

**Paper #94 The Systems Engineering Conundrum: Where is the Engineering?**

INCOSE IS 2021

Session 8.4.3

July 21, 2021 2:40 PM EDT

Presenter Charles Wasson – SE Textbook Author, INCOSE Fellow and ESEP



**31<sup>st</sup>** Annual **INCOSE**  
international symposium

virtual event

July 17 - 22, 2021

**Charles Wasson,**

SE Textbook Author, INCOSE Fellow and ESEP

Wasson Strategics, LLC

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# **The Systems Engineering Conundrum: Where is the Engineering?**

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**The Systems Engineering Conundrum - Where is the Engineering?**

## **Problem Statement**

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**“Where is the Engineering?” ... Problem Statement**

- Despite “Engineering” being a key part of its name, “Systems Engineering” command media\*, in general, exhibit:
  - A plethora of objective evidence on Systems Management and Processes.
  - Only inferences ... of a complete set of science and math-based concepts, principles, and practices unique to SE that guide its application.

\* Industry, government, and professional organizations.

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**The Systems Engineering Conundrum - Where is the Engineering?****Presentation Overview**

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**Presentation Overview**

- **Introduction**
  - SE's Technical Competency Void
  - Evolution of the Systems Management
- **Misinformation and Misconceptions of SE Practice**
  - The Systems Engineering Process
  - Model-Based Systems Engineering (MBSE)
- **Where is the Engineering? INCOSE's Vision**
  - What Business is INCOSE In?
- **Summary**
- **Chat Q&A's**

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**The Systems Engineering Conundrum - Where is the Engineering?****Introduction – SE's Technical Competency Void**

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### Previous Papers Contributing to this Topic

**IS 2018**  
Paper #153

**SE Management is Not SE Core Competency:  
Time to Shift this Outdated, 60-Year-Old Paradigm**

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**28<sup>th</sup> Annual INCOSE International Symposium**  
Washington, DC, USA  
July 7 - 12, 2018

**IS 2019**  
Paper #84

**The State of Systems Engineering Technical Practice  
versus Discipline: A Survey of INCOSE Chapter  
Attendees in North America**

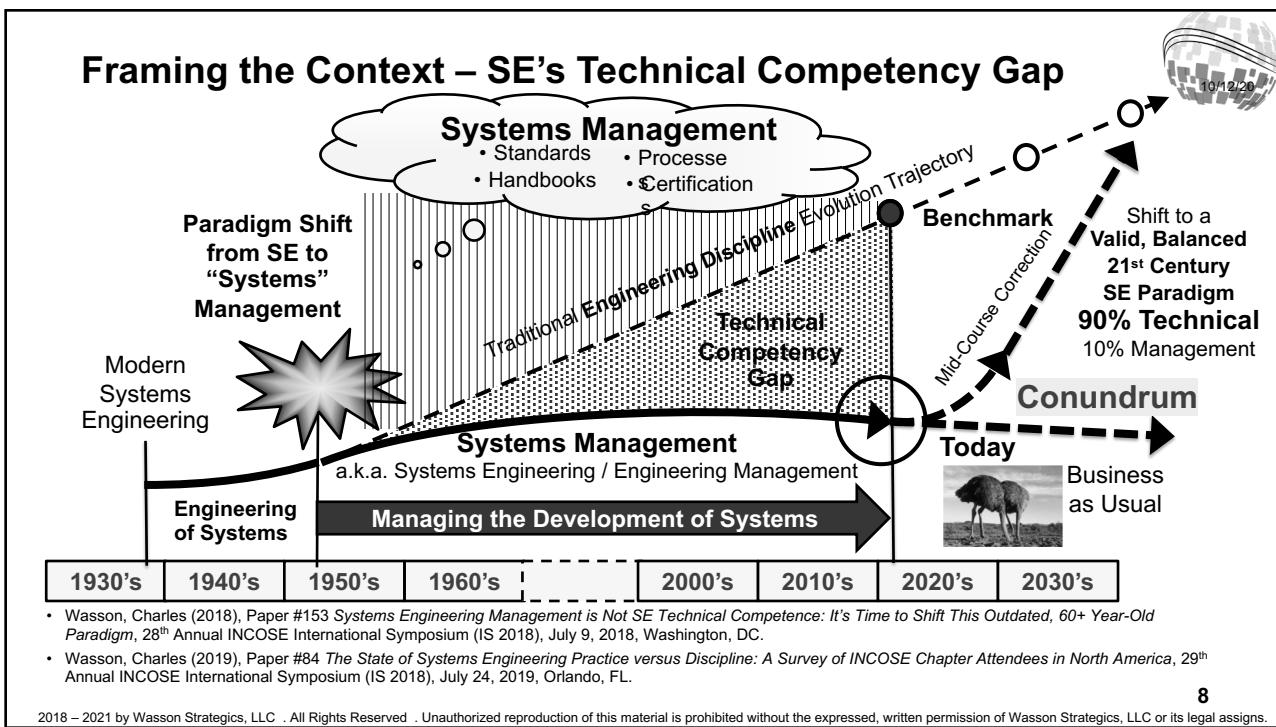
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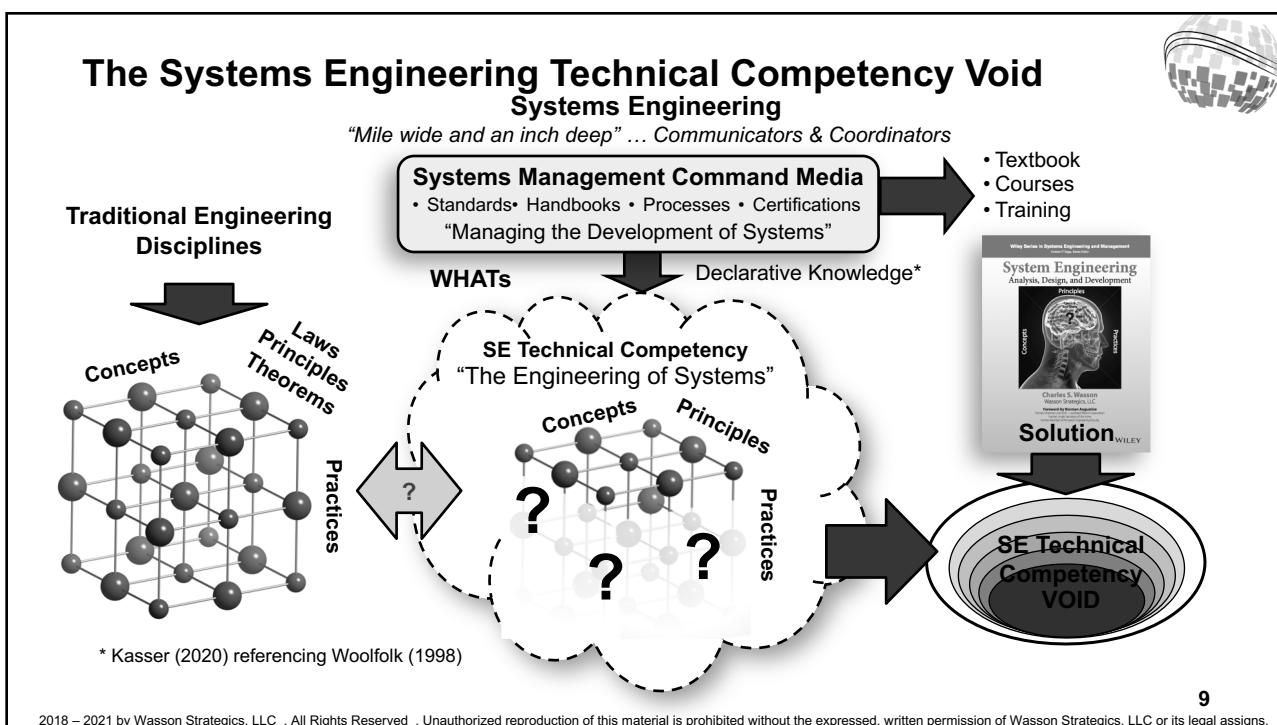
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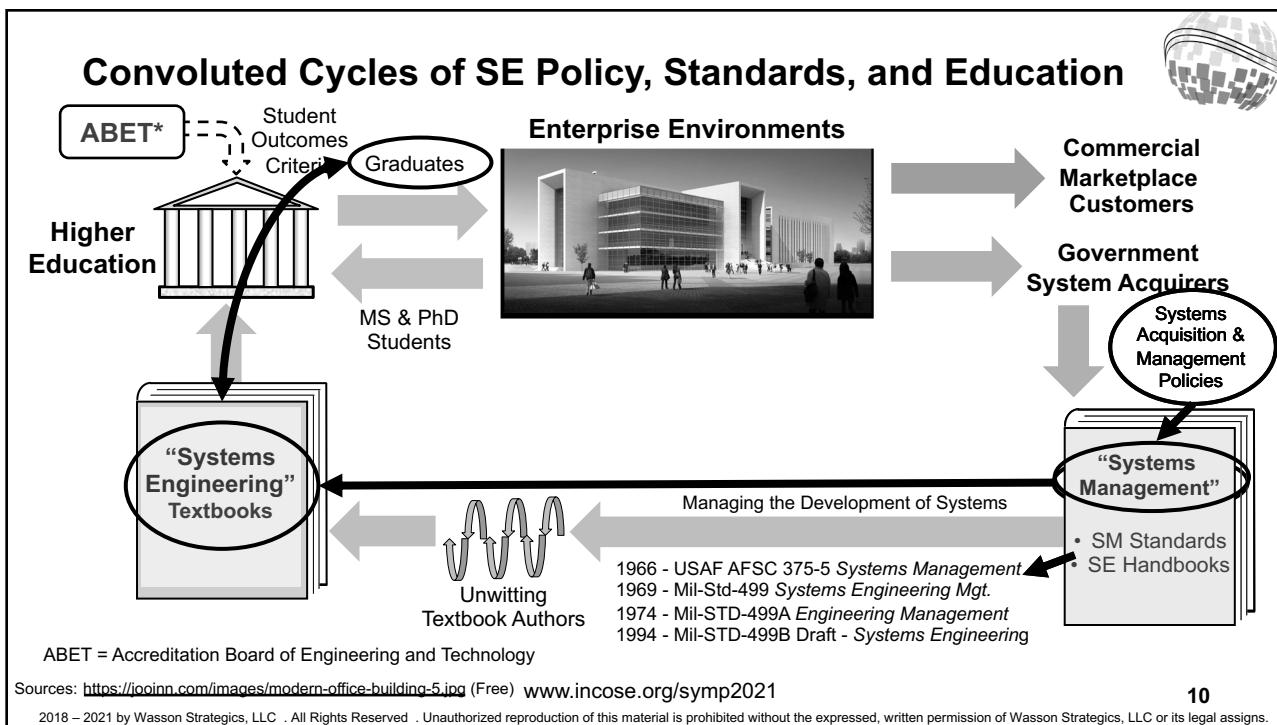
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### Root Problem in SE Education ... Lack of ABET SE Criteria

As of 2021  
No changes on this page since at least the 2012-2013 Academic Year Edition  
*2020-2021 Criteria for Accrediting Engineering Programs*

**PROGRAM CRITERIA FOR SYSTEMS AND SIMILARLY NAMED ENGINEERING PROGRAMS**  
Co-Lead Societies: American Society of Mechanical Engineers, CSAB, Institute of Electrical and Electronics Engineers, Institute of Industrial and Systems Engineers, ISA, International Council on Systems Engineering, or SAE International

Engineering

These program criteria apply to engineering programs that include "systems (without other modifiers)" in their title.

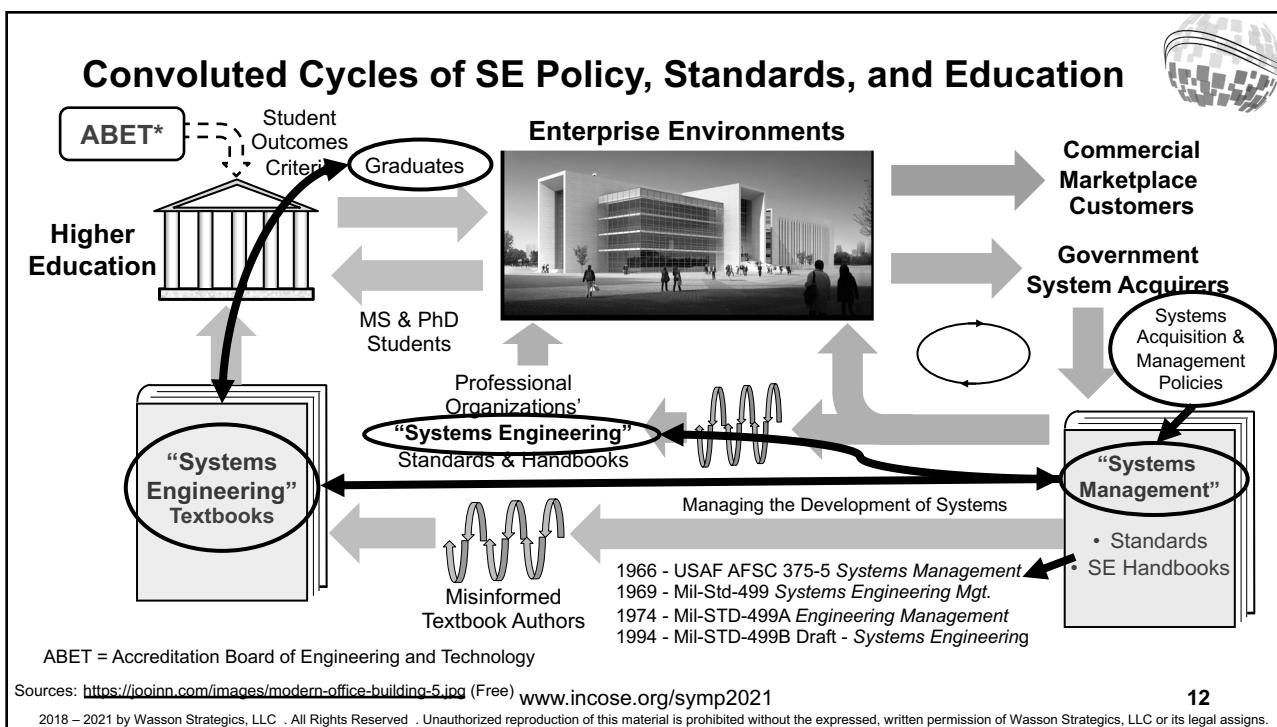
There are no program- specific criteria beyond the General Criteria.

Sources:

- ABET (2020), *Criteria for Accrediting Engineering Programs*, 2020 – 2021, Section III, p. 38, 11/2/19, Baltimore, MD: Accreditation Engineering Commission, ABET.
- Email correspondence with ABET dated March 25, 2021.

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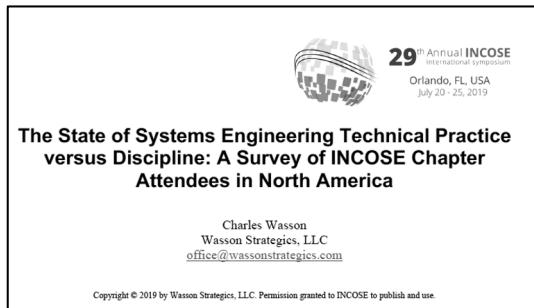
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### 2017 – 2018 SE Competency Survey

#### 2017 – 2018 SE Survey\*

INCOSE

#### SE Competency Framework



Level 5 Expert	
Level 4 Lead Practitioner	
Level 3 Practitioner	
Level 2 Supervised Practitioner	
Level 1 Awareness	

Minimum Technical  
Competency Threshold for  
a Genuine SE

1.90 Average INCOSE SE  
Chapter Attendee  
Competency Level

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### The Systems Engineering Conundrum - Where is the Engineering?

### Misinformation and Misconceptions of SE Practice

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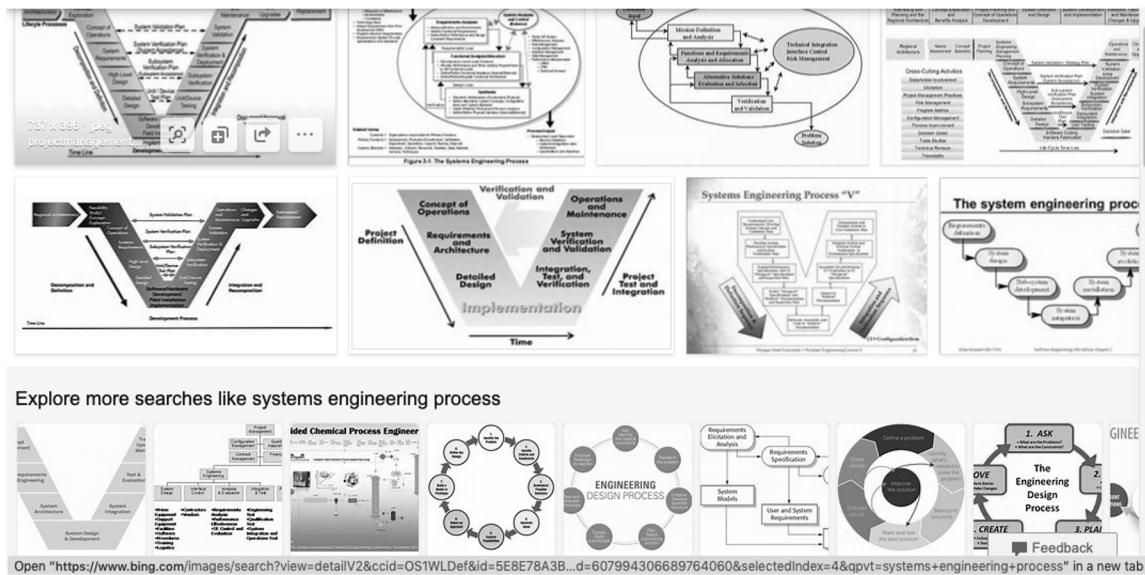
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## The V-Model is Not THE Systems Engineering Process



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## The V-Model IS NOT the SE Process

### Forsberg and Mooz “Project Cycle” (1991)

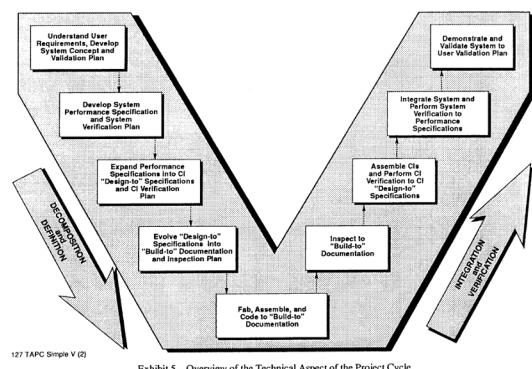
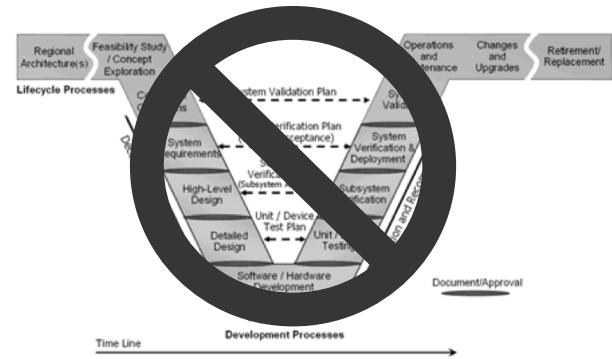


Exhibit 5—Overview of the Technical Aspect of the Project Cycle

## Overview of the Systems Engineering Process



## The V-Model:

- **IS NOT** the Systems Engineering Process
- Actually a Project Level System Development Process, one of several PROJECT system development process models.
- Was referred to as the PROJECT CYCLE by Forsberg and Mooz, the originators in 1991!!

Forsberg, Kevin, and Mooz, Hal; (1991), *The Relationship of Systems Engineering to the Project Cycle*, Figure 5, p. 60, 1st INCOSE Symposium: Chattanooga, TN: In

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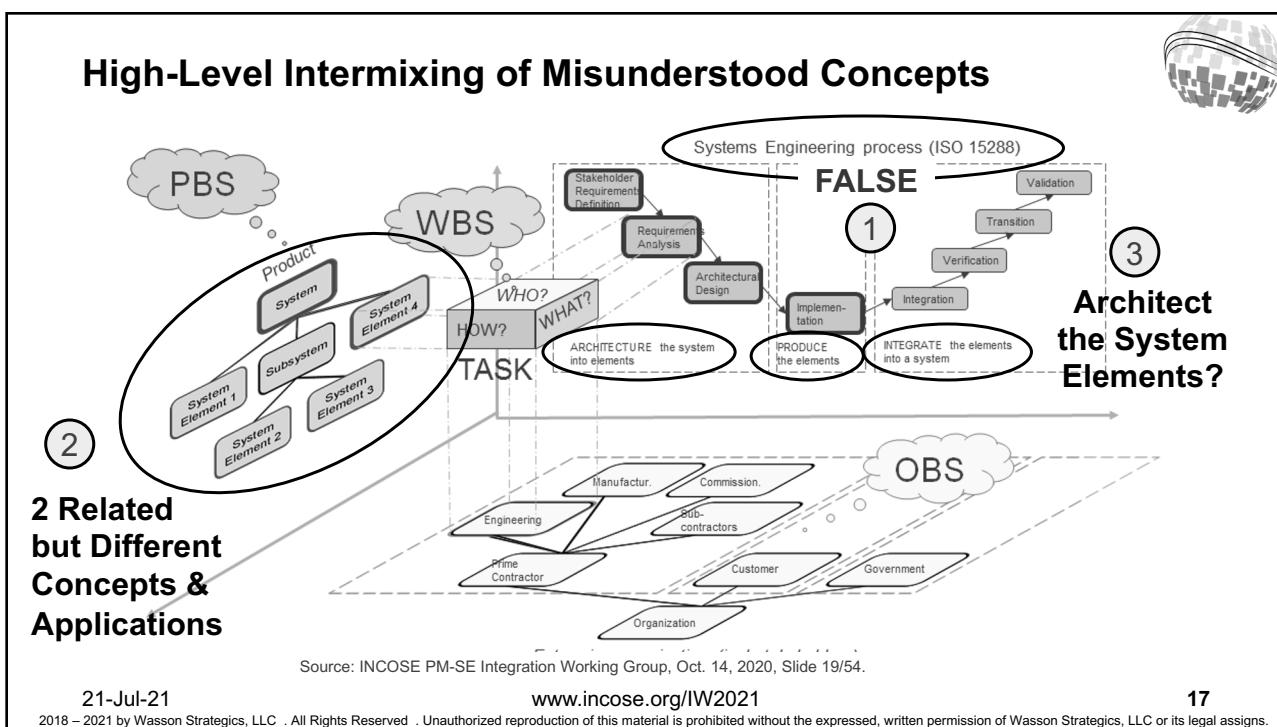
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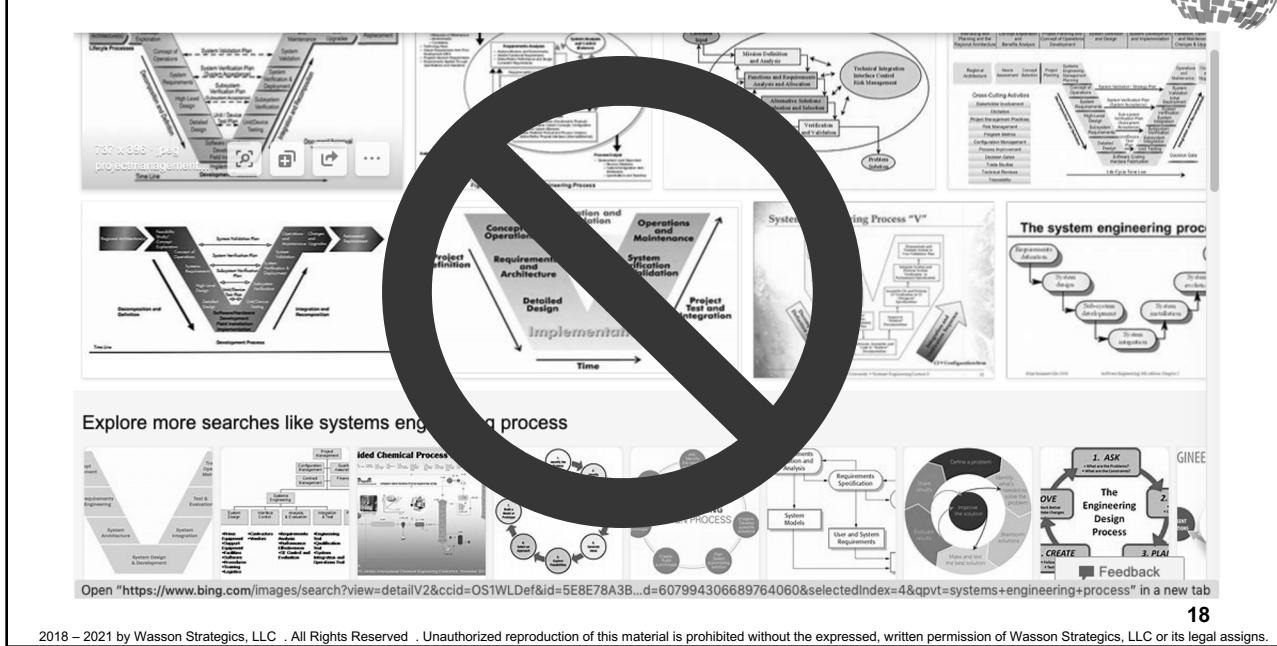
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## Internet Misinformation About THE Real SE Process



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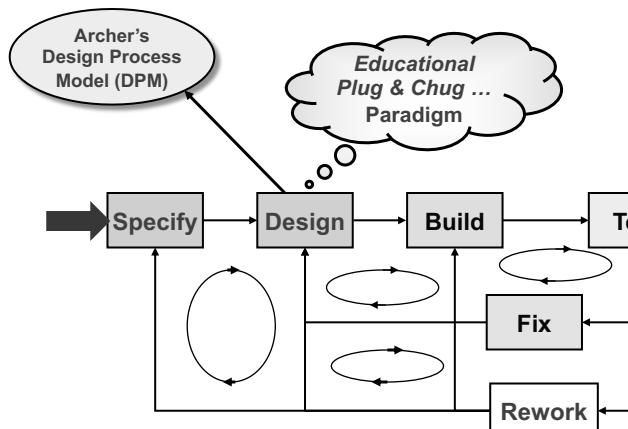
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### SDBTF Paradigm Misperceived to be the SE Process



**SDBTF – Specify-Design-Build-Test-Fix Engineering Paradigm**

- Commonly found in most enterprises claiming to perform SE.
- Derivative of the Scientific Method intended for scientific inquiries or investigations, ... not SE and development. Typically evolves from University Engr. Lab classes.
- **Migrates unmitigated and unchecked** into industry and government where it has thrived for decades.
- An *ad hoc, endless loop* process that is *inefficient and ineffective*.
- Focuses on SE *activities*, not *performance-based outcomes*, which leads to project technical, cost, and schedule performance issues.



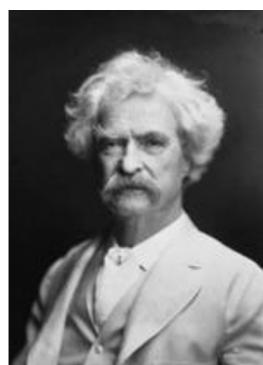
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### Illustrative Quote by American Author Mark Twain



**“What gets us into trouble  
is not ... what we don't know.**

**It's what we know for sure ...  
that just (isn't) so.”**

Source: <https://www.goodreads.com/quotes/738123-what-gets-us-into-trouble-is-not-what-we-don-t>

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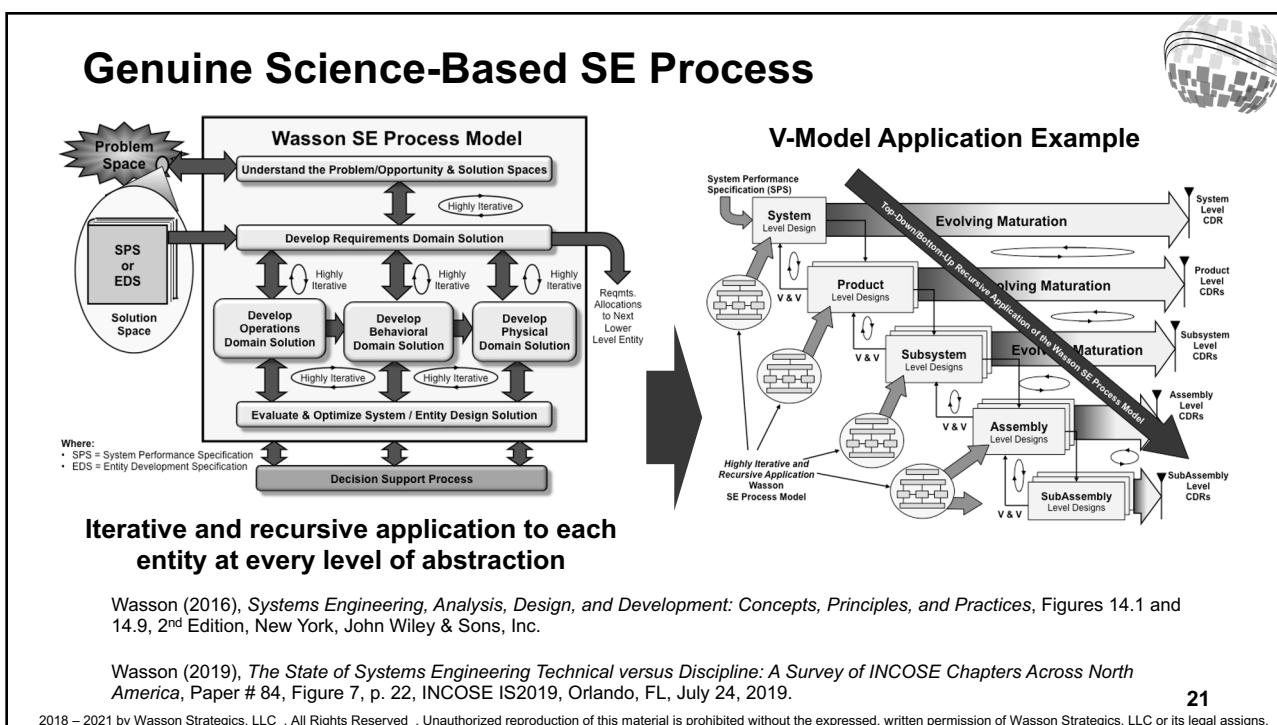
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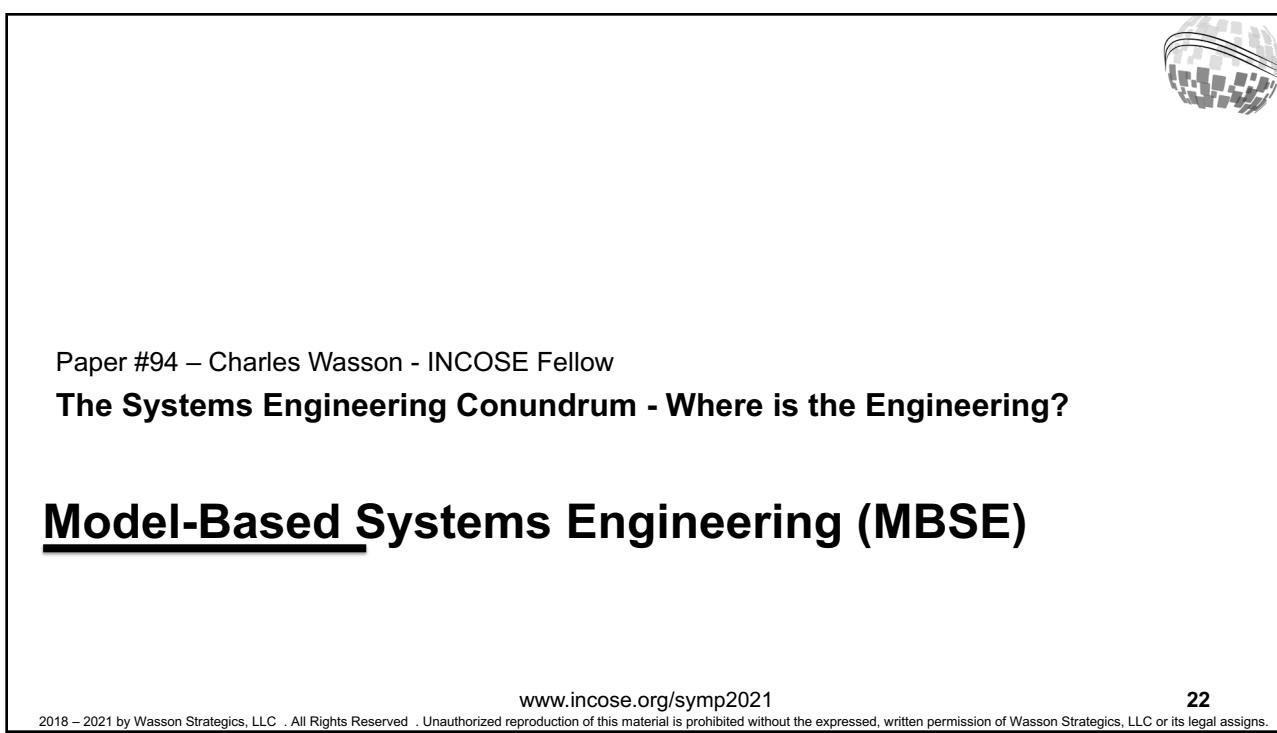
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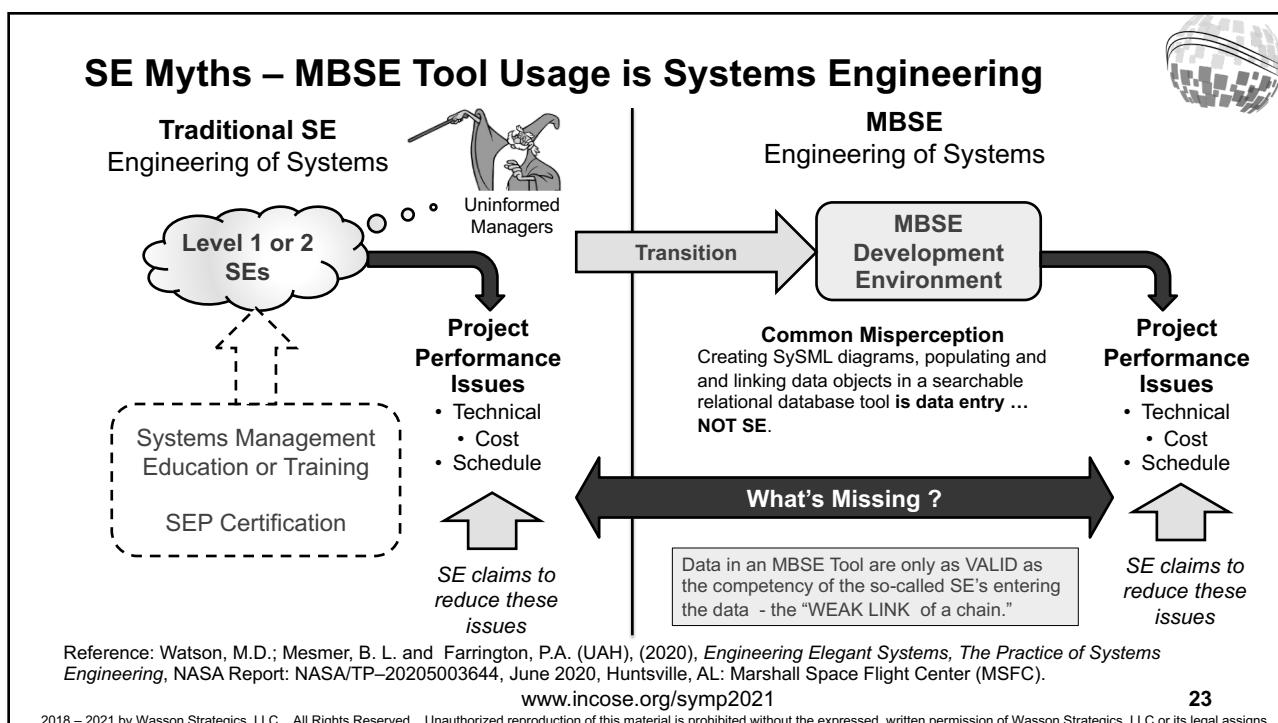
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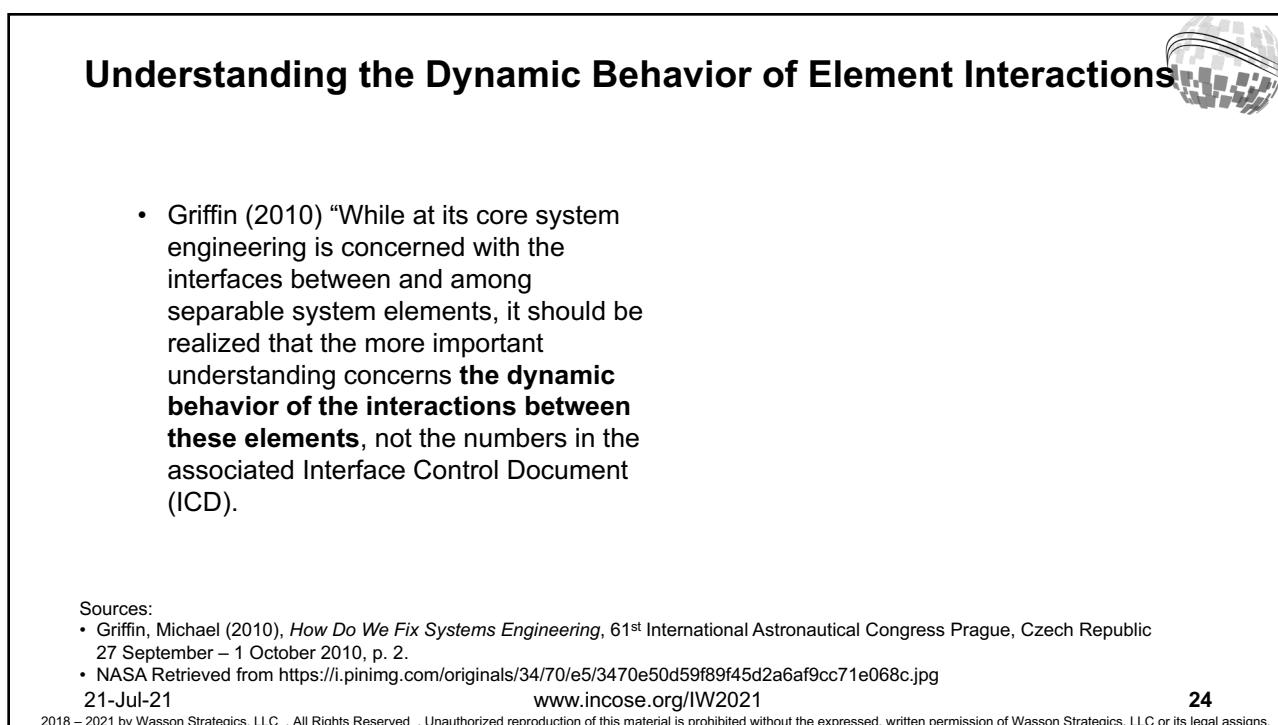
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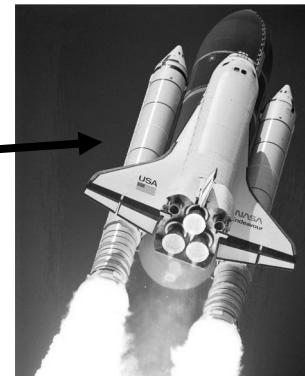
### Understanding the Dynamic Behavior of Element Interactions



- Griffin (2010) "While at its core system engineering is concerned with the interfaces between and among separable system elements, it should be realized that the more important understanding concerns **the dynamic behavior of the interactions between these elements**, not the numbers in the associated Interface Control Document (ICD)."

#### Space Shuttles

- Challenger
- Columbia



#### Sources:

- Griffin, Michael (2010), *How Do We Fix Systems Engineering*, 61<sup>st</sup> International Astronautical Congress Prague, Czech Republic 27 September – 1 October 2010, p. 2.
- NASA Retrieved from <https://i.pinimg.com/originals/34/70/e5/3470e50d59f89f45d2a6af9cc71e068c.jpg>

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### Griffin's (2010) Elegant Design Questions Seldom Asked



- Griffin (2010) also posed 4 key questions (there are others) concerning Elegant System Design as noted earlier in the Heuristics-Bridging Team Panel discussion that you seldom hear asked:
  - "How do you know the design will actually work?"
  - Is the design robust?
  - Is the design efficient?
  - Does it accomplish its intended purposes while minimizing unintended actions, side effects, and consequences?"

#### Source

- Griffin, Michael (2010), *How Do We Fix Systems Engineering*, 61<sup>st</sup> International Astronautical Congress Prague, Czech Republic, 27 September – 1 October 2010, p. 2.

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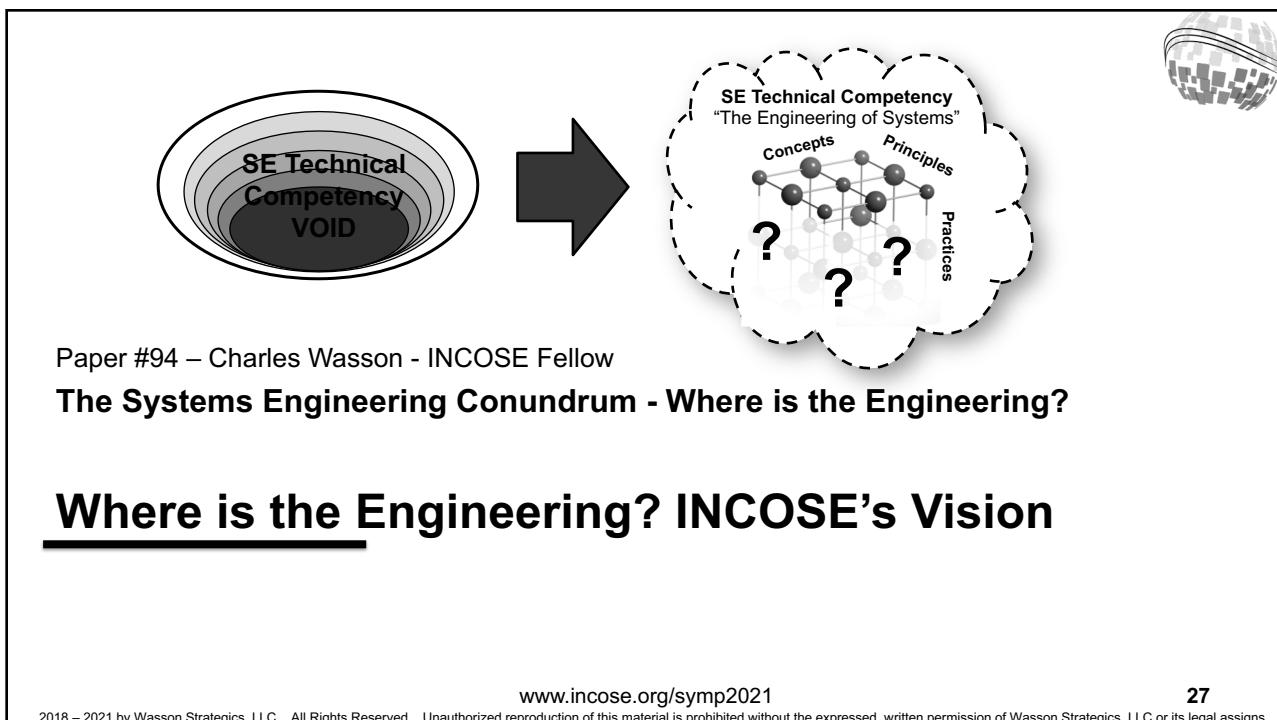
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**While You Have Been Sleeping ...**

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**While You Have Been Sleeping ...**

The screenshot shows the INCOSE website homepage. At the top, there are navigation links for 'Collaboration', 'Store', 'Contact us', and 'Portal "Connect"'. The INCOSE logo is in the center, with the tagline 'A better world through a systems approach' below it. A large callout box in the center contains the text: 'What does this mean? What is the "code speak"? Isn't INCOSE about ... Systems Engineering?'. Below this box are three buttons: 'INCOSE news and events.', 'Impactful products and state-of-the-art research.', and 'Get involved with INCOSE near you.'

What does this mean?      What is the “code speak”?

Isn’t INCOSE about ... Systems Engineering?

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**Unresolved Competency Issues ... to GST**

**Unresolved SE Technical Competency Issues**

The diagram illustrates the relationship between unresolved competency issues in Systems Engineering (SE) and the broader context of General Systems Theory (GST). On the left, a timeline from the 1930's to 2030's shows the evolution of SE from 'Modern Systems Engineering' to 'Systems Management'. It highlights the 'Parallel Shift to "Systems" Management' and the 'Technical Competency Gap' (80% Management vs. 20% Technical). On the right, INCOSE's mission is framed as 'A Better World Through a Systems Approach?'. A large arrow points from the unresolved issues to the GST side, which includes a cloud labeled 'Abstract Systems Theory' and a double-headed arrow between 'Systems Approach' and 'General Systems Theory\* (GST)'. The GST side lists 'Systems Philosophy', 'Systems Sciences', and 'Systems Technology'. Below this is 'Engineered Systems Implementation'. A question mark '???' is placed between the INCOSE section and the GST section.

INCOSE's  
A Better World Through a Systems  
Approach?

Systems Approach

Abstract Systems Theory

General Systems Theory\* (GST)

- Systems Philosophy
- Systems Sciences
- Systems Technology

Engineered Systems Implementation

???

Bertalanffy, Ludwig Von, (1972), "The History and Status of General Systems Theory," *Academy of Management Journal*, pp. 407-426, Dec. 1972, Vol. 15, No. 4, Briarcliff Manor, NY.

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**What is INCOSE's "A Better World Through a Systems Approach"?**

... For several years the INCOSE BoD has been ... moving away from SE ...

Is SE a Home Port for INCOSE or just an occasional a Port of Call?

Systems Approach

Systems Sciences

Systems Philosophy

Systems Technology

SE in our rear view mirror

Managing the Development of Systems

What our travels say ... about who INCOSE is ...

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**What is INCOSE's "Systems Approach" to SE – Option A?**

Simplification

The Universe

Celestial Systems\*

Natural Systems

Human Systems

Observables

Engineered Systems, Products, and Services Solutions

Needs

----- May or may not be present

(Bertalanffy, 1972) General Systems Theory (GST)

Systems Sciences

Systems Philosophy

Systems Technology

Engineering of System Solutions

Genuine SEs

CE

EE

HFE

ChemE

ME

SwE

IE

BioE

Et al

Enabling Sciences Influences

Drives?

Drives?

Enabling Technologies Influences

Systems Approach

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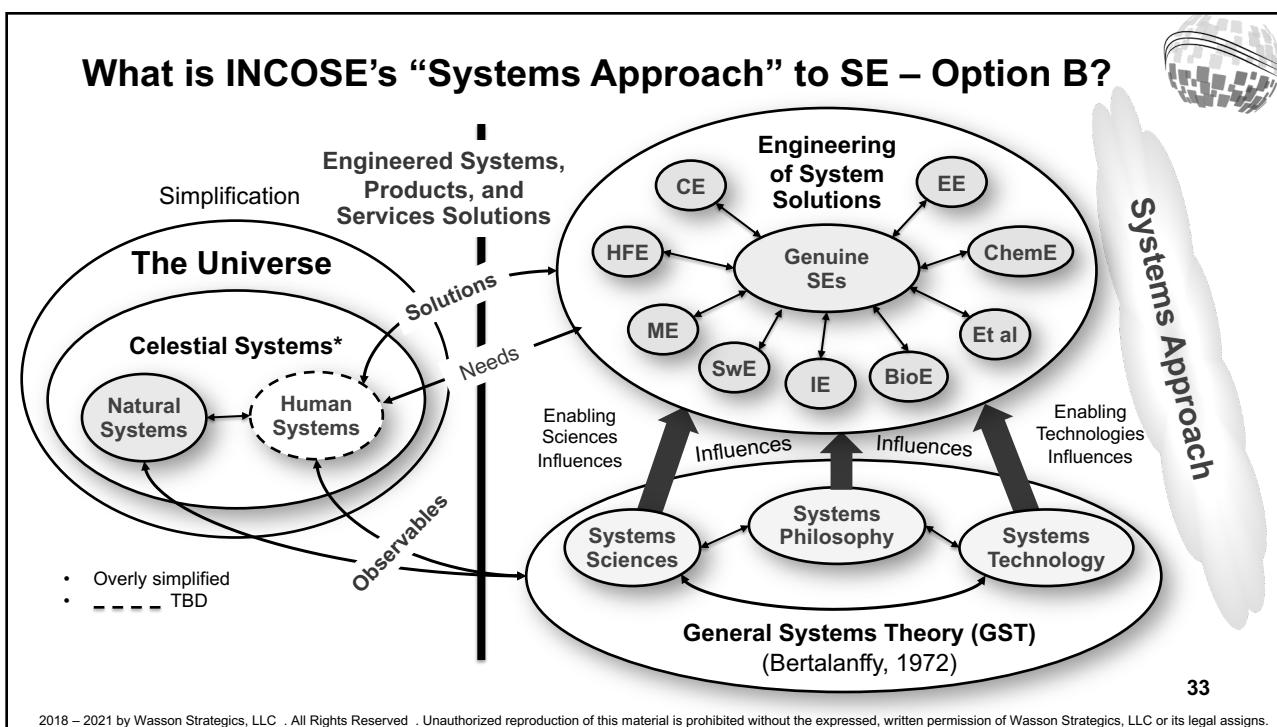
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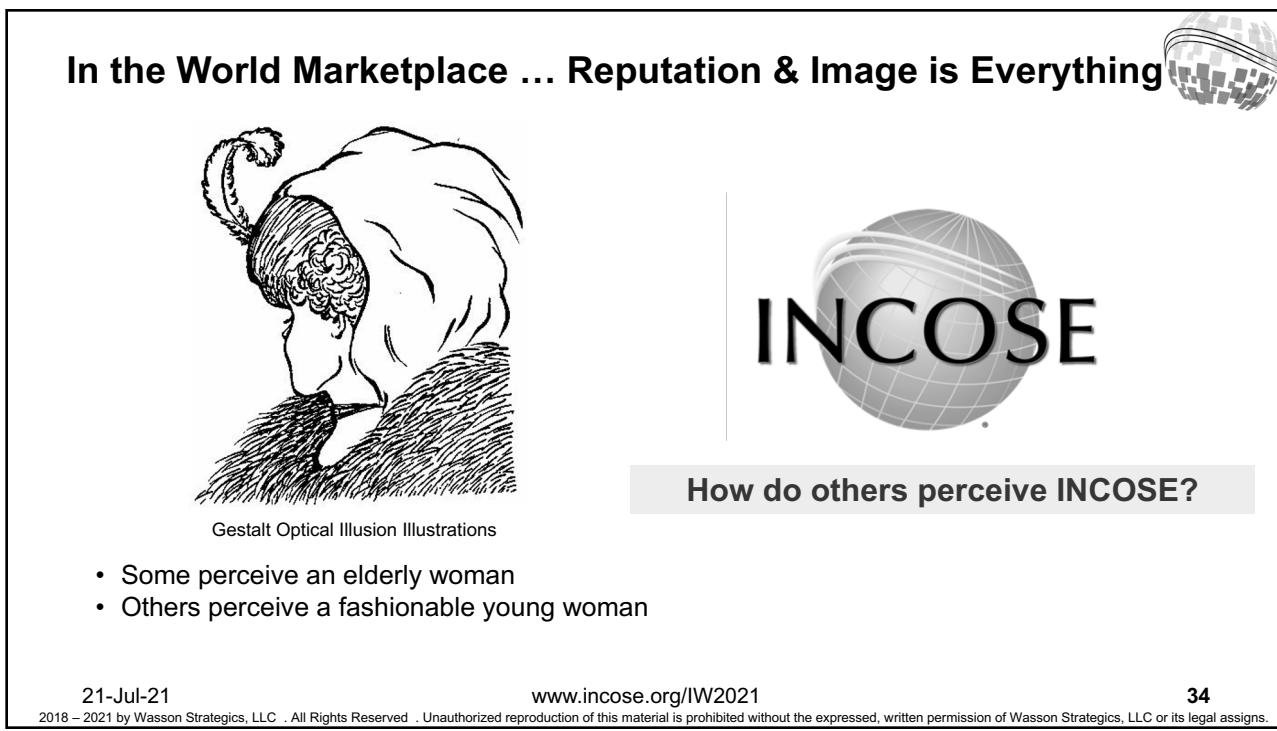
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### INCOSE's Identity Crisis?

Is INCOSE the International Council on ...



- Systems Management (INCOSM)?
- Systems Approach (INCOSA)?
- Systems Philosophy (INCOSP)?
- Systems Sciences (INCOSS)?
- Systems Technology (INCOST)?
- Systems Engineering (INCOSE)?

### Where is the Engineering in INCOSE?

Is the reason INCOSE is having problems retaining NEW members after 2 years due to these issues – What business is INCOSE in?

INCOSE processes promote measuring system performance and annual surveys. Yet, lacks data as to why NEW members leave.

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### The Systems Engineering Conundrum - Where is the Engineering?

## Where is the Engineering? Summary

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# Thank You!

Best wishes for continued success in  
Systems Engineering!



**Charles Wasson**

SE Textbook Author, INCOSE Fellow, and ESEP

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*Music Composed and Performed By*

**Jimmy Bowland**

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