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

A Systems Engineering Framework for Navigating Complexity

Dean Beale, Dorothy McKinney, Andrew Pickard and Ricardo Valerdi

INCOSE International Symposium 2025 | Ottawa, Canada

Agenda

Agenda:

- Introduction and Motivation
- The Cynefin Framework and the INCOSE Complexity Primer Definitions
- The Threshold of Complexity
- Confounding Factors
- The Pleko Framework
- Alignment with COSYSMO
- Key Findings, Recommendations, Conclusions and Path Forward

Introduction and Motivation

- The Cynefin Framework is popular for complex decision-making
- Aim: To adapt Cynefin insights using updated INCOSE definitions
- Outcome: The Pleko Framework for Systems Engineers

INCOSE (2021). Complexity Primer for Systems Engineers, Revision 1 INCOSE-TP-2021-007-01. https://portal.incose.org/commerce/store?productId=INCOSE-PRIMCOMPLEXITY

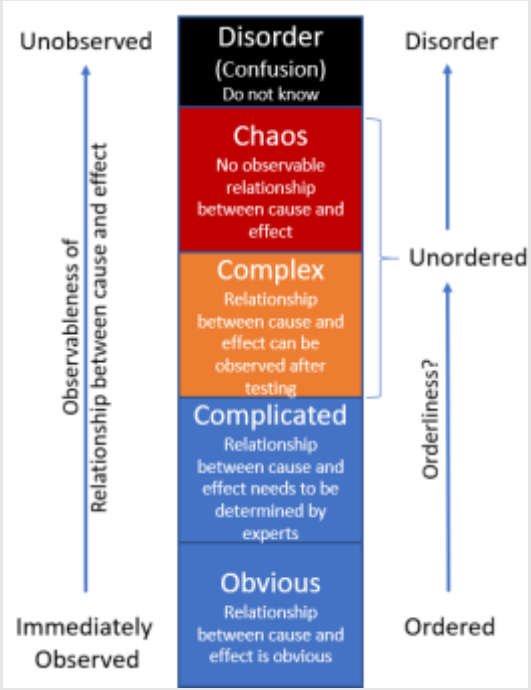
Kurtz & Snowden (2003). The new dynamics of strategy: Sense-making in a complex and complicated world. IBM Systems Journal, Vol. 42, No 3, 2003.

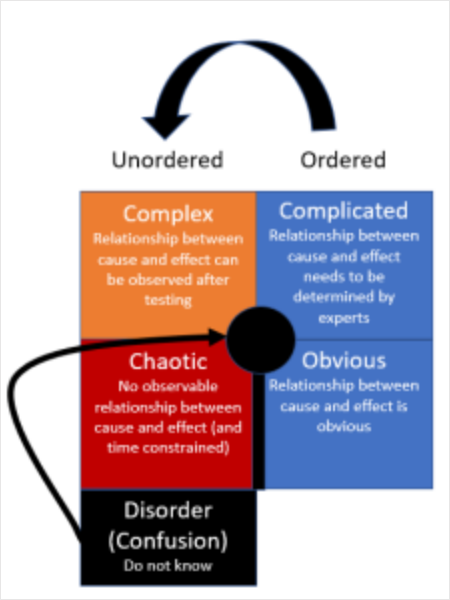
Terms used	Complexity Primer	Cynefin
Simple/ Obvious/ Clear	Relationship **readily comprehended (implying complete certainty)**	Relationship between cause and effect **obvious (Ordered) (Simple/Clear).**
Complicated	Relationships can be **unfolded and comprehended,** leading to **sufficient certainty** between cause and effect.	Relationship between cause and effect can be **determined by experts. (Ordered).**
Complex	Relationships are weaved together, so they are **not fully comprehended,** leading to **insufficient certainty** between cause and effect.	The relationship between cause and effect is **observable only after testing**. (& unrepeatable) **(Unordered).**
Chaotic	**No comprehension** of relationships between elements* **(implying no certainty).**	**No observable relationship** between cause and effect (and time-constrained) **(Unordered).**
Confusion (Disorder)		**Cannot see** which “domain” applies **(Disorder).**

The Cynefin Framework

- Domains: Simple, Complicated, Complex, Chaotic
- No explicit definitions, inferred from usage
- Single-axis: observable cause-effect relationships
- Folded at the Complicated / Complex boundary

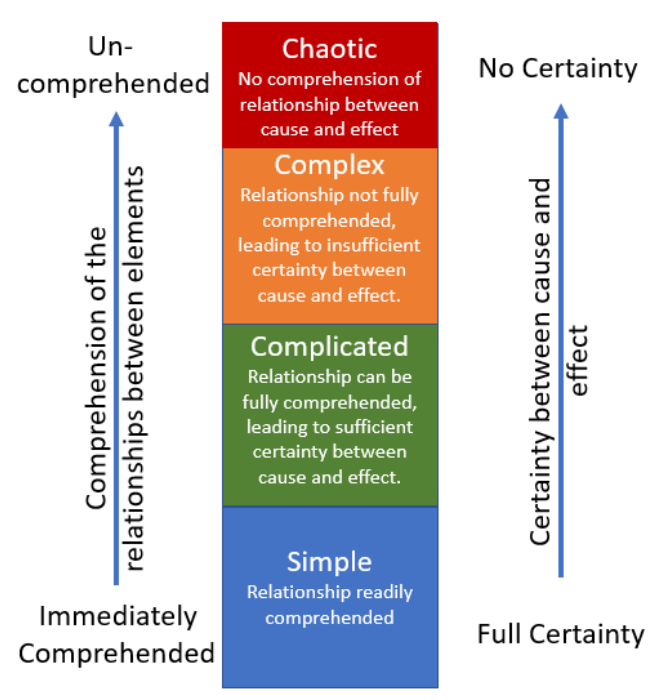
Snowden, D. J., & Boone, M. E. (2007, November). A Leader's Framework for Decision Making. Harvard Business Review.





INCOSE Complexity Primer Definitions

- Simple: Relationships are readily comprehended
- Complicated: Relationships can be unfolded, experts can comprehend
- Complex: Relationships are weaved, cannot be fully comprehended
- Chaotic: No comprehension of relationships
- Complex Systems Primer implied axis showing how the complex and complicated terms relate (Crown Copyright © 2022)

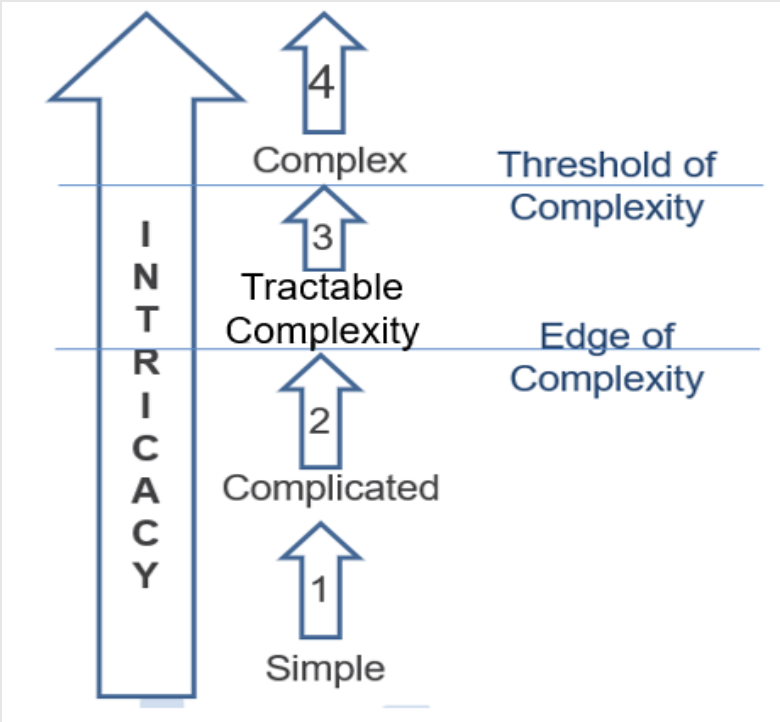


Contrasting Perspectives & Axis Differences

- Cynefin: Objective assessment after engagement
- INCOSE Complexity Primer: Subjective, pre-engagement observer comprehension
- Focus for Systems Engineers: Balance objectivity with subjective needs
- Cynefin: Order & observable-ness
- INCOSE Complexity Primer: Comprehension & sufficiency of certainty
- Cynefin includes the Disorder domain; The INCOSE Complexity Primer model covers Disorder in Uncomprehended, along with Chaos. It is hard to prove definitively if the system is chaotic or disordered, but much easier to indicate that you have not seen the order, so we think “Uncomprehended” is more useful.

Threshold of Complexity

- “Threshold of complexity” (Wolfram, 2002): shift from ordered to unordered
- Complicated solutions won’t work in complex space
- Complex space needs new mindsets & adaptive approaches
- In reality order and unorder intertwine and interact
- How to handle each element of a system, as complicated or complex, depends on how the system is broken down and divided and depends somewhat on the skill of the Systems Engineer.
- Coupling between system elements and non-linearity drive the system into tractable complexity



Confounding and Simplifying Factors

Confounding Factors:

- Confounding factors can push otherwise simple/complicated problems into the complex domain
- Opportunity to mitigate by understanding these factors
- Consider for each System element

Simplifying Factors:

- Applied to remove unnecessary complexity
- Consider those most relevant to the element to be addressed

Confounding Factors	Simplifying Factors
Unfamiliarity	Increased Skill
Novelty	Suitable Culture
Dynamicity	Adaptability
Unpredictability	Resilience
Environmental Threat	Co-Location
Constraints	Common Vision
Fragility	Robust Relationships
Variety of Opinions	Equality Mindset
	Experimentation
	Iterative Delivery
	Expectation Management

Paper 337 – A Systems Engineering Framework for Navigating Complexity

The Pleko Framework

Original single comprehension axis split into:

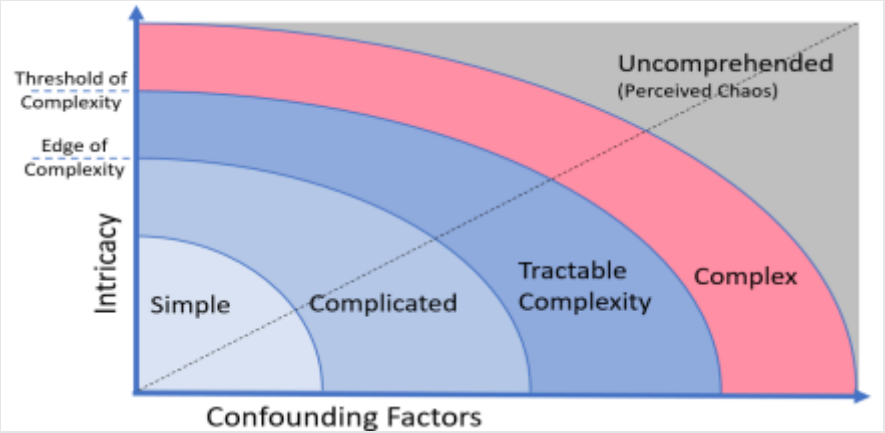
1. Intricacy (innate complexity of the system)
2. Confounding (and Simplifying) factors (external influences)

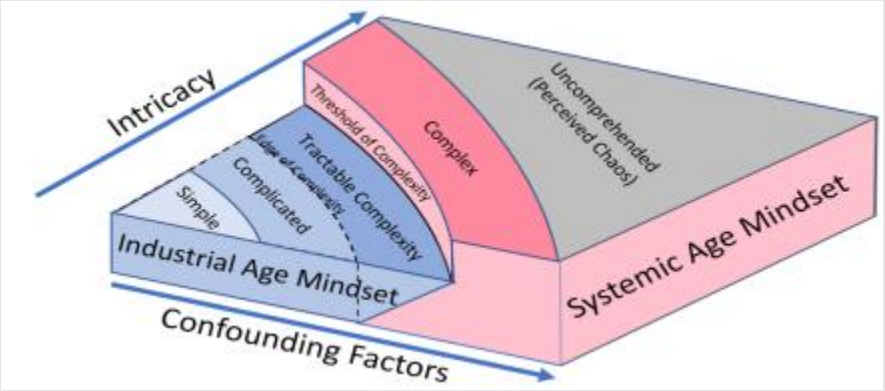
Developed from INCOSE definitions & Cynefin insights

- 2D framework: Intricacy vs Confounding Factors
- Key transition: Edge vs Threshold of complexity

Visualization of the Pleko Framework:

- 2D version: clarity in splitting challenge drivers
- 3D version: illustrates mindset shift from complicated to complex domains





Paper 337 – A Systems Engineering Framework for Navigating Complexity

Alignment with COSYSMO

COSYSMO (cost estimation model)

- Intricacy factors align with size drivers
- Confounding and Simplifying factors align with effort multipliers
- Enhances cost-benefit analysis for complexity mitigation
- Analytic Hierarchy Process (AHP) used by the team at the INCOSE 2025 IW to weight the Intricacy, confounding and Simplifying Factors

COSYSMO Factors				PLEKO Factors																	
				Intricacy Factors					Confounding Factors								Simplifying Factors				
Size Driver or Effort Multiplier?	Effort Multiplier Type?	Factor	Description	Develop Elegant Solutions	Effective Clumping	Identify Patterns	Level of Abstraction	Viewpoint Change	Constraints	Dynamicity	Environmental Threat	Fragility	Novelness	Unfamiliarity	Unpredictability	Variety of People	Adaptability	Change the Culture	Change the Rules	Change the Skills	Design for Resilience
Size Driver		REQ	Number of System Requirements	1881	1881	1881	1881	1881													
Size Driver		INTF	Number of Major Interfaces	2442	2442	2442	2442	2442													
Size Driver		ALG	Number of Critical Algorithms	2384	2384	2384	2384	2384													
Size Driver		OPSC	Number of Operational Scenarios	1612	1612	1612	1612	1612													
Effort Multiplier	Product	RQMT	Requirements Understanding						1.36	1.36			1.36	1.36							
Effort Multiplier	Product	ARCH	Architecture Understanding									1.27		1.27	1.27		1.27				1.27
Effort Multiplier	Product	LSVC	Level of Service Requirements								1.00			1.00	1.00						
Effort Multiplier	Product	MIGR	Migration Complexity						1.54			1.54		1.54	1.54		1.54				
Effort Multiplier	Product	TRSK	Technology Risk						1.00			1.00	1.00	1.00	1.00						
Effort Multiplier	Product	DOCU	Documentation						1.13												
Effort Multiplier	Platform	INST	Number & Diversity of Installations/Platforms						1.23	1.23		1.23			1.23		1.23				
Effort Multiplier	Platform	RECU	Number of Recursive Levels in the Design									1.21	1.21		1.21						1.21
Effort Multiplier	Personnel	TEAM	Stakeholder Team Cohesion						1.22			1.22				1.22		1.22			
Effort Multiplier	Personnel	PCAP	Personnel/Team Capability						1.00			1.00				1.00				1.00	
Effort Multiplier	Personnel	PEXP	Personnel Experience/Continuity						0.82			0.82				0.82				0.82	
Effort Multiplier	Project	PROC	Process Capability						0.68			0.68							0.68		
Effort Multiplier	Project	SITE	Multisite Coordination						1.00			1.00				1.00		1.00	1.00		
Effort Multiplier	Project	TOOL	Tool Support						1.00			1.00				1.00				1.00	

Pleko Calibration

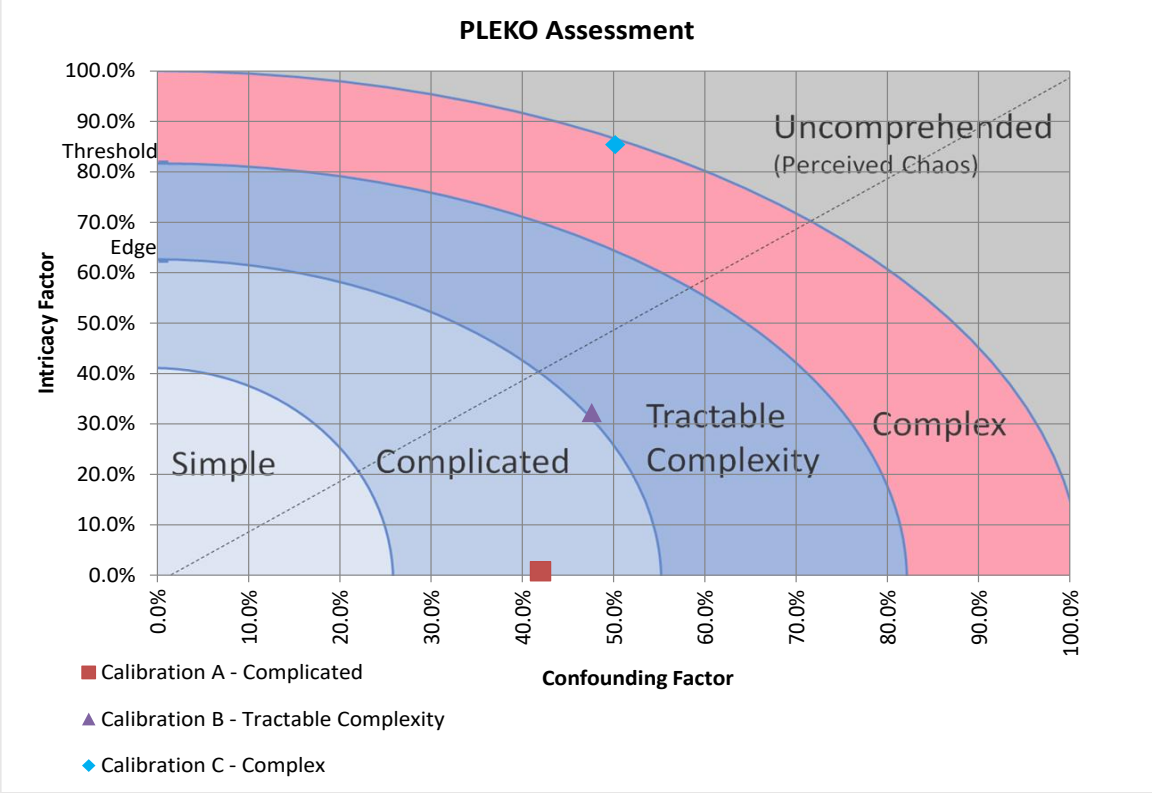
Calibration:

- Based on three COSYSMO case studies and an assessment of the complexity of each system

In the previous slide:

- Green cells weigh four times as heavily as Yellow cells
- White cells weight = 0
- 100% Intricacy Factor = an intricacy score of 17,000
- 100% Confounding Factor = a confounding score of 50

However, more calibration points need to be included



Key Findings, Recommendations and Conclusions

Findings:

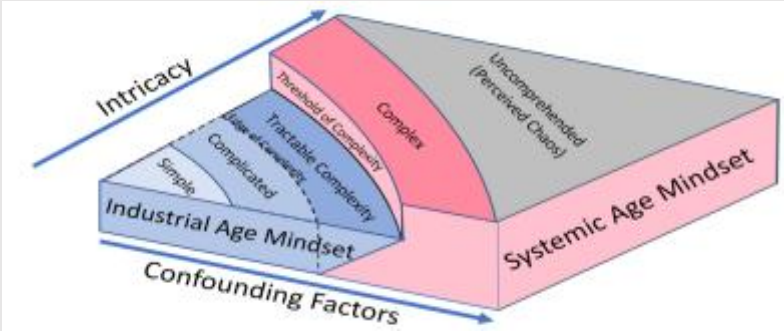
- We failed, the Pleko framework does not replace Cynefin
- Pleko is useful for the problem-bounding phase for driving out unnecessary complexity
- Cynefin is best for managing challenges post-bounding
- Pleko can map to the established COSYSMO Framework

Recommendations - Next steps:

- Add more calibration points
- Real-world use cases
- Strengthen COSYSMO alignment

Conclusions:

- The Pleko Framework: a practical tool for Systems Engineers
- Complements Cynefin & other tools
- Potential for better understanding and mitigating complexity in engineering practice



Authors

Dean Beale

Dorothy McKinney

Andrew Pickard

Ricardo Valerdi

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

Thank You!

Questions?