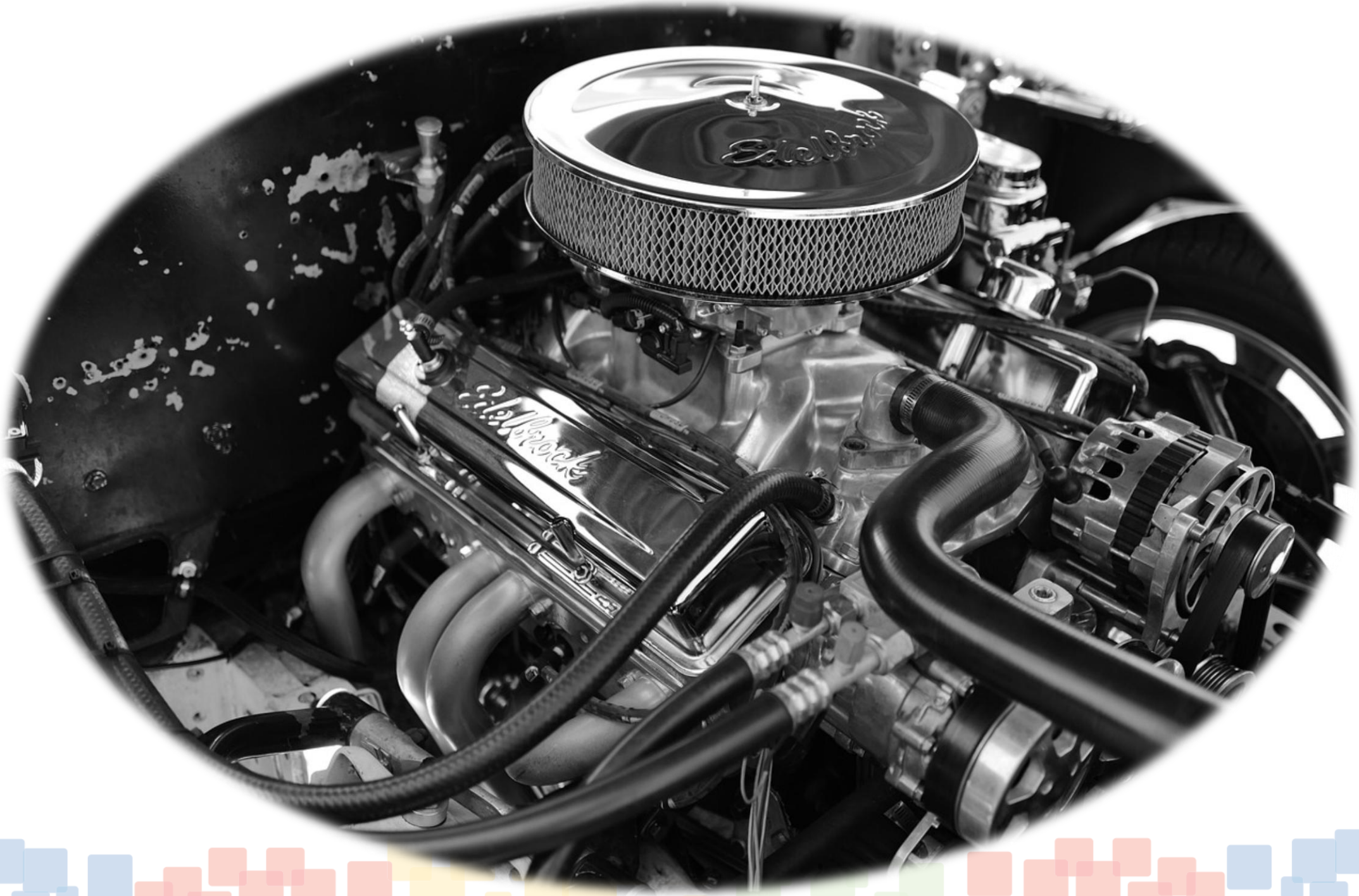
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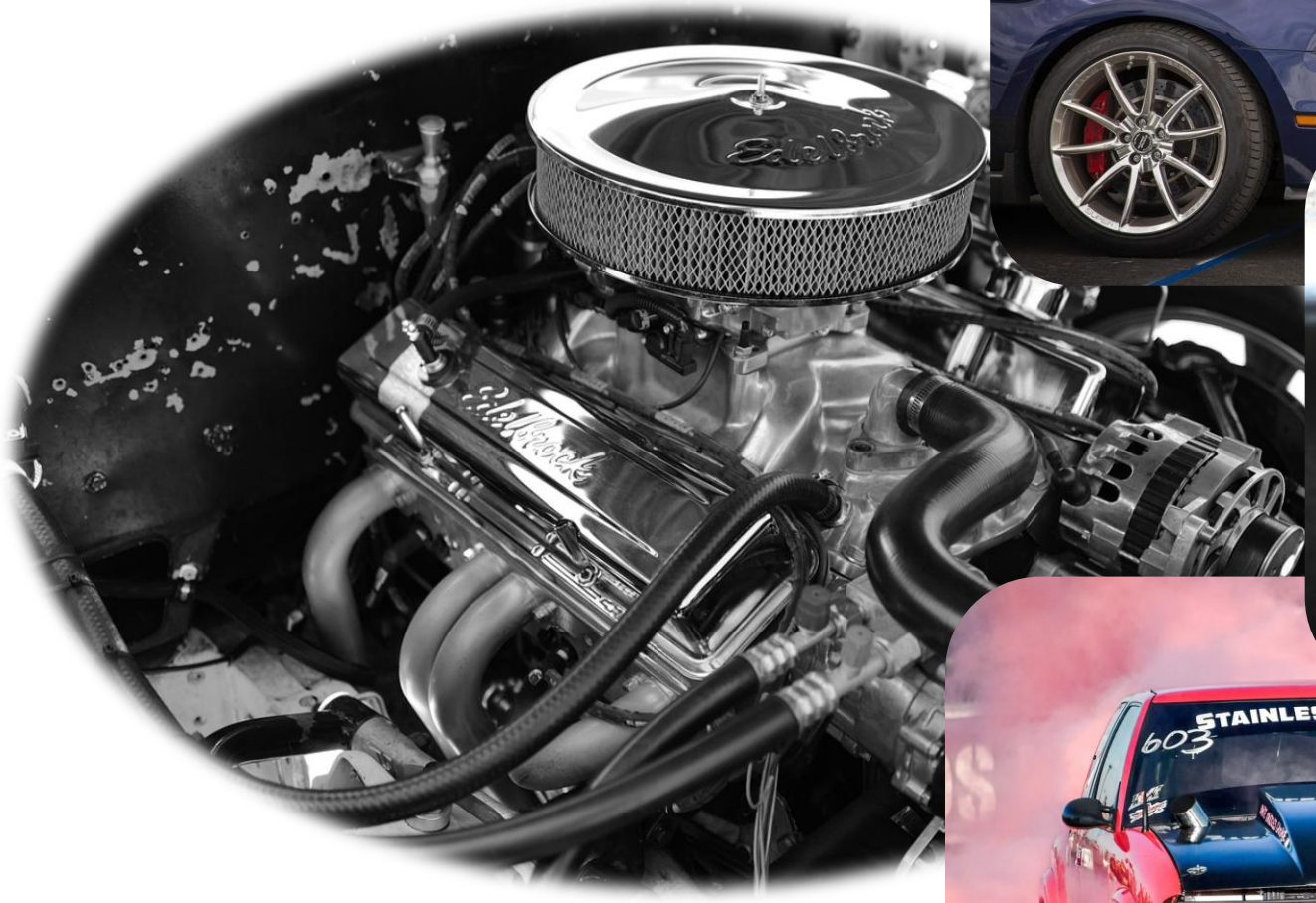



Shell


STAINLESS DIESEL
603

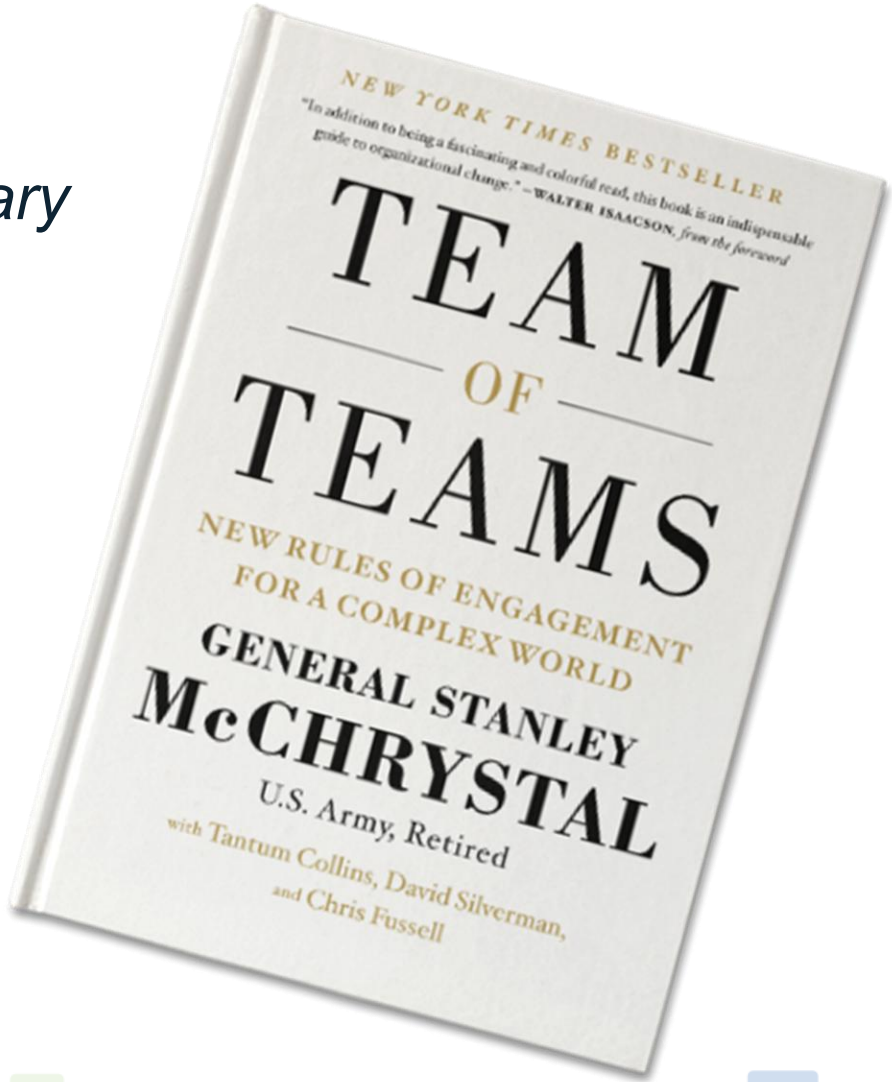
CONTEXT MATTERS

Appreciating the Importance of Context

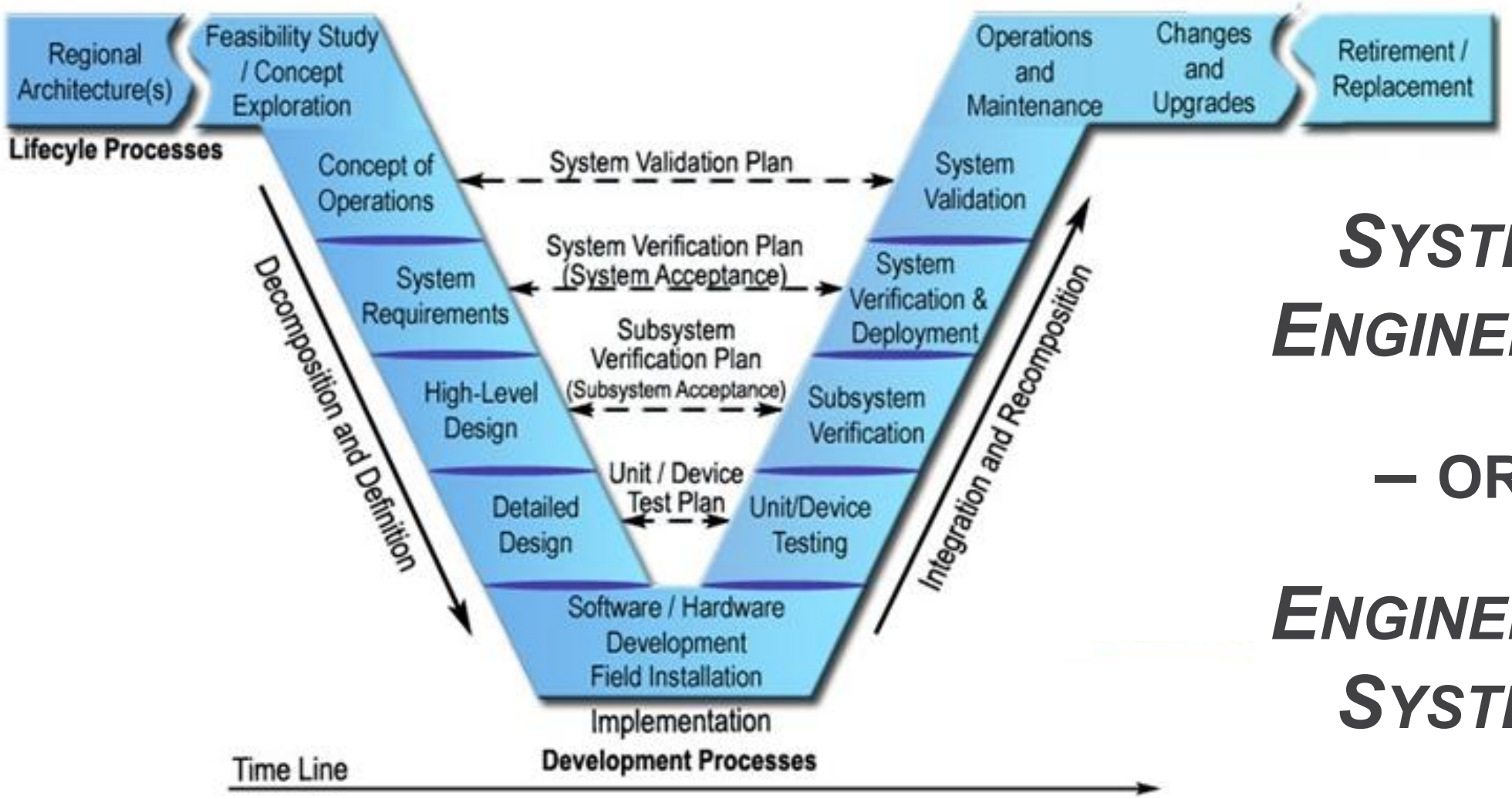
One cannot understand a part of a system without at least a rudimentary understanding of the whole.

Functioning in an interdependent environment requires that every team possess a holistic understanding of the interaction between all the moving parts.

People can only be empowered if they have enough context to make good decisions.



Revisiting the “Beloved” Systems Vee

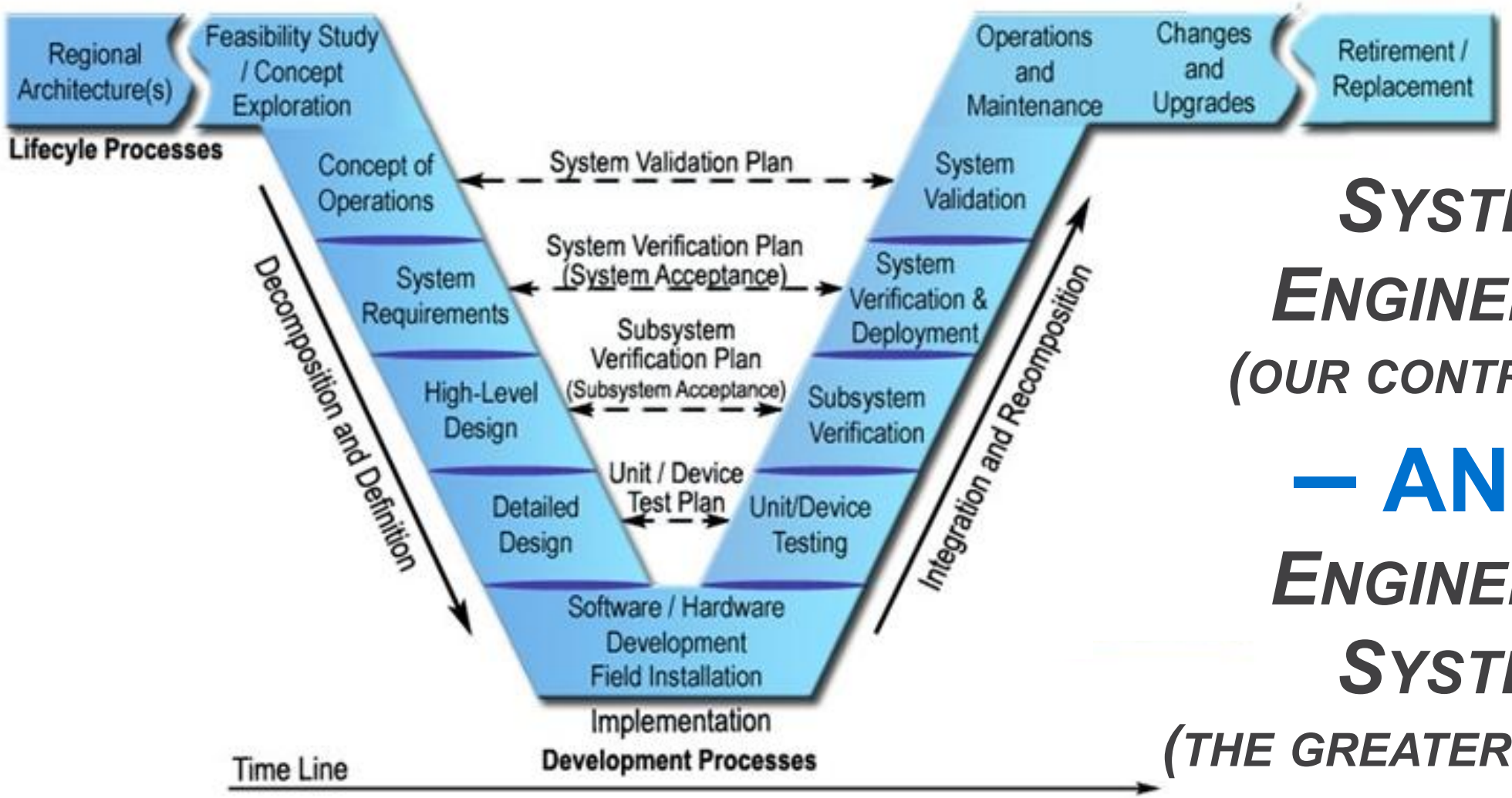


SYSTEMS ENGINEERING

– OR –

ENGINEERING SYSTEMS

Revisiting the “Beloved” Systems Vee



SYSTEMS ENGINEERING

(OUR CONTRIBUTION)

– AND –

ENGINEERING SYSTEMS

(THE GREATER LIFECYCLE)

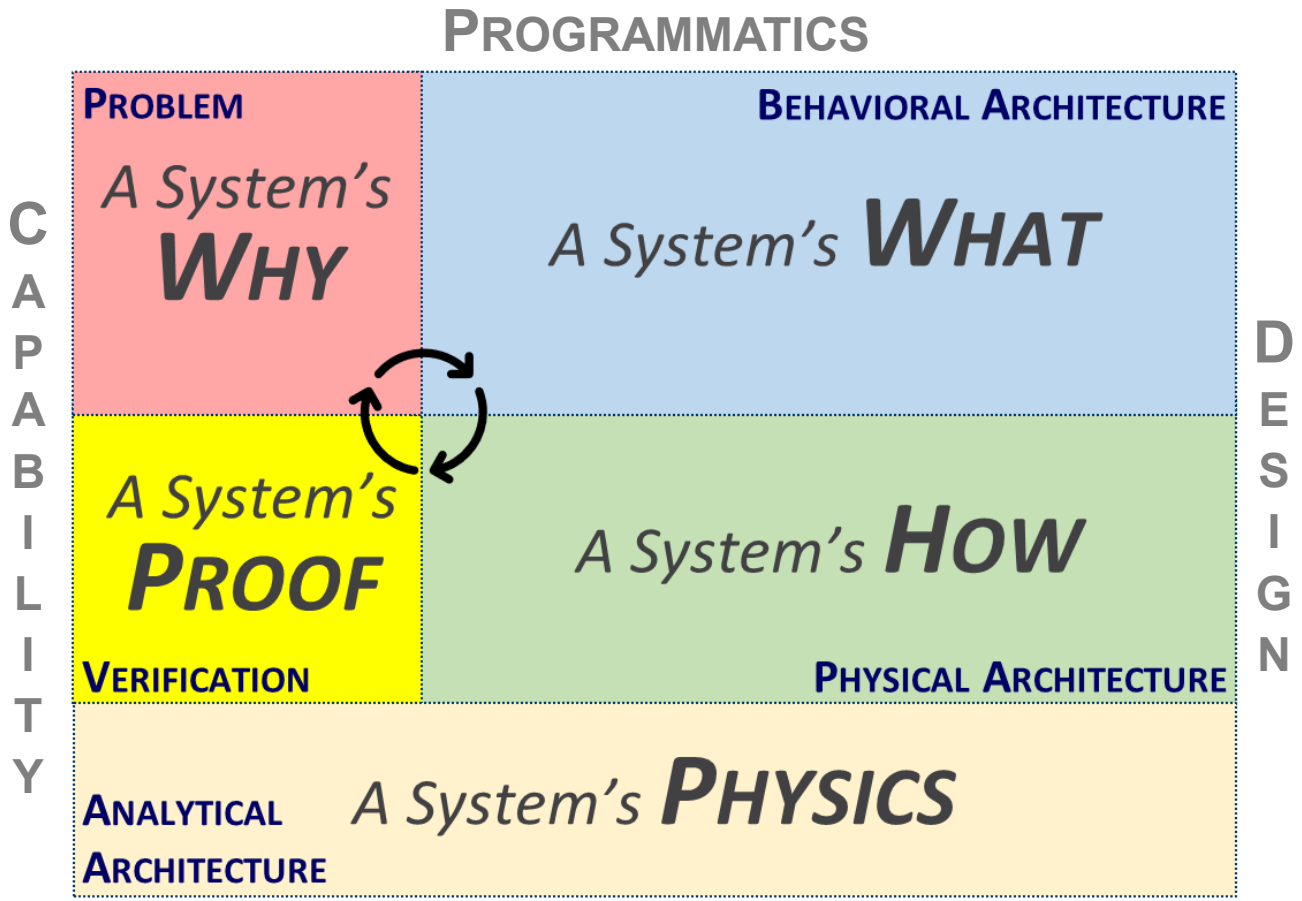
Systems Engineering

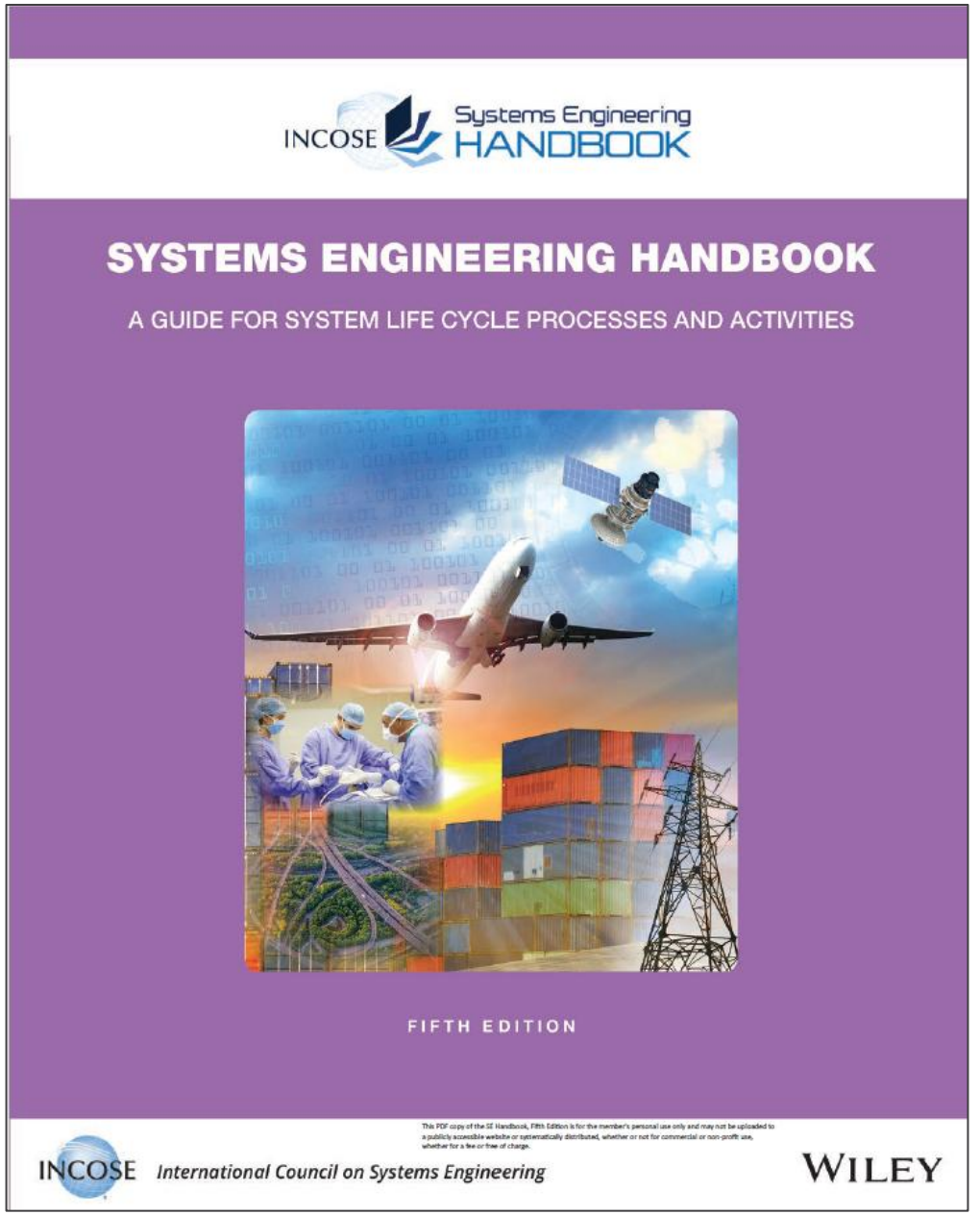
discipline ~~approach~~ Systems Engineering is a transdisciplinary and integrative to enable the successful realization, use, and retirement of engineered systems, using systems principles and concepts, and scientific, technological, and management methods.

INCOSE

Looking Inward

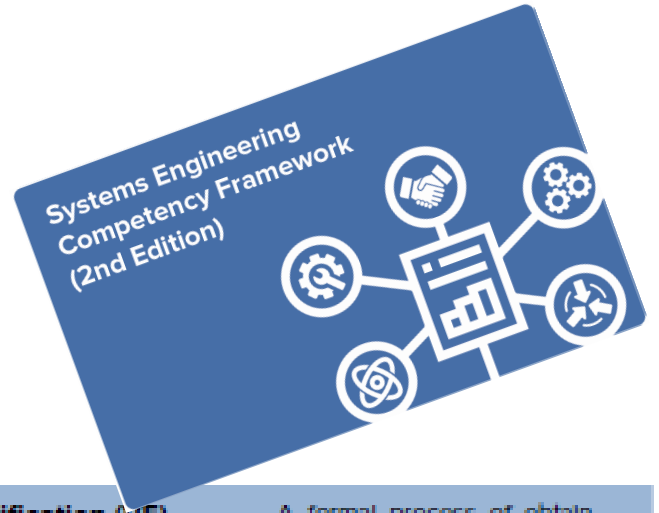
Informing Our Processes, Methods, and Tools





Looking Inward

Advancing Our Core and Technical Competencies



CORE COMPETENCIES

Core competencies underpin engineering as well as systems engineering.

Systems Thinking (ST)	The application of the fundamental concepts of systems thinking to systems engineering;
Life Cycles (LC)	Selection of the appropriate life cycles in the realization of a system;
Capability Engineering (CP)	An appreciation of the role the system of interest plays in the system of which it is a part;
General Engineering (GE)	Foundational concepts in mathematics, science and engineering and their application;
Critical Thinking (CT)	The objective analysis and evaluation of a topic in order to form a judgement;
Systems Modeling and Analysis (SM)	Provision of rigorous data and information including the use of modeling to support technical understanding and decision making.

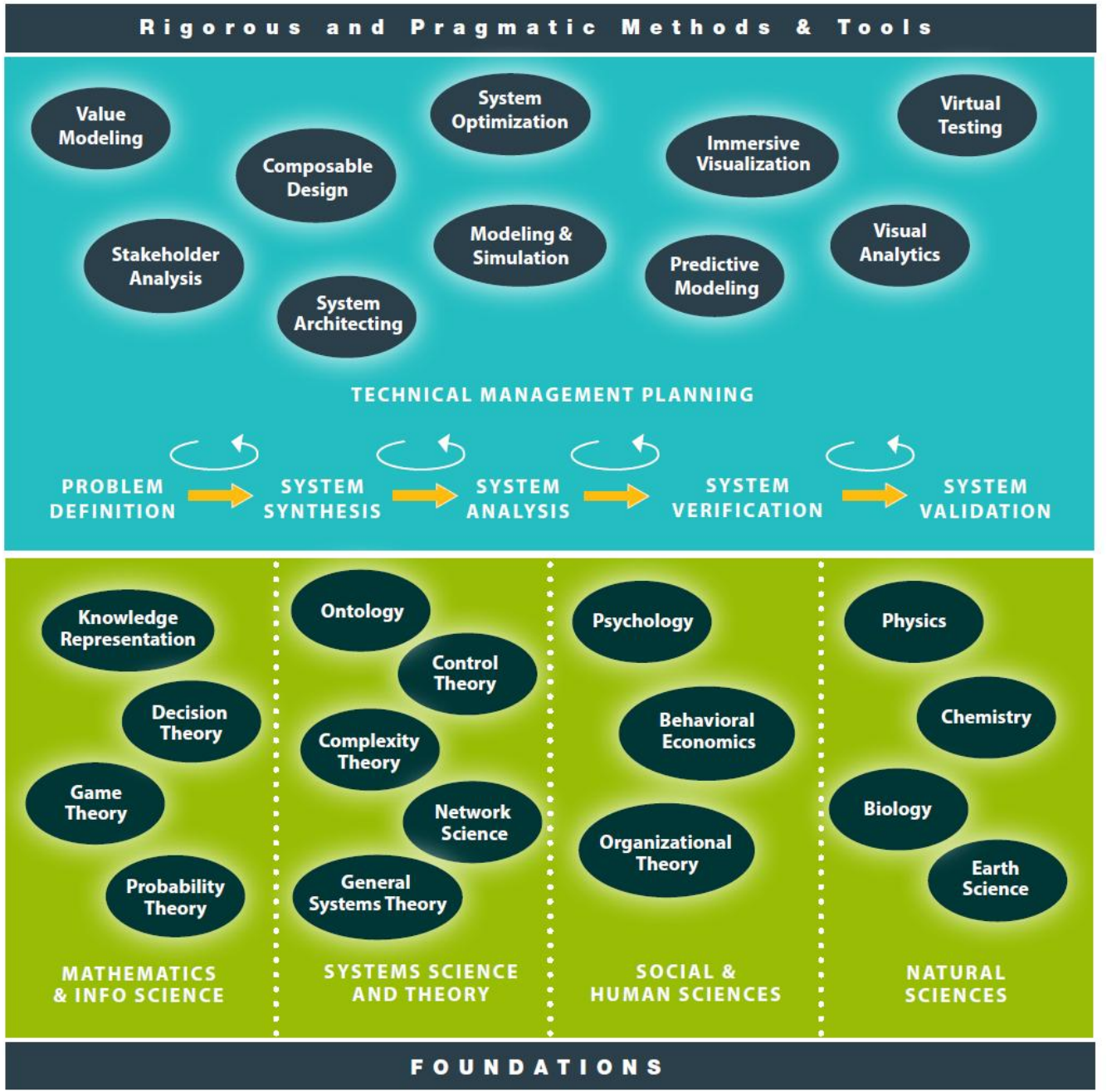
TECHNICAL COMPETENCIES

The ability to perform tasks associated primarily with the suite of Technical Processes identified in the INCOSE SE Handbook.

Requirements Definition (RD)	To analyze the stakeholder needs and expectations to establish the requirements for a system;
System Architecting (SA)	The definition of the system structure, interfaces and associated derived requirements to produce a solution that can be implemented;
Design for... (DF)	Ensuring that the requirements of all life cycle stages are addressed at the correct point in the system design;
Integration (IN)	The logical process for assembling a set of system elements and aggregates into the realized system, product or service;
Interfaces (IF)	The identification, definition and control of interactions across system or system element boundaries;
Verification (VE)	A formal process of obtaining objective evidence that a system fulfils its specified requirements and characteristics;
Validation (VA)	A formal process of obtaining objective evidence that the system achieves its intended use in its intended operational environment;
Transition (TR)	Integration of a verified system into its operational environment including the wider system of which it forms a part;
Utilization and Support (US)	When the system is used to deliver its capabilities and is sustained over its lifetime.
Retirement (RE)	The final stage of a system life cycle, where the existence of a system is ended for a specific use, through controlled activities.

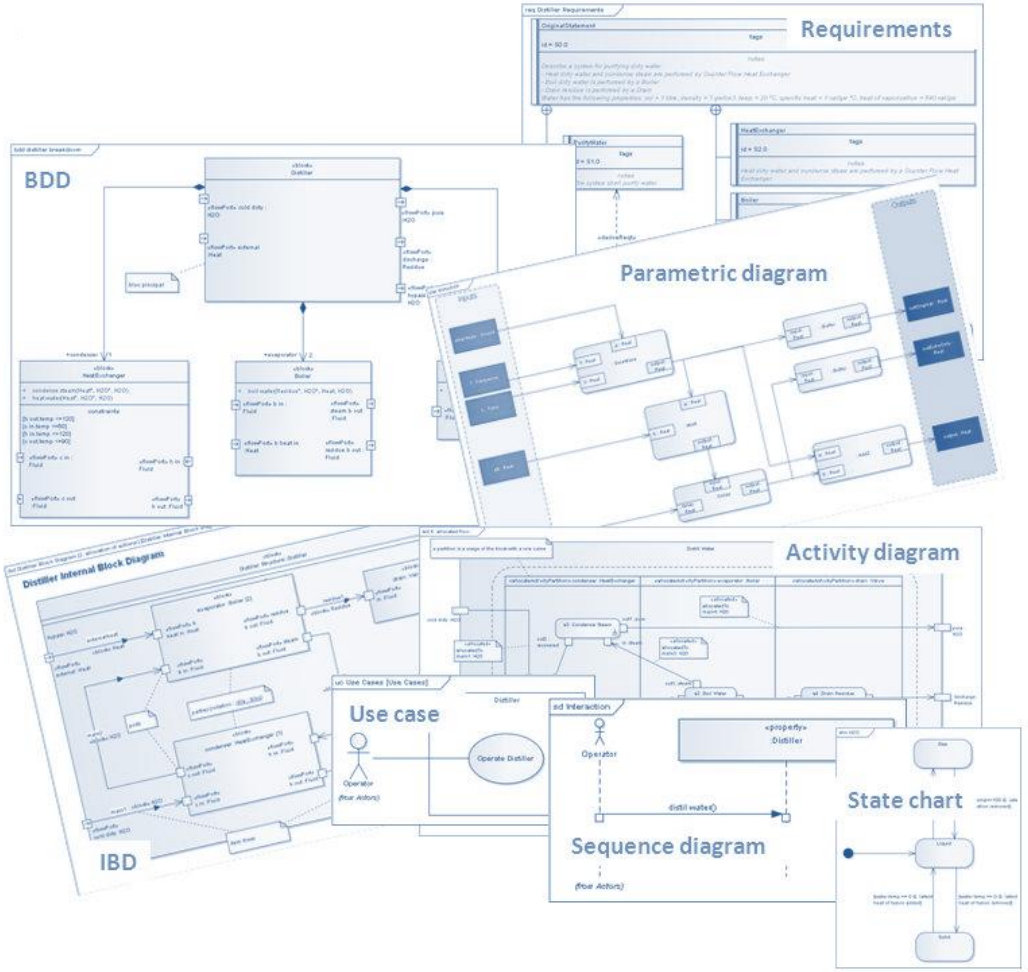
Looking Inward

Solidifying the Foundation



Looking Inward

Digitizing and Digitalizing Our Discipline



Systems Engineering

Systems Engineering is a transdisciplinary and integrative approach to enable the successful realization, use, and retirement of engineered systems, using systems principles and concepts, and scientific, technological, and management methods.

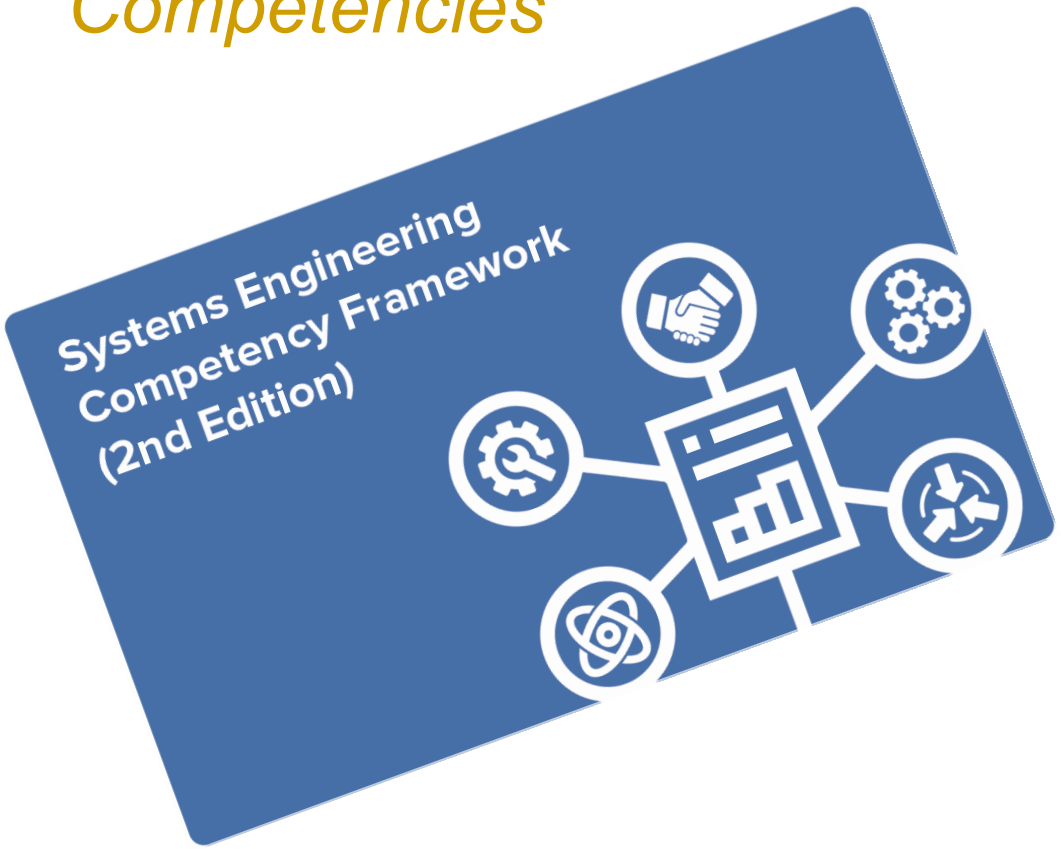
INCOSE

Looking Outward and Upward

Moving from Mono- to Multi- Lingual and Phase across the Lifecycle

Looking Outward and Upward

Advancing Our Greater Competencies



PROFESSIONAL COMPETENCIES

Behavioral competencies well-established within the Human Resources (HR) domain. To facilitate alignment with existing HR frameworks, where practicable, competency definitions have been taken from well-established, internationally recognized definitions rather than partial or complete re-invention by INCOSE.

Communications (CC)	The dynamic process of transmitting or exchanging information;
Ethics and Professionalism (EP)	The personal, organizational, and corporate standards of behavior expected of systems engineers;
Technical Leadership (TL)	The application of technical knowledge and experience in systems engineering together with appropriate professional competencies;
Negotiation (NE)	Dialogue between two or more parties intended to reach a beneficial outcome where difference exist between them;
Team Dynamics (TD)	The unconscious, psychological forces that influence the direction of a team's behavior and performance;
Facilitation (FA)	The act of helping others to deal with a process, solve a problem, or reach a goal without getting directly getting involved;
Emotional Intelligence (EI)	The ability to monitor one's own and others' feelings and use this information to guide thinking and action;
Coaching and Mentoring (ME)	Development approaches based on the use of one-to-one conversations to enhance an individual's skills, knowledge or work performance.

MANAGEMENT COMPETENCIES

The ability to perform tasks associated with controlling and managing Systems Engineering activities. This includes tasks associated with the Management Processes identified in the INCOSE SE Handbook.

Planning (PL)	Producing, coordinating and maintaining effective and workable plans across multiple disciplines;
Monitoring and Control (MC)	Assessment of an ongoing project to see if the current plans are aligned and feasible;
Decision Management (DM)	The structured, analytical framework for objectively identifying, characterizing and evaluating a set of alternatives;
Concurrent Engineering (CE)	A work methodology based on the parallelization of tasks;
Business and Enterprise Integration (BE)	The consideration of needs and requirements of other internal stakeholders as part of the system development;
Acquisition and Supply (AS)	Obtaining or providing a product or service in accordance with requirements;
Information Management (IM)	Addresses activities associated with all aspects of information, to provide designated stakeholders with appropriate levels of timeliness, accuracy and security;
Configuration Management (CM)	Ensuring the overall coherence of system functional, performance and physical characteristics throughout its life cycle;
Risk and Opportunity Management (RO)	The identification and reduction in the probability of uncertain events, or maximizing the potential of opportunities provided by them,

Looking Outward and Upward

Embracing the Paradoxical Mindset

SYSTEMS ENGINEERING Research Center

HELIX

Important Characteristics of Effective Systems Engineers

1. **Paradoxical Mindset**
   - Big Picture Thinking *and* Attention to Detail
   - Strategic *and* Tactical
   - Analytic *and* Synthetic
   - Courageous *and* Humble
   - Methodical *and* Creative

2. **Effective Communication**
   - Modes *(oral and written; good speakers and listeners)*
   - Audience *(bridge between problem domain and solution domain)*
   - Content *(social, managerial, technical)*
   - Purpose *(understanding needs, negotiation, information brokering, technical arbitration, driving consensus)*

3. **Flexible Comfort Zone**
   - Open Minded
   - Rational Risk Taking
   - Multidisciplinary
   - Enjoys Challenges

4. **Smart Leadership**
   - Quick Learning and Abstraction
   - Knowing when to stop
   - Focused on 'Vision' for System
   - Ability to Connect the Dots
   - Patience

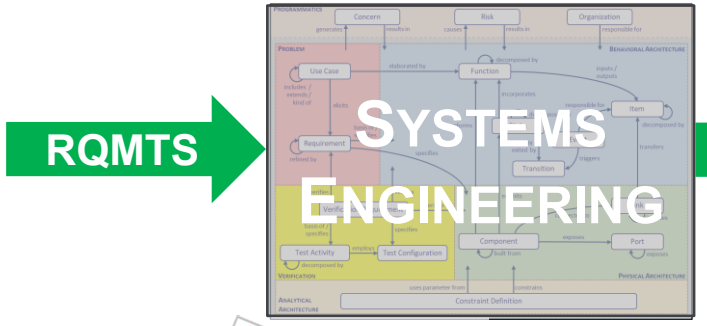
5. **Self Starter**
   - Curiosity
   - Passionate and Motivated
   - Eager to Learn

Helix Workshop, Washington DC July 23, 2014 18

Helix Credit: Art Pyster, Deva Henry, Nicole Hutchison. Steven Institute of Technology, 2014

Looking Outward and Upward

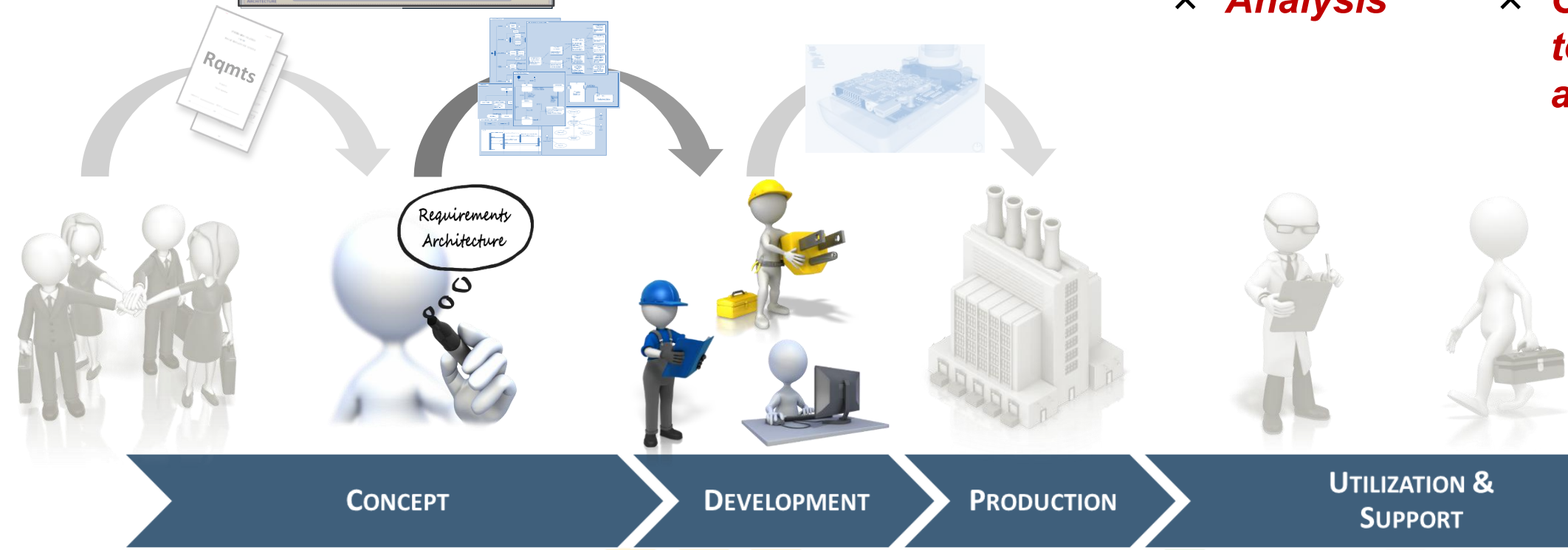
Keeping the Black Box Opaque



- ✓ ***Design envelope***
- ✓ ***Interfaces***
- ✓ ***Role***

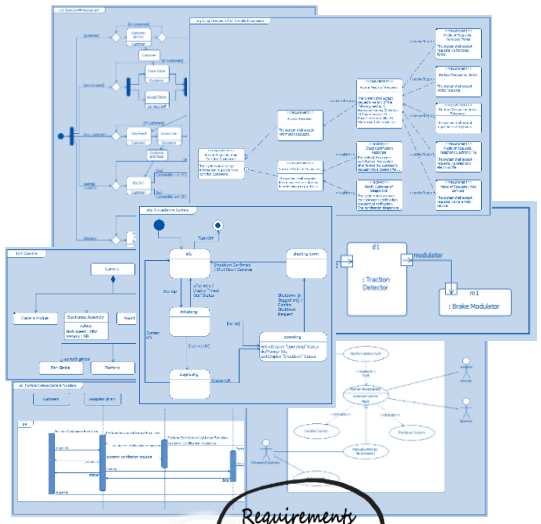
- × ***Traceability***
- × ***Abstractions***
- × ***Alternatives***
- × ***Analysis***

- × ***Risks***
- × ***Concerns***
- × ***Design journey***
- × ***Other SE tools, techniques, and details***

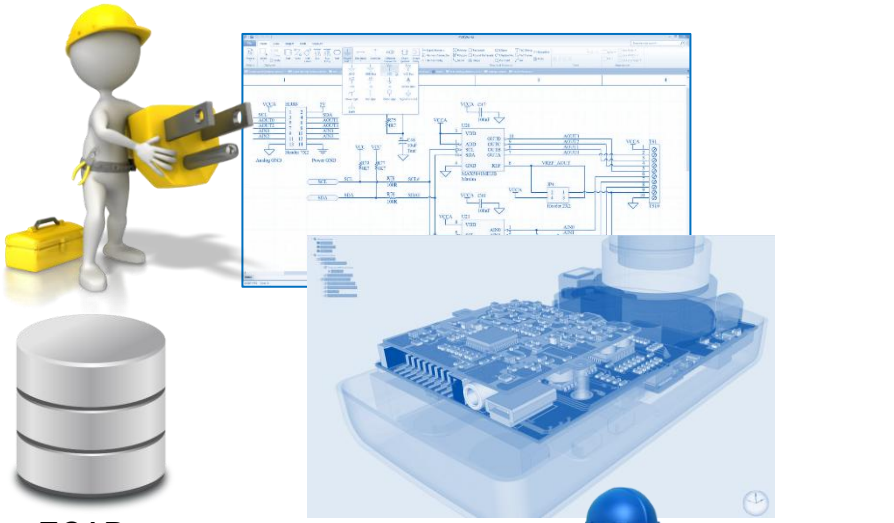


Looking Outward and Upward

Avoiding the Trap of Silos of Excellence



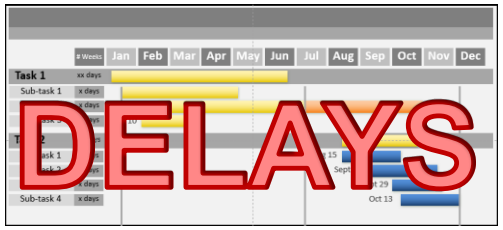
MBSE



ECAD

ALM

MCAD



CONCEPT | DEVELOPMENT | PRODUCTION

Looking Outward and Upward

Connecting the Engineering Lifecycle

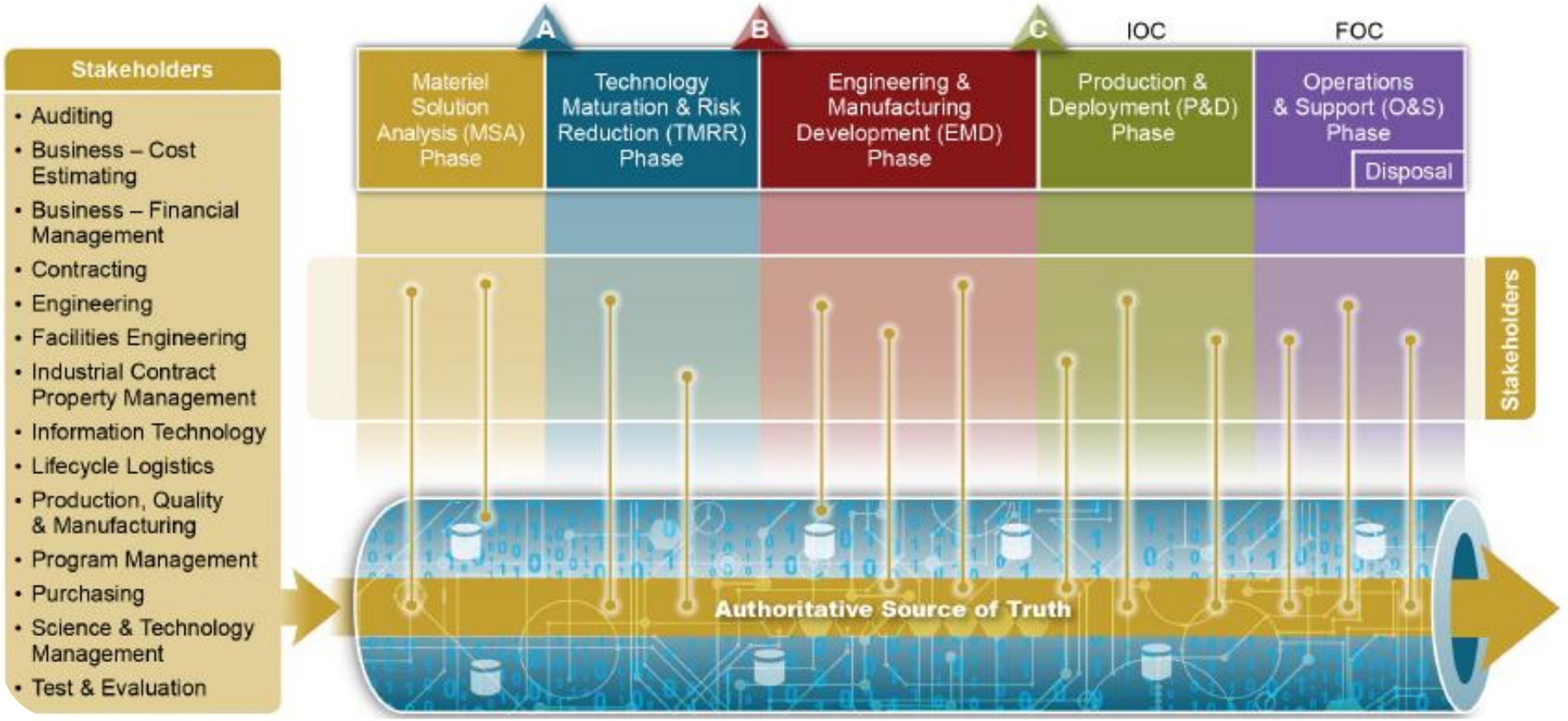


Image Credit: US Department of Defense, 2018

An integrated approach using authoritative data and models as a continuum across disciplines and across the lifecycle

Department of Defense
Digital Engineering Strategy

Looking Outward and Upward

Transforming the Engineering Lifecycle through Digital Engineering

Digital Engineering *a critical enabler for the modern engineering enterprise*

MBSE

connective tissue of the Digital Engineering environment

Systems Engineering

technical connective tissue of the project team

Data

oxygen fueling 21st century engineering and operations

Looking Outward and Upward

Positioning not as the Watchmaker but as the Beekeeper

Be bright

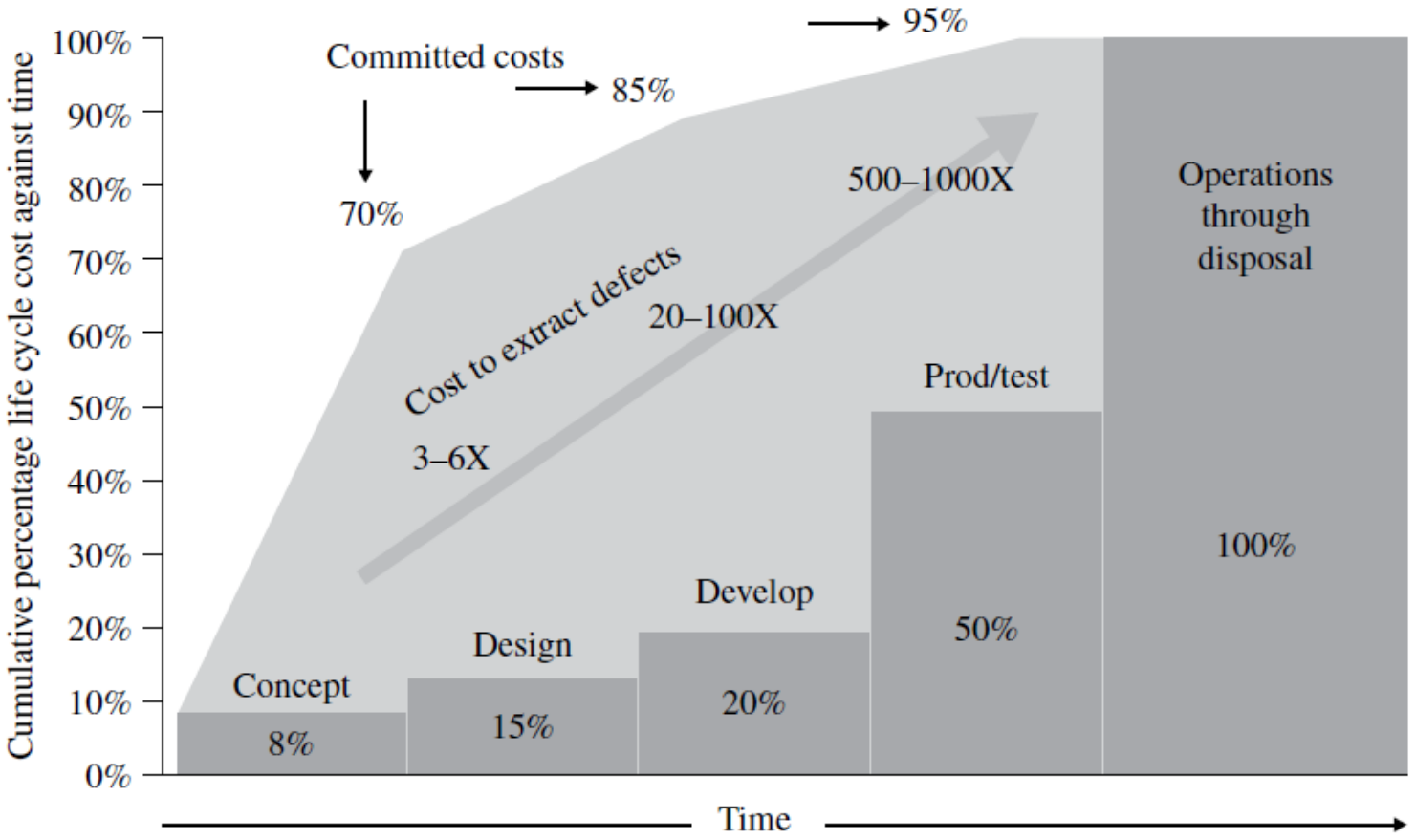
Be brief

Be gone!

3 Bs credit David Walden, Sysnovation

Looking Outward and Upward

Focusing on the Business Value of Systems Engineering

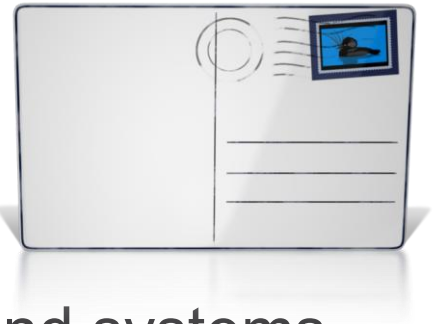


- ✓ *Understanding the problem*
- ✓ *Integrating the team*
- ✓ *Defining the seams*
- ✓ *Addressing the gaps*
- ✓ *Guarding the why*

Credit: Defense Acquisition University

Looking Outward and Upward

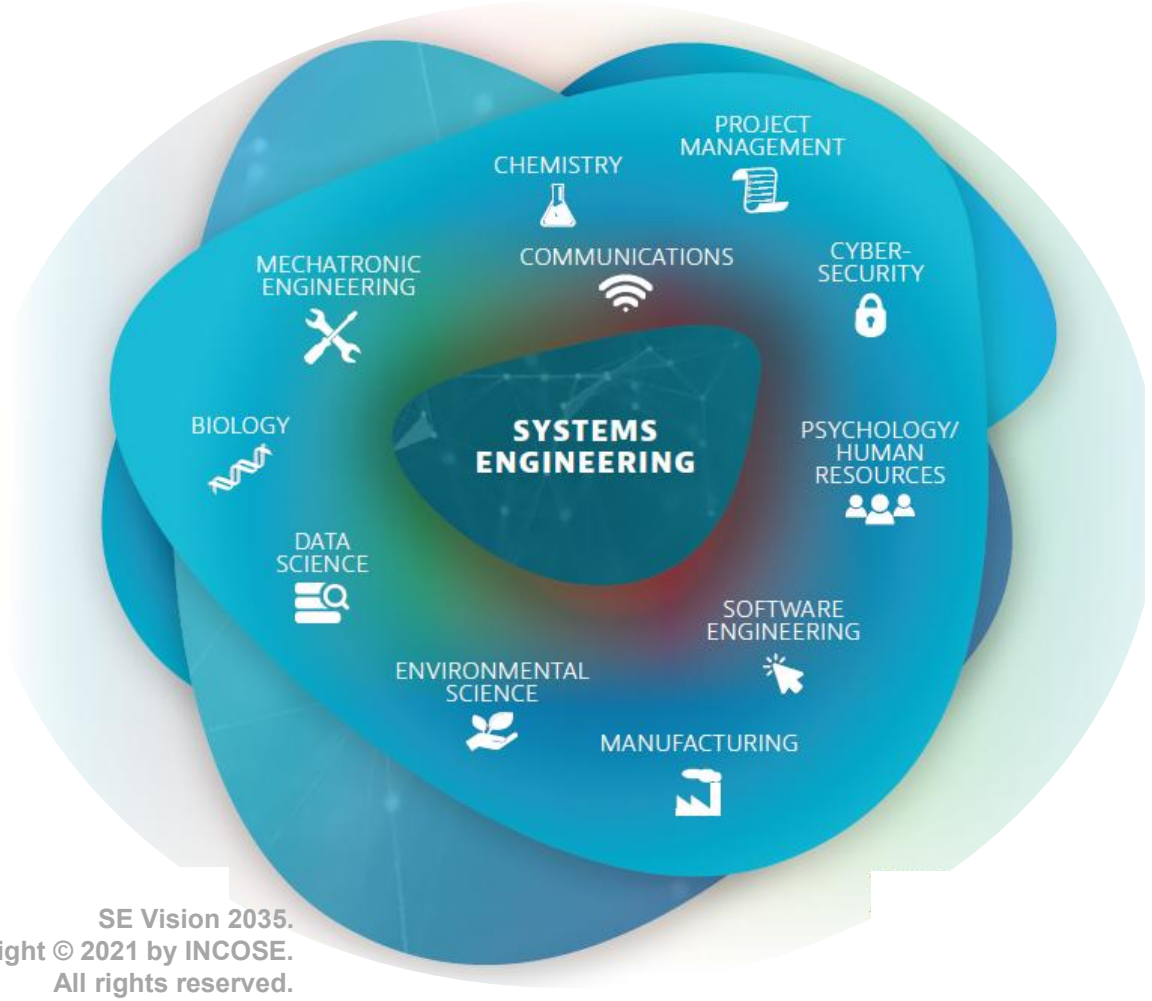
Informing and Influencing in Context



- The product **seamlessly** integrates into the customer's workflow and systems, **reliably** meets all their needs, and **delights** the customer
- The key performance parameters ensure **robust** delivery of clear **market differentiation**
- Technical scope/program **work is clearly tied to market impact**
- Technical **risks** are **retired early and robustly**
- **Creative ideas** come from everyone, and designs are **optimized across organizational boundaries**
- Design **decisions** are clearly identified and closed in a timely fashion (and **stay closed**)
- Designs **integrate easily**
- Quality problems (when they exist) are **found and resolved early** and few design issues escape to the field
- Institutional **knowledge is available to everyone** when and how they need it

Adapted from Chris Unger, GE Healthcare, 2014

Leveraging Our Frames, Embracing Our Responsibility



Systems Engineering
– AND –
Engineering Systems

Embracing system, lifecycle, enterprise and society

Optimizing systems engineering by suboptimizing systems engineering

Questions and Discussion

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35th Annual INCOSE international symposium

hybrid event

Ottawa, Canada

July 26 - 31, 2025