Systems thinking as it applies to systems engineering

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http://therightrequirement.com

Presented to the INCOSE-CC
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Apologies and warning

- This talk perceives traditional systems engineering in a different way
- It's based on a different paradigm
- It's not the INCOSE paradigm
- It worked for me 100%
- The perceptions may challenge you
- The perceptions may offend you
- The talk is designed to make you think
- Some of the information may be dated

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Problem-solving (ST's perspective)

	Conventional thinking	Systems thinking
How a problem is explored	Isolate parts to understand behaviour	Explore emergent nature of the system as a whole

- Think about your car or your camera
- Problem, it does not start or turn on
- Where does the solution come from?
- Years of research took place

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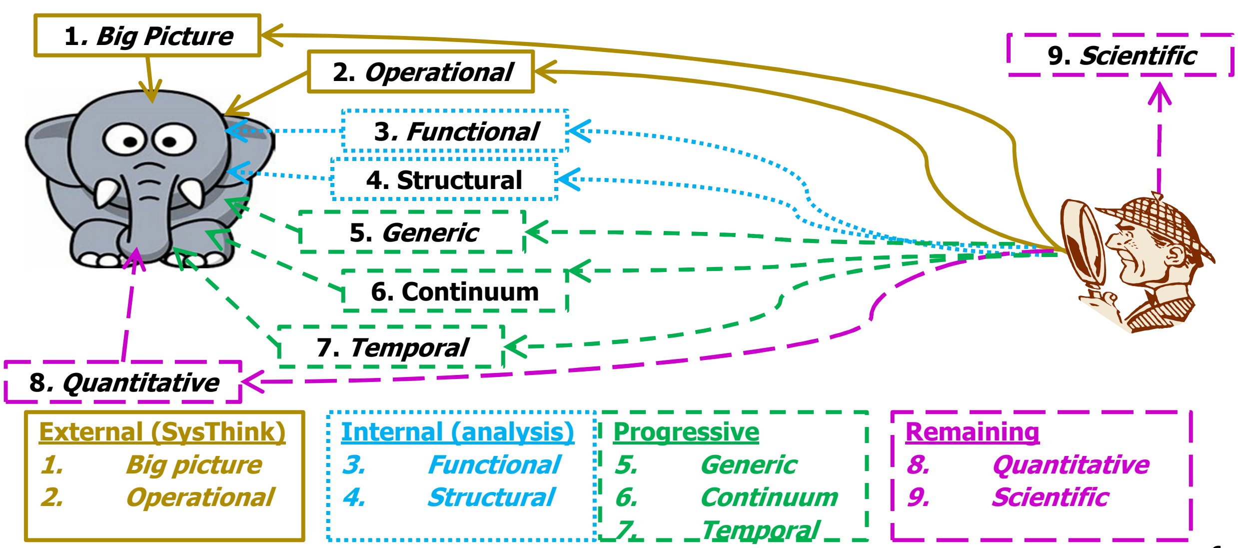
The Holistic Thinking Perspectives



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Which perspective is needed?

- It depends on the problem
- External
  - ~Systems thinking
    - How object relates to …
- Internal
  - Analysis
    - How object functions
- Progressive and Remaining
  - Beyond systems thinking

Understanding of situations

Solutions

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Example: Camera

- ***Big picture:*** where cameras are used and for what purpose
- ***Operational:*** (What) capturing images, transporting safely, viewing images, adjusting settings, and charging the battery
- ***Functional:*** (How) capturing images, storing images, retrieving images, deleting images, battery charging functions, etc.
- ***Structural:*** camera body, camera case and charger
- ***Generic:*** painting, sketching and other image capture methods/devices
- ***Continuum:*** different types and models of cameras, different materials used to construct camera
- ***Temporal:*** evolution of the image capturing media from photographic plates to film to solid-state memory to …
- ***Quantitative:*** numbers pixels per inch, lens characteristics, etc.
- ***Scientific:*** depends on problem or issue

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When I think about a camera

- ***Understanding how a camera works***
  - The *Functional* and *Structural HTPs*
  - The system contains the camera as a closed system
- ***Capturing images***
  - The *Operational* HTP
  - The system contains the camera and operator and whatever is being photographed as a closed system
- ***Transporting camera***
  - The *Operational HTP*
  - The system contains the camera, operator and camera case as a closed system
- ***Recharging a camera***
  - The *Operational* HTP
  - The system contains the camera, operator and charger as a closed system

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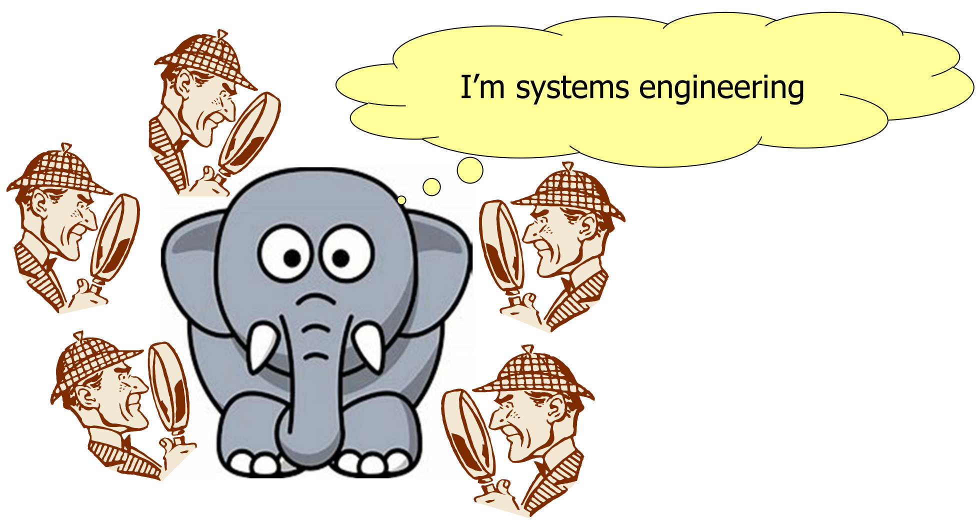
The elephant



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Big Picture perspective

- The principle of heriarchies
- Systems engineering education
- Systems thinking – sort of
- Context for systems engineering in domain
- Different views and opinions
- Systems engineering is performed in projects
- Process, product, problems
- Overlaps with other disciplines
- Focus on process
- MBSE

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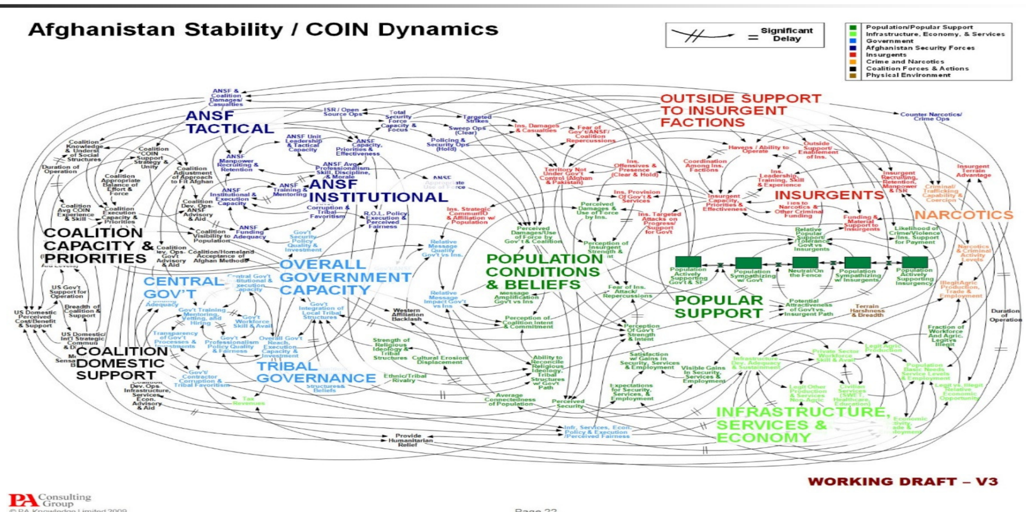
"When we understand that slide, we'll have won the war," General McChrystal



* http://msnbcmedia.msn.com/i/MSNBC/Components/Photo/2009/December/091202/091203-engel-big-9a.jpg, accessed 8 April, 2011

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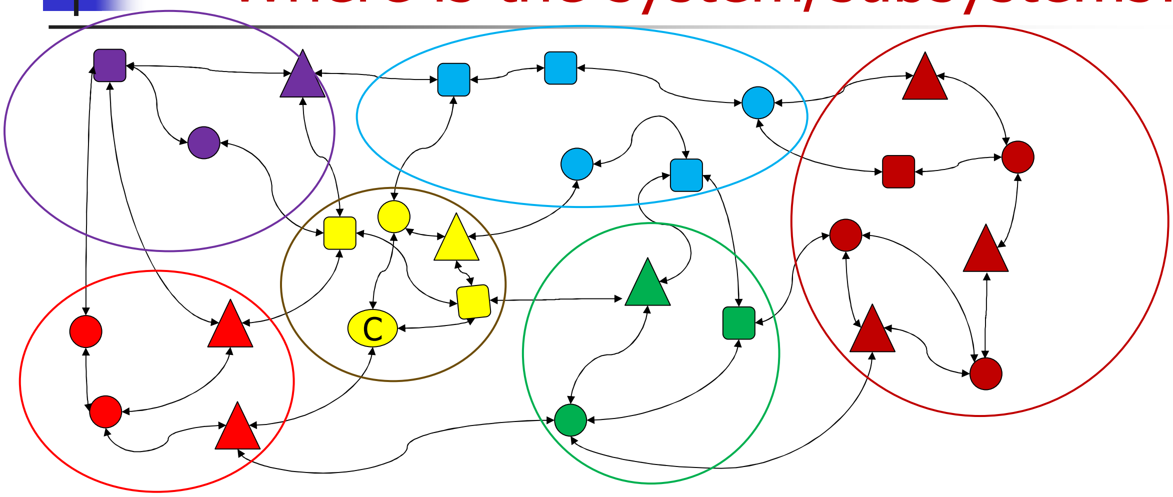
Where is the system/subsystems?



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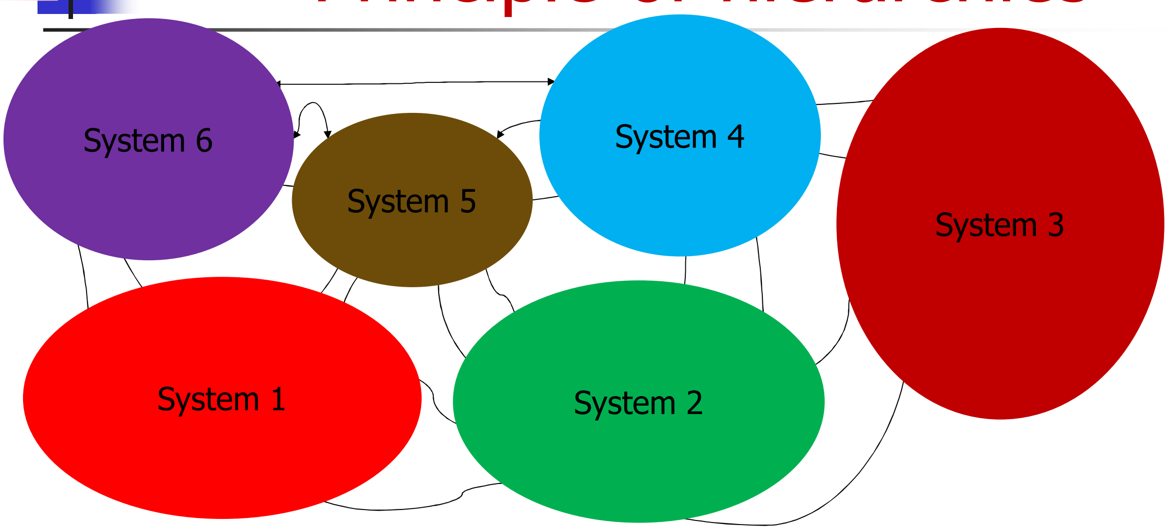
Principle of hierarchies



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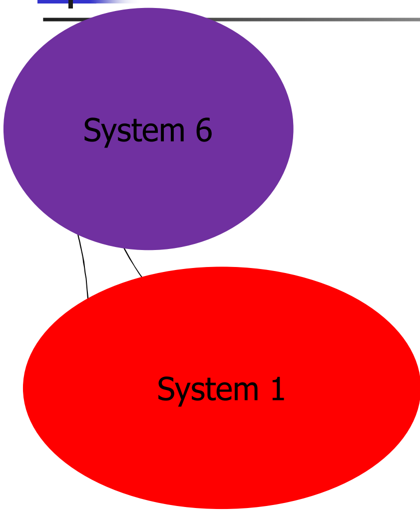
Principle of hierarchies



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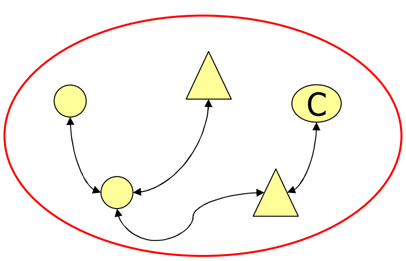
Principle of hierarchies



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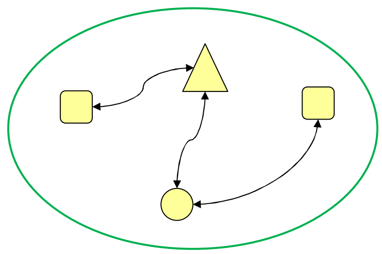
Principle of hierarchies



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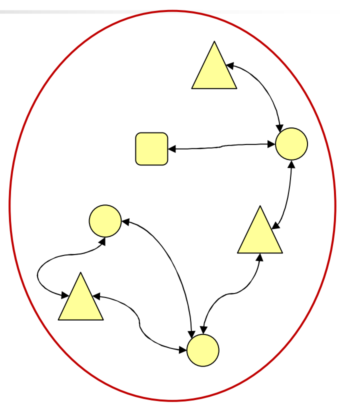
Principle of hierarchies



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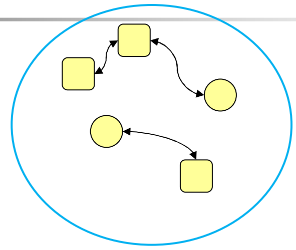
Principle of hierarchies



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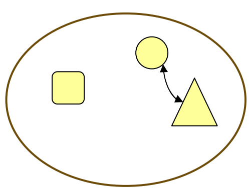
Principle of hierarchies



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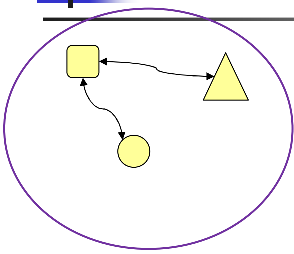
Principle of hierarchies



Just like the camera

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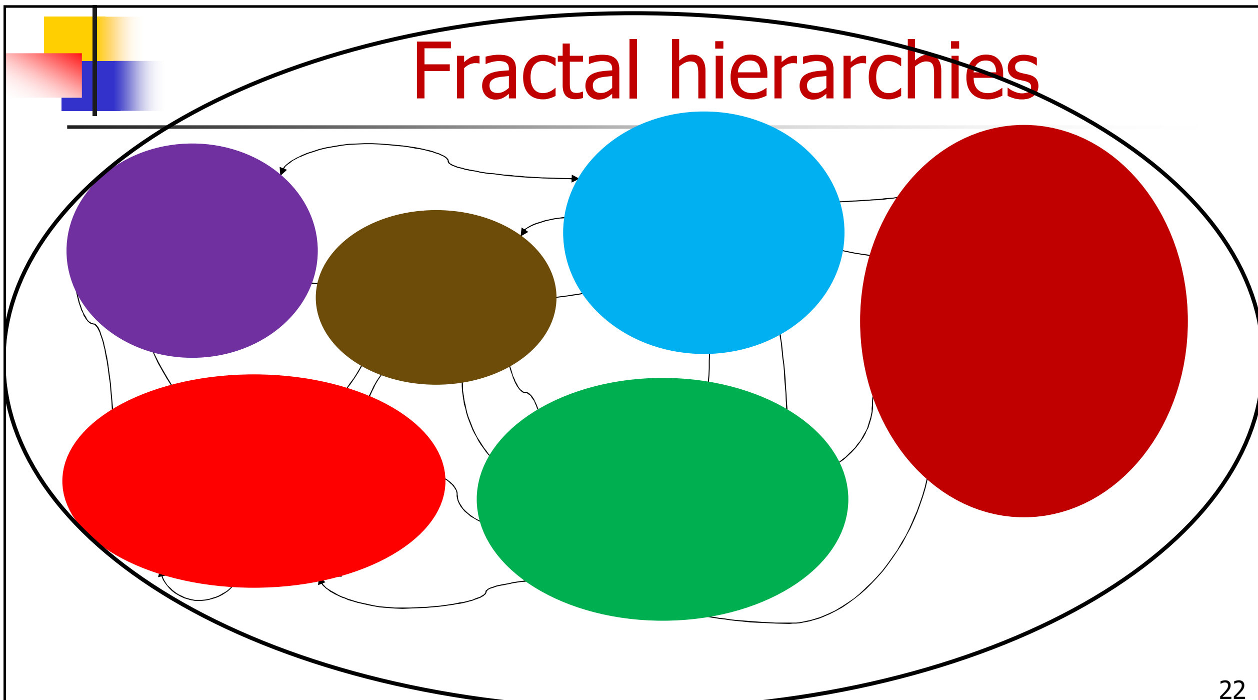
Fractal hierarchies



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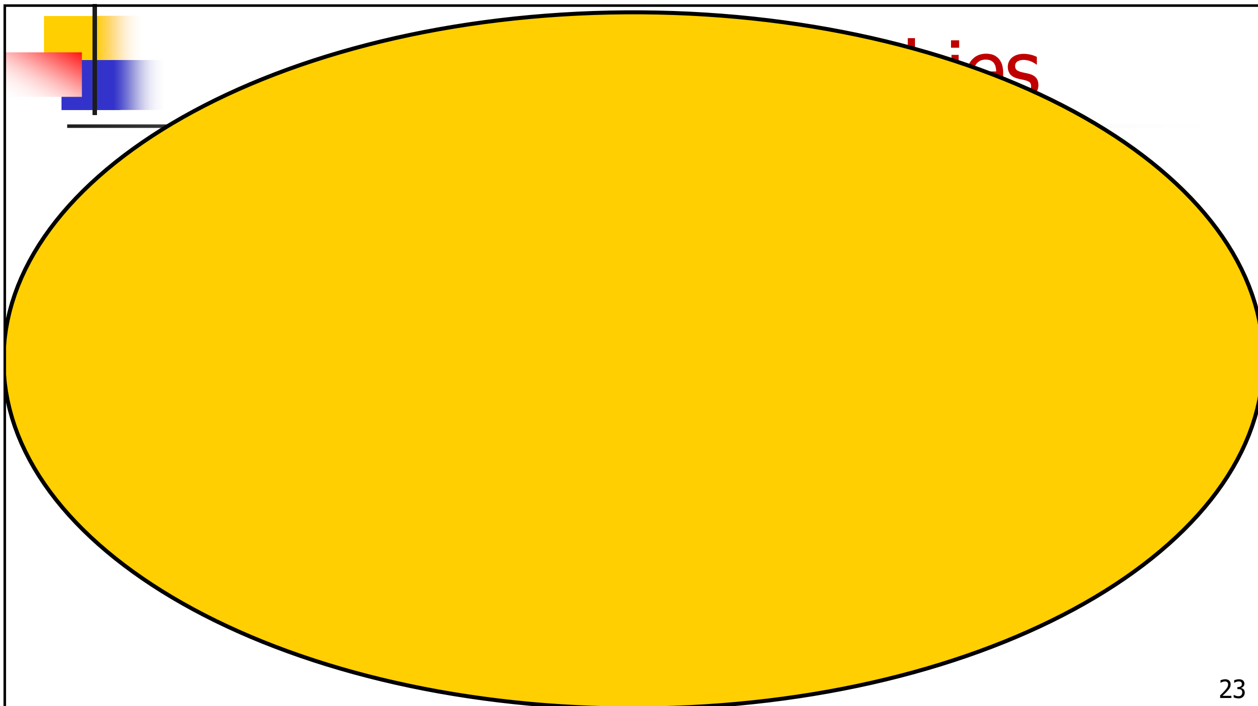

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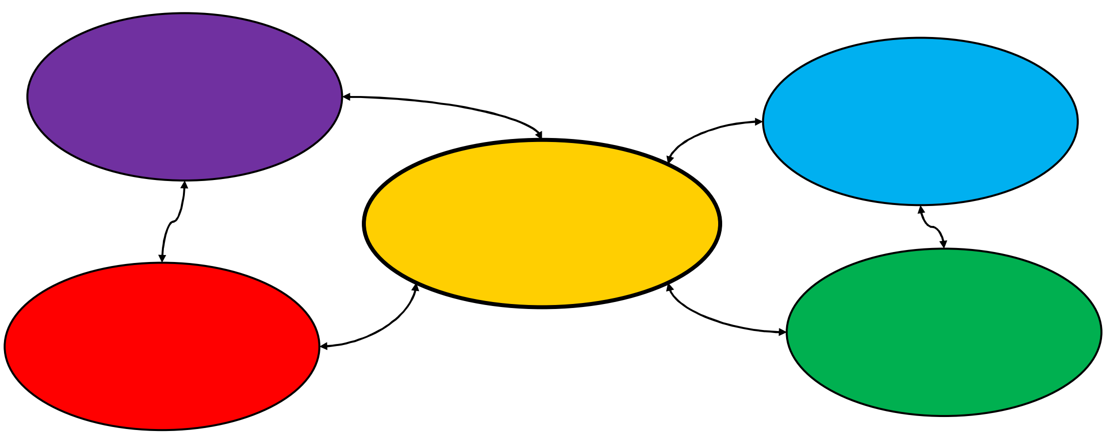
Principle of hierarchies



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The systems optimization paradox

- The systems optimization paradox which was stated by Machol and Miles who wrote,

"*the principle of suboptimization states that optimization of each subsystem independently will not lead in general to a system optimum, and that improvement of a particular subsystem actually may worsen the overall system. Since every system is merely a subsystem of some larger system, this principle presents a difficult if not insoluble problem, - one that is always present in any major systems design*" [34] page 39)..

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1999-2006 Systems engineering education (in general)

- We focus on what is easy to teach
  - We teach parts without relating them
  - Different universities teach different parts
  - We show relationships but don't go into details
  - We teach 'what' but not 'how'
  - We don't teach the basic building blocks of solutions
  - We ignore the gaps
  - We teach things that are not representative of reality
  - We ignore the paradigm of change
    - Get all requirements up front
- We don't use optimal pedagogy or technology
- We teach process or doing it by numbers
  - Declarative and procedural knowledge

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Systems thinking is not taught very well

- We teach
  - **Need for systems thinking and its history**
  - When you are doing it, you'll know it
  - Systems dynamics, Checkland's SSM
  - The Fifth Discipline (Senge)
    - Causal loops
    - Linear thinking is bad [is it in every instance?]
  - Vendor/trainers "My approach will solve all your problems"
    - Maslow's Hammer syndrome
- We don't teach
  - When, where and how to apply systems thinking (systemically and systematically)
- Basic influencing literature
  - Generally coming from OR community, not SE community

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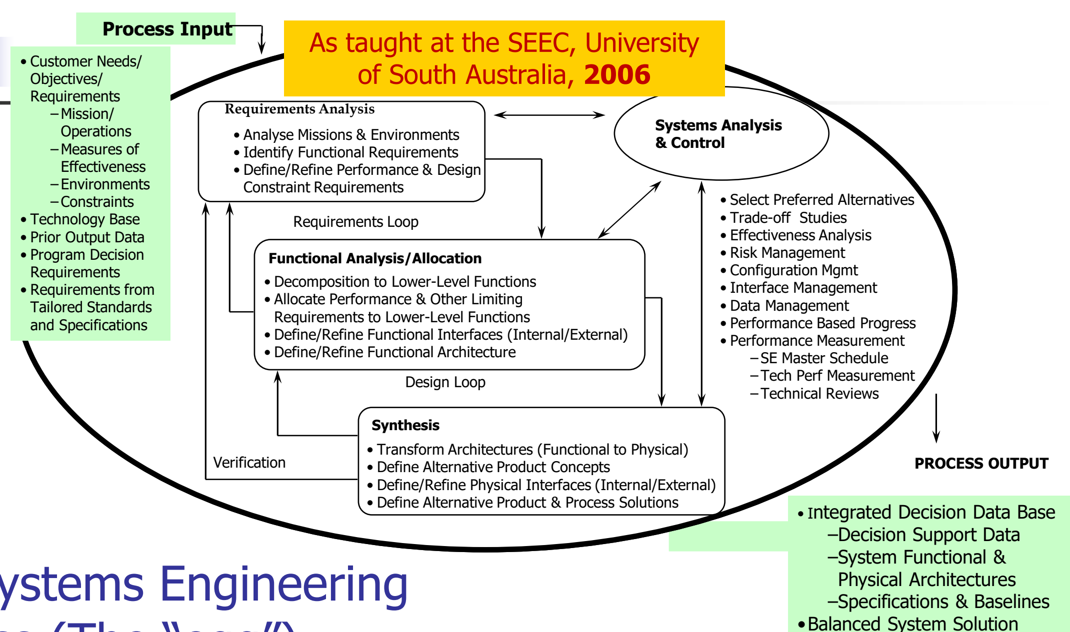

The Systems Engineering Process (The "egg")

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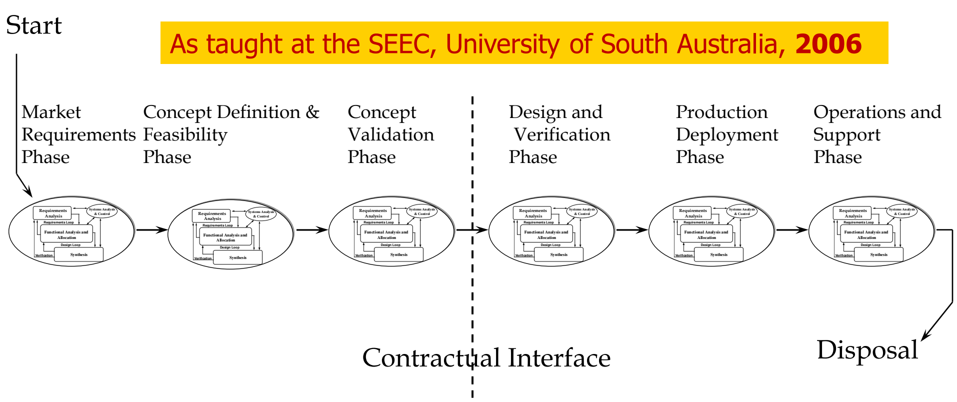
A Typical System Lifecycle

As taught at the SEEC, University of South Australia, **2006**



Each phase invokes the Systems Engineering Process, see egg

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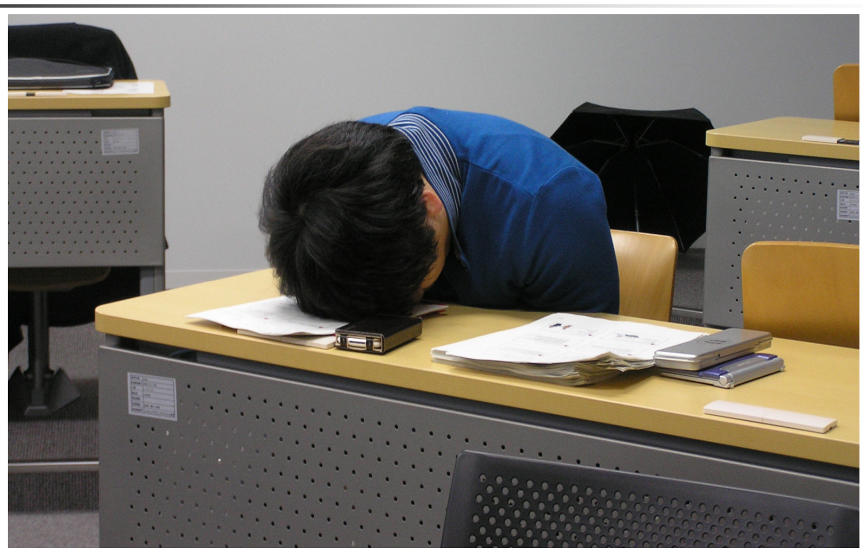
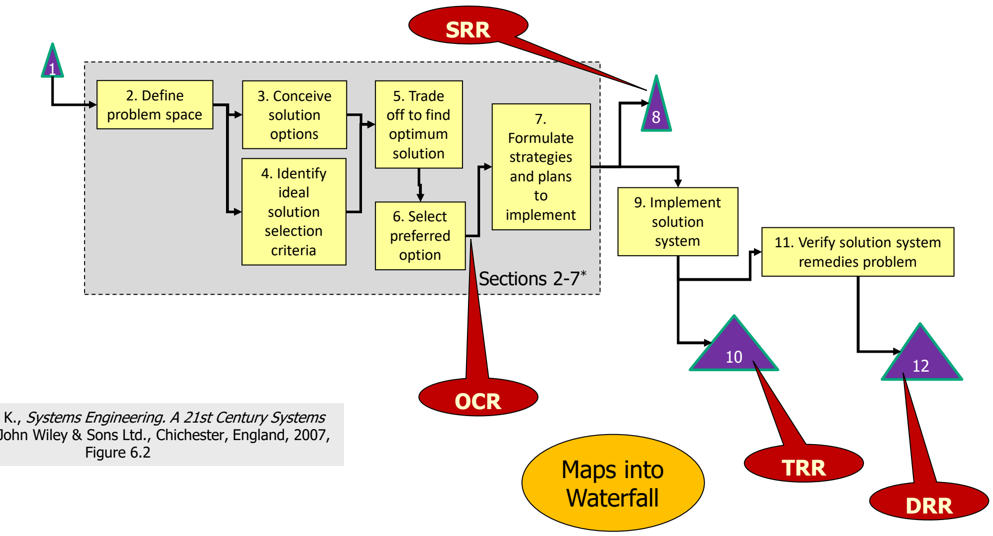
Student reactions



The systems engineering problem-solving paradigm* SDP



* Hitchins, D. K., *Systems Engineering. A 21st Century Systems Methodology*, John Wiley & Sons Ltd., Chichester, England, 2007, Figure 6.2

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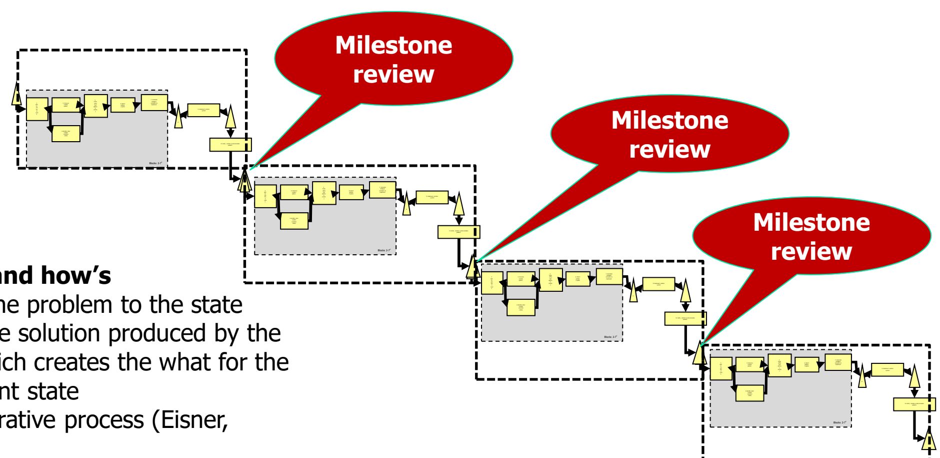
The systems engineering problem-solving paradigm* in each state of the Waterfall



- **What's and how's**
- What is the problem to the state
- How is the solution produced by the state, which creates the what for the subsequent state
- It's an iterative process (Eisner, 1988)

* Hitchins, D. K., *Systems Engineering. A 21st Century Systems Methodology*, John Wiley & Sons Ltd., Chichester, England, 2007, Figure 6.2

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The systems development process*

Stakeholder Requirements

System Requirements

Magic happens

System in being

* Clothier, J., Cook, SC., verbal discussions, SEEC, UniSA

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Text books (a selection)

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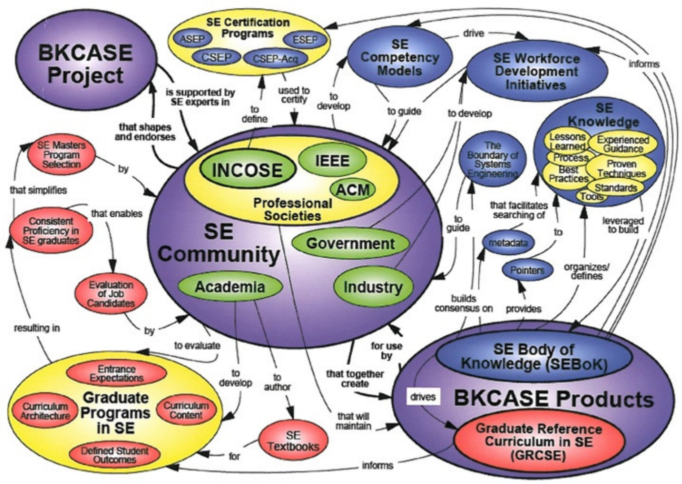
Ignoring principle of hierarchies

- Ignores Miller's rule
- 3 levels in hierarchy in drawing
- No direct connection between SE knowledge and INCOSE
- Wishful thinking
- BoK does not inform textbooks
- BoK does not inform academia



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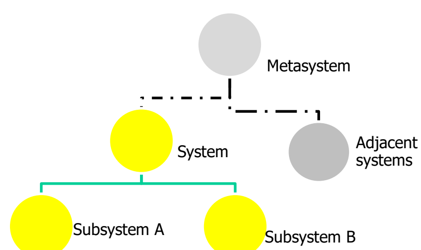
Structural perspective

- **Internal** structure of system
- Static view
- Architecture framework
- Components
  - **T**echnology
    - Availability
  - **I**nformation
    - Content
    - Dependability (accuracy and timeliness)
  - **P**eople
    - Type and availability
- Internal subsystem boundaries/partitions
- Standards



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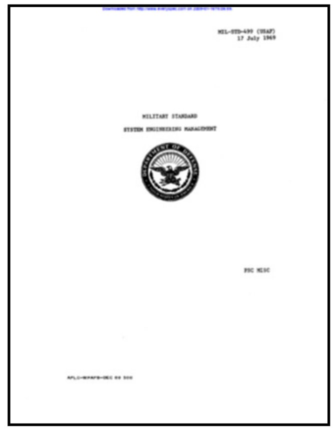
499 Systems engineering management

- Purpose to develop a Systems Engineering Management Plan
  - Not doing systems engineering
- Provided two templates to be tailored
- Tailoring does not seem to have taken place
- MIL-STD 499A ~~Systems~~ Engineering Management



MIL-STD's freely available at http://www.everyspec.com

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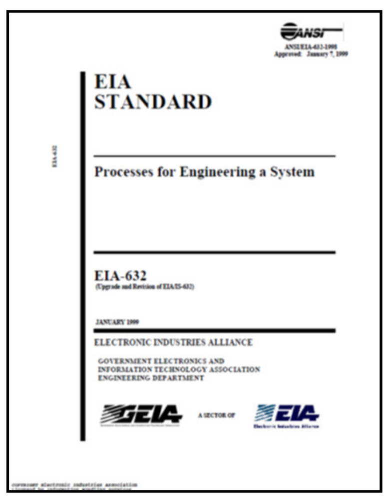
EIA-632

- Process for engineering a system
- Not for systems engineering



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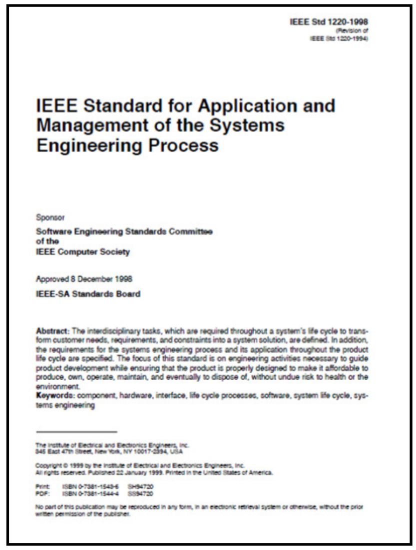
IEEE-1220

- Management of the systems engineering process
- Not doing systems engineering


IEEE Std 1220-1998
(Revision of
IEEE Std 1220-1994)

IEEE Standard for Application and Management of the Systems Engineering Process

Sponsor
Software Engineering Standards Committee
of the
IEEE Computer Society

Approved 8 December 1998
IEEE-SA Standards Board

Abstract: The interdisciplinary tasks, which are required throughout a system's life cycle to transform customer needs, requirements, and constraints into a system solution, are defined. In addition, the requirements for the systems engineering process and its application throughout the product life cycle are specified. The focus of this standard is on engineering activities necessary to guide product development while ensuring that the product is properly designed to make it affordable to produce, own, operate, maintain, and eventually to dispose of, without undue risk to health or the environment.
Keywords: component, hardware, interface, life cycle processes, software, system life cycle, systems engineering

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Focus of Standards – *Temporal* perspective

SE Categories	MIL-STD-499C	ANSI/ EIA 632	IEEE-1220	CMMI	ISO-15288
Conceptualizing problem and alternative solutions	No	No	No	No	No
Mission/purpose definition	No	No	✓	✓	✓
Requirements engineering	✓	✓	✓	✓	✓
System architecting	✓	✓	✓	✓	✓
System implementation	No	✓	No	✓	✓
Technical analysis	✓	✓	✓	✓	✓
Technical management/ leadership	✓	✓	✓	✓	✓
Verification & validation	✓	✓	✓	✓	✓

Based on Table 5 in Honour E.C., Valerdi R., "Advancing an Ontology for Systems Engineering to Allow Consistent Measurement", CSER 2006

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DoD Directive 5000

- DoD Directive 5000.1 required ***Systems Engineering.***
  - "Acquisition programs shall be managed through the application of a systems engineering approach that optimizes total system performance and minimizes total ownership costs. A modular open-systems approach shall be employed, where feasible"
- DoD Instruction 5000.2 emphasized the use of systems engineering
- DoD 5000.2-R **gutted** systems engineering

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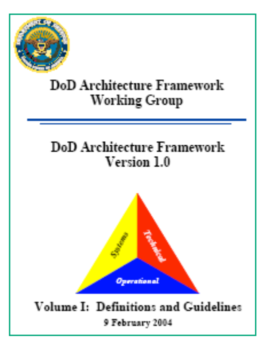
DoDAF: good idea but…

- **"The purpose of the DoDAF** is to provide correct and timely information to decision makers involved in future acquisitions of communications equipment"

  Volume I: **83** pages
  Definitions, Guidelines, and Background
  Volume II: **249** pages
  Product Descriptions
  Deskbook: **256** pages
  Supplementary information to Framework users
  CADM **696** pages
  core data model
  Over 1200 data elements



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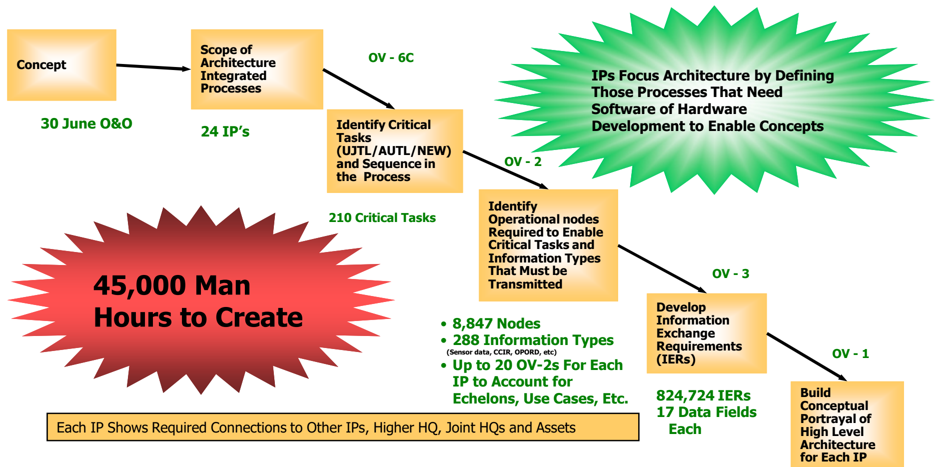
But it has become too expensive and complicated



Slide source FCS System of Systems' Engineering and Integration Scott Davis, NDIA Systems Engineering Conference 2003

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DoDAF OV-1?

OV-1 Describes use of system

Use of DODAF

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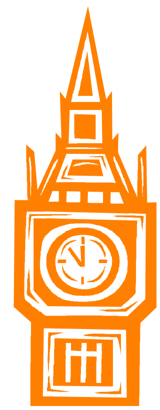
Temporal perspectives

- How the system behaves over time
  - Relationships
  - Patterns of behavior
    - prevention
  - Availability - Maintenance, Logistics
  - Obsolescence
  - Reflection on past
    - Lessons learned
- Changes and their effects
  - Innovative and adaptive
- Current paradigm is a step in the staircase of history
  - opens mind to new thoughts



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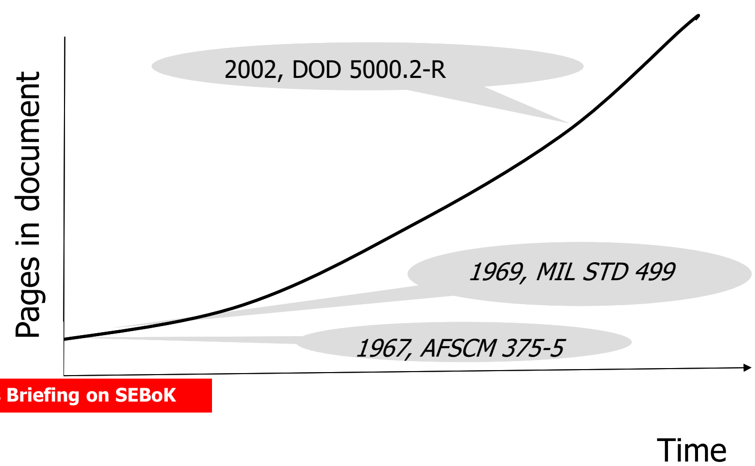
Degree of micromanagement in "systems engineering" Standards



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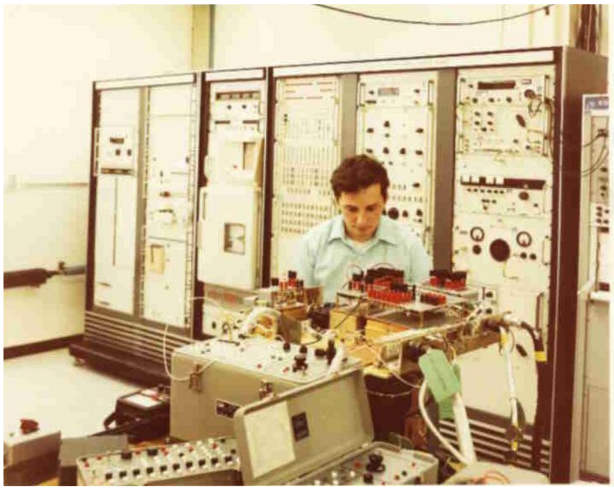
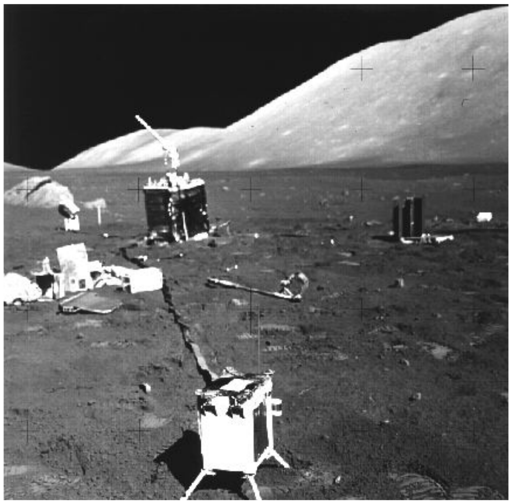
Successes: NASA Apollo





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Successes: Singapore*

- Social System
  - Public Housing
- Economic System
  - Industrial Development
- Defence System
  - Air Defence

Dr Goh Keng Swee
- Minister
- Visionary
- Economist
- Systems Architect
- Systems Engineer

*LUI Pao Chuen, Singapore: An Example of Large Scale Systems Engineering, APSEC, 23 March 2007.

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Poorly practiced -2 but need not be

Cost and Schedule Outcomes Sorted by Percent of Product Development Remaining

Programs	Percent cost growth[a]	Schedule growth, in months	Percent of development remaining
Aerial Common Sensor	45%	24	85%
Future Combat System	48%	48	78%
Joint Strike Fighter	30%	23	60%
Expeditionary Fighting Vehicle	61%	48	49%
C-130 Avionics Modernization Program	122%	Delays anticipated	Undetermined
Global Hawk (RQ-4B)	166%	Delays anticipated	Undetermined

Sources: DOD (data); GAO (analysis and presentation).

[a]Cost growth is expressed as the percent change in program development cost estimates in 2005 base year dollars.

Bragging a little here: JSF **overrun predicted** in Kasser J.E., "Writing Requirements for Flexible Systems", *Proceedings of the INCOSE-UK Spring Symposium* May 2001.

Data from GAO Report 06-368, 2006

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Top 5 systems engineering issues in 2003*

1. Lack of awareness of the importance, value, timing, accountability, and organizational structure of Systems Engineering (SE) on programs
2. Adequate, qualified resources are generally not available within Government and industry for allocation on major programs
3. Insufficient systems engineering tools and environments to effectively execute systems engineering on programs
4. Requirements definition, development and management is not applied consistently and effectively
5. **Poor initial program formulation**

* As noted in the 2003 Task Group Report by the US National Defense Industrial Association (NDIA) Systems Engineering Division

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Top 5 systems engineering issues in 2003*

"It is a poor workman who blames his tools"

3. Insufficient systen ineering tools and environments to effectively execute systems e ring on programs

How did INCOSE' address the issues?

MBSE

* As noted in the 2003 Task Group Report by the US National Defense Industrial Association (NDIA) Systems Engineering Division

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Effective systems engineers

- *"Systems, even very large systems, are not developed by the tools of Systems Engineering, but only by the engineers using the tools."* *

- Dr. Robert A. Frosch, 1969
  - Assistant Secretary of the Navy for Research and Development
  - Later becoming NASA Administrator during the Carter Administration (1977-1981)

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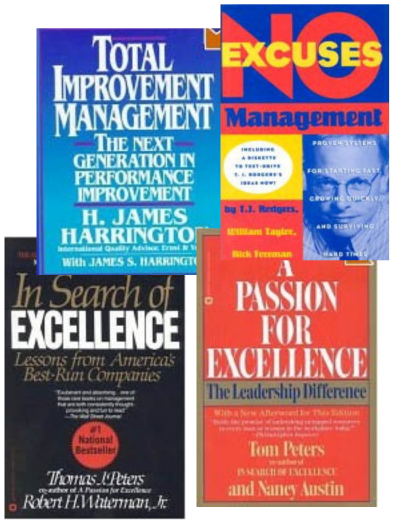
The focus is on **people** not process

- Literature
  - Is full of advice as to how to make projects succeed
  - Has little if anything to say about the proliferating process standards
- Garbage-in-garbage-out



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Failures due to poor practice

- **Inadequate systems engineering in the early design and definition stages** of a project has historically been the cause of major program technical, cost, and schedule problems.
  - **2003** United States of America Department of Defense report on the acquisition of national security space programs
- **The area not covered in the Standards**
- In the March-April 2005 issue of Defense AT & L (pages 14-17), Michael W. Wynne, acting under secretary of defense for acquisition, technology and logistics, and Mark D. Schaeffer, principal deputy, defense systems and director, systems engineering, Office of the USD(AT & L), called for the revitalization of systems engineering across the Department of Defense. "Analyses of a sampling of major acquisition programs show **a definite linkage between escalating costs and the ineffective application of systems engineering,"**
  - http://findarticles.com/p/articles/mi_m0QMG/is_3_34/ai_n13790803

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Standards produced ….

- **Inadequate systems engineering in the early design and definition stages** of a project has historically bee… f major program technical, cost, and sc…
  - **2003** United States of America Departm… rams
- In the March-April 200… nse for acqui… en… Defense. "Ar…
  a … costs and the in… systems engineering,"
  - …/mi_m0QMG/is_3_34/ai_n13790803

Conclusion (Scientific HTP)
Standards might help you produce the wrong system more effectively

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Continuum perspective: observe

1. Dichotomies
   - Complexity
   - Systems and systems of systems
2. Differences between
   - Lifecycle models
   - Systems engineering and other disciplines
   - Roles and activities
     - SETR and SETA
   - Various version of the systems engineering process
   - 'A' and 'B' paradigms
   - Domains of the problem
   - Types of problems
   - Subjective and objective complexity
   - Types of systems engineers

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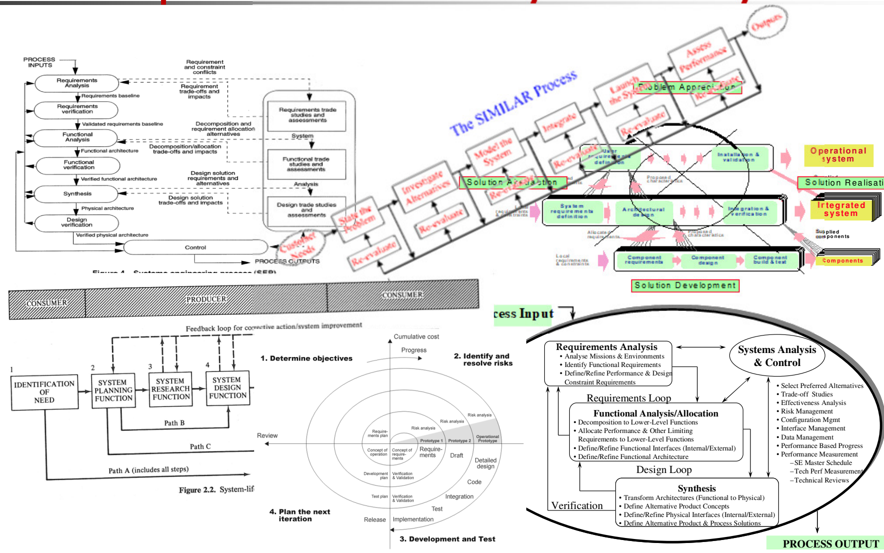
Which process and why are they different?



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‘A’ and ‘B’ paradigms

‘A’ paradigm (original)

CONOPS → System Architecture → Requirements → Subsystem Design

‘B’ paradigm (many real-world projects)

Requirements → CONOPS → System Architecture → Subsystem Design

- Shown as a linear flow for educational purposes
  - E.g. an infeasible requirement may modify the CONOPS which would be shown as a confusing feedback loop
- Constraints (legal, etc.) also drive CONOPS and system architecture in both paradigms
- System architecture may change during subsystem design

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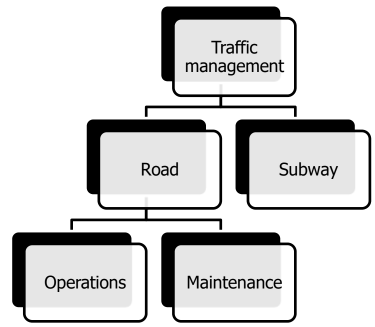
Domains of the problem

1. Problem
   - E.g. reducing road traffic congestion
     - in road traffic management domain
2. Solution
   - E.g. subway system
3. Implementation
   - E.g. tunnel boring, road traffic management



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Five types of systems engineers*

- **Type V [Innovator, engineer-leader]**
  - Problem formulator and problem solver
  - Directs and performs systems engineering
- **Type IV [Problem formulator]**
  - Has the ability to examine the situation and define the problem
  - [Cannot conceptualise a solution]
- **Type III [Problem solver]**
  - Has the expertise to conceptualize the solution system and plan the implementation of the solution
- **Type II [Apprentice, doer]**
  - Has the ability to follow a process to implement a physical solution system
- **Type I [Problem causer]**
  - Has to be told "how" to so something

* Kasser, Hitchins and Huynh, 2009

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Generic perspective

- What is systems engineering similar to?
  - Other disciplines?
- ~~Early stages of disciplines~~
  - ~~Myths and defects~~
- ~~Frameworks in other disciplines~~
- ~~Tiger Pro~~

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Systems engineering is similar to Math

- Mathematics
  - A set of mathematical tools for remedying mathematical problems
    - Used in all disciplines
    - **Structured as pure and applied mathematics**
- Systems engineering – the activity (SETA)
  - A set of problem-solving tools for remedying complex problems
    - Deal with parts and their interactions as a whole
    - Used in all disciplines
    - **Structured as pure and applied systems engineering (as used in domain systems engineering)**

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Three types of SETA

1. Pure systems engineering
   - Systems thinking and beyond
     - Cognitive skills, problem formulation/ solving, quantitative methods, decision-making
2. Applied systems engineering (scenarios)
   - Requirements, architectures, V&V, engineering management, engineering, *ilities, etc.
3. Domain systems engineering

Similar to Mathematics (pure and applied)

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Operational perspective

- What systems engineers do
  - Scenarios or Use Cases
  - Work in **processes**
- What systems engineers produce
  - Create **products**
    - Documents, etc.
    - Different degrees of complexity
- What systems engineers don't produce
  - **Systems**

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SETA scenarios

- Use pure systems engineering thinking tools in following applied systems engineering activities
  - Conceptual design
  - Requirements management
  - Architecting
  - Interface management
  - Testing
  - Integrating
  - Verification and validation
  - Engineering management
  - Others

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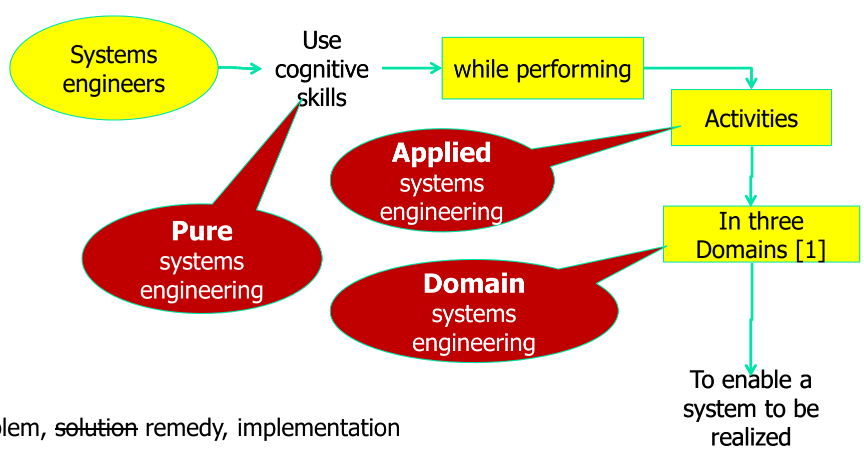
Pure, applied and domain systems engineering



[1] Problem, ~~solution~~ remedy, implementation

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Scientific perspective

Statement of the problem and solution
- Filtering out pertinent information
- Similar to 'trial and error' approach to problem solving

Hypothesis formulation and testing

Guesses

Designs

Research questions

Outcome of critical thinking

Issue or problematic situation (as-is)

Critical thinking

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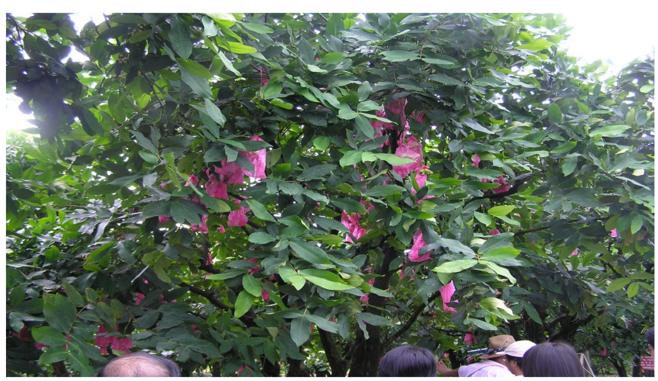
Critical thinking - Plastic bag tree?



Conclusions, decisions and inferences are only as good as your domain knowledge

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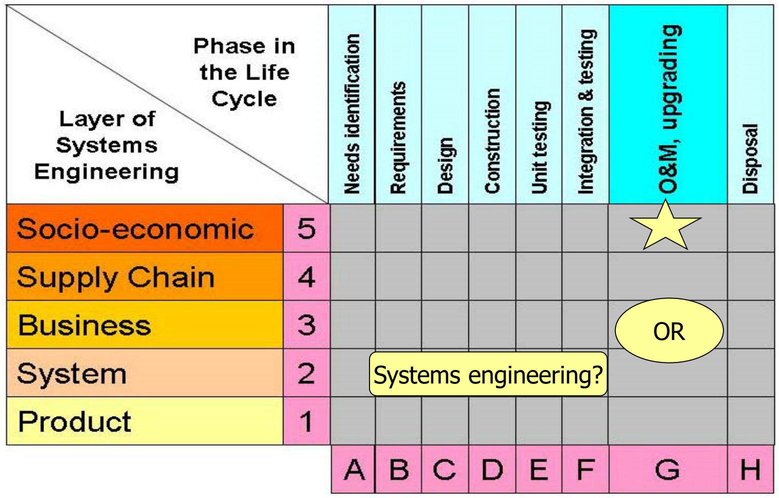
The Hitchins-Kasser-Massie Framework for understanding systems engineering*

- Systems engineers work in boxes
- Many systems engineers have no idea what is going on in the other boxes
- Kasser and Massie, A Framework for a Systems Engineering Body of Knowledge, *proceedings of the 11th International Symposium of the INCOSE, Melbourne, Australia, 2001.*
- Kasser, J. E., The Hitchins-Kasser-Massie (HKM) Framework for Systems Engineering, *proceedings of the 17th International Symposium of the INCOSE,* San Diego, CA., 2007.



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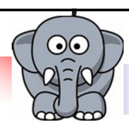

Reasons systems engineering is confusing and sometimes contradictory

Camp/ Pure/Applied	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
Lifecycle (all or part)[1]	X	X	-	X	-	X	-	X	X
Process	-	X	-	X	-	X	-	X	X
Problem	-	-	X	-	-	-	X	-	X
[Meta-] Discipline	-	X	-	-	-	-	-	-	X
Domain	-	-	-	-	-	X	-	-	X
Systems thinking	X	-	X	-	X	-	X	-	X
Enabler	-	-	-	-	X	-	-	-	X
Pure systems engineering	X	-	X	-	X	-	X	-	X
Applied systems engineering	X	X	X	X	-	X	-	X	X

Note 1 The parts of the lifecycle may be different, so what is done is different

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What you can do with this understanding

1. Define the information you need by
   1. Positioning your area of activity in the HKM Framework
   2. Identifying the camp (perspective) you need to view it from
   3. Defining the mixture of pure, applied and domain systems engineering
2. Find the book or course that will provide the information
   - Asking someone in an INCOSE working group or Café, or fellow student, coach, mentor, etc. who has faced the type of problem before
3. For example, if you want to get a Master's degree

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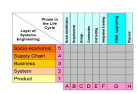
Las Vegas, NV
June 30 - July 3, 2014

HKMF area coverage

Hitchins Layer	1	2	3	4	5	6	7	8	9	10	11
5 Socio-economic		0.06									
4 Supply chain		0.19									
3 Business/SoS	0.10	0.06	0.10				0.10				0.10
2 System	0.80	0.19	0.50	0.17	0.30	0.50	0.50	0.20	0.10	0.40	0.50
1 Product		0.13							0.10		0.20

Lifecycle phase	1	2	3	4	5	6	7	8	9	10	11
A. Needs	0.10	0.31	0.10								0.20
B. Requirements	0.01	0.01	0.23	0.17	0.10	0.10	0.10			0.01	*
C. Design/Architecting	0.10	0.06	0.23	0.17	0.10	0.10	0.05			0.11	*
D. Construction		0.01									*
E. Unit testing		0.01									*
F. Integration & Testing	0.10	0.01	0.03		0.10	0.10	0.10			0.12	*
G. Operations	0.01										*
H. Disposal	0.01										*

0.1 means 1 course



* Present but not documented on web site, expect same applies to other degrees

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Five top aspects (requirements)

- The five top aspects of the engineering design process that best equip secondary students to understand, manage, and solve technological problems (Wicklein, et al., 2009):
  1. Multiple solutions to a problem/requirement,
  2. Oral communications
  3. Graphical/pictorial communication
  4. Ability to handle open-ended/ill-defined problems
  5. Systems thinking

	1	2	3	4	5	6	7	8	9	10	11
1. Multiple solutions to a problem/requirement											HT
2. Oral communications											HT
3. Graphical/pictorial communication											HT
4. Ability to handle open-ended/ill-defined problems											HT
5. Systems thinking			0.01								HT

0.1 means 1 course

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Questions and comments

- Academia is not teaching the right things in systems engineering Master's courses
  - Kasser J.E., Zhao Y-Y., "Towards a Grand Unified Theory of Systems Engineering", SETE 2014
  - Kasser J.E., "Improving the practice of systems engineering by adjusting the terminology", submitted to EMEASEC, 2014
- Who wants to create/join a new INCOSE working group to address these issues?
- INCOSE's response to the presentation came in an email from Cecilia Haskins
- I was banned from presenting at the IS for the following two years

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The complexity dichotomy

The need to develop new tools and techniques to solve these problems

- The problems posed by complexity seem to be unmanageable (Shinner, 1976)
- The systemic reason for the challenged projects in the Chaos, 1998 study was their inherent complexity (Bar-Yam, 2003)
- "*For all practical purposes adequate testing of complex engineered systems is impossible*" (Bar-Yam, 2003)
- The Complexity Primer for Systems Engineers (Sheard et al., 2013)

These complex problems are being remedied successfully

- National railway networks
- Cruise ships (fleets)
- International airlines
- International air freight forwarding companies
- Automated rapid transit systems
- Banking via Internet and automatic teller machines (ATM)
- Hospitals
- Oil rigs
- Etc.

Systems thinking: the elephant in the room Copyright Joseph Kasser 2019

Why do men say "ladies first"?

YouTube.com/Laughing colours, 2016

Systems engineers, good systems and outstanding systems engineers

- The difference between a systems engineer, a good systems engineer and an outstanding systems engineer
  1. **A systems engineer** creates the system **the customer asks for**
  2. **A good systems engineer** creates the system **the customer wants**
  3. **An outstanding systems engineer** creates the system **the customer needs**

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Let me tell you about George

- George conscientiously reads every one of the hundreds of requirements provided by the customer
- He has great difficulty understanding what the customer really wants
- He even tries to relate the requirements in a hierarchical structure
- It doesn't help much
- He tries modeling the requirements using a MBSE tool
- George still can't get a complete set of requirements from the customer
- The customer changes the requirements each time George talks with him

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George (as – is)

- George is a good systems engineer
- George is following the systems engineering process based on the Standards
- The customer is unhappy
- The project is going nowhere
- George cares but has no idea what to do about the situation

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George is stressed out

- **Because he is trying to**
  - Be a **good systems engineer**
  - Understand what the customer wants
- And even if he can understand what the customer wants, he still may not have defined the system the customer needs
  - Which is one reason the customer keeps changing the requirements
- **George needs to use the stress-free approach used by outstanding systems engineers**

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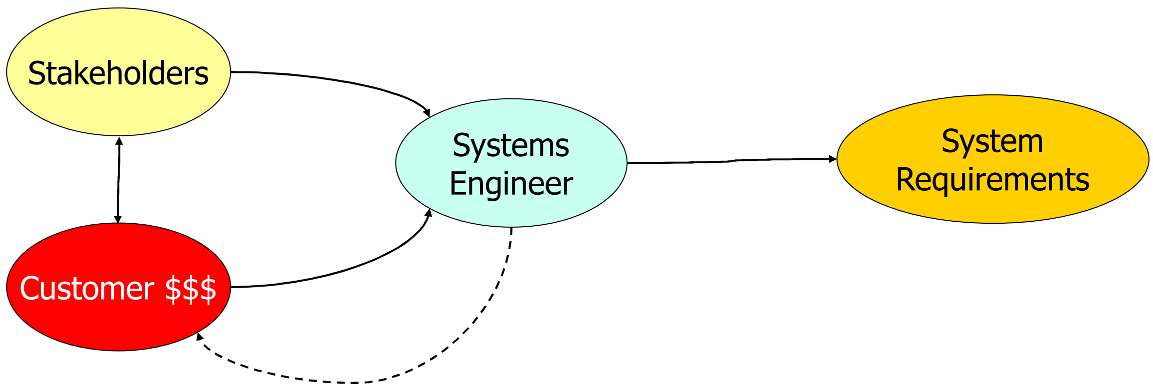
1. The systems engineer (nominal)



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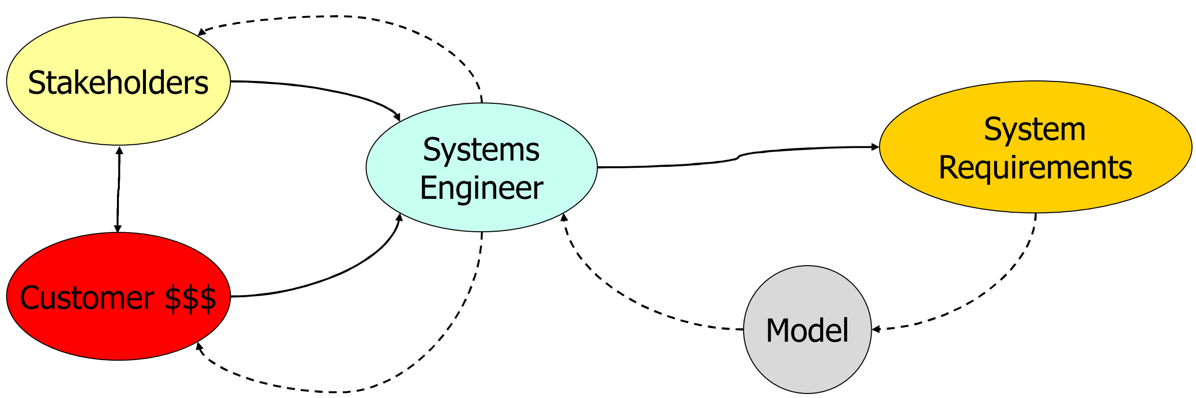
2. The good systems engineer (nominal)



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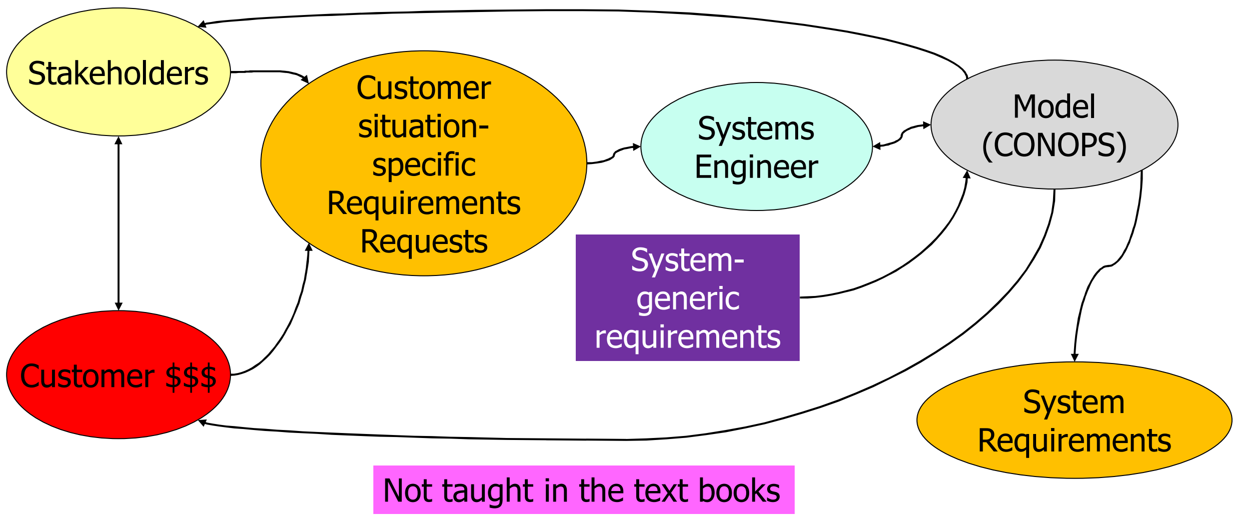
3. The outstanding systems engineer (nominal) understanding the need



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What you can do with this understanding

1. You can follow George's footsteps
   1. Become an outstanding systems engineer
   2. Learn how to apply systems thinking and beyond to problems
   3. Learn how other outstanding systems engineers tackled the type of problem you are facing
   4. Network with other others pursuing the same goal
   5. Join my Facebook group "Tackling Complex Problems"

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Benefits and drawbacks

- When you really use **systems thinking and beyond** you see things differently to other people
- You ask uncomfortable questions
- You challenge assumptions
- You are comfortable with knowing that you don't know in some instances
- You see solutions where other people see problems
- Nobody realizes the achievement because there weren't any problems
- You see what could have been so you are dissatisfied with your outcome when everyone else is raving about how good it is
- You are in a different paradigm

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Lessons learned

- You can't really solve a problem unless you understand the three domains
- Need to view a problematic situation from a number of perspectives in a systemic and systematic manner
- You need systems thinking and beyond to create (innovative) solutions
- Communications is the key
  - To success
  - To achieving recognition
  - Show future problems and plans mitigation (public risk management)
    - Use CRIP charts (YouTube video)
    - Use Enhanced Traffic Light charts (YouTube video)

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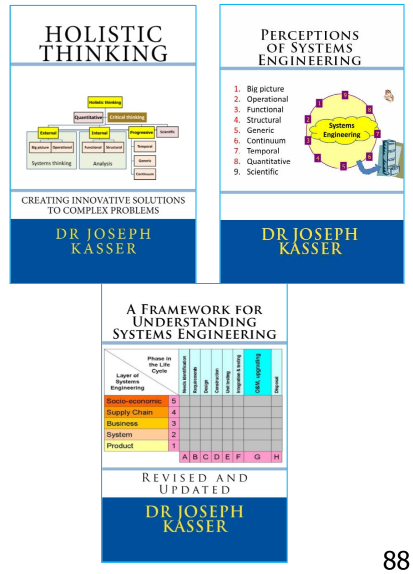
Be an outstanding systems engineer

- Join my Facebook group "Tackling Complex Problems"
- Read my published papers
  - Download from INCOSE or my website
- These three books (as pdf) are free for a limited time if you send me an email request
- Talk to me about your problem
- You might even qualify to join my EverCourses



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Situation Awareness States

6A Walking away	6.B Trying to change the situation
6. Doing something about the situation	
5. Working out how to make the change	
4. Grumbling and complaining	
3. Accepting situation (living with/without it)	
2. Identifying that something needs to change/could be changed	
1. Not realizing that something needs to change	

Progress may not be linear

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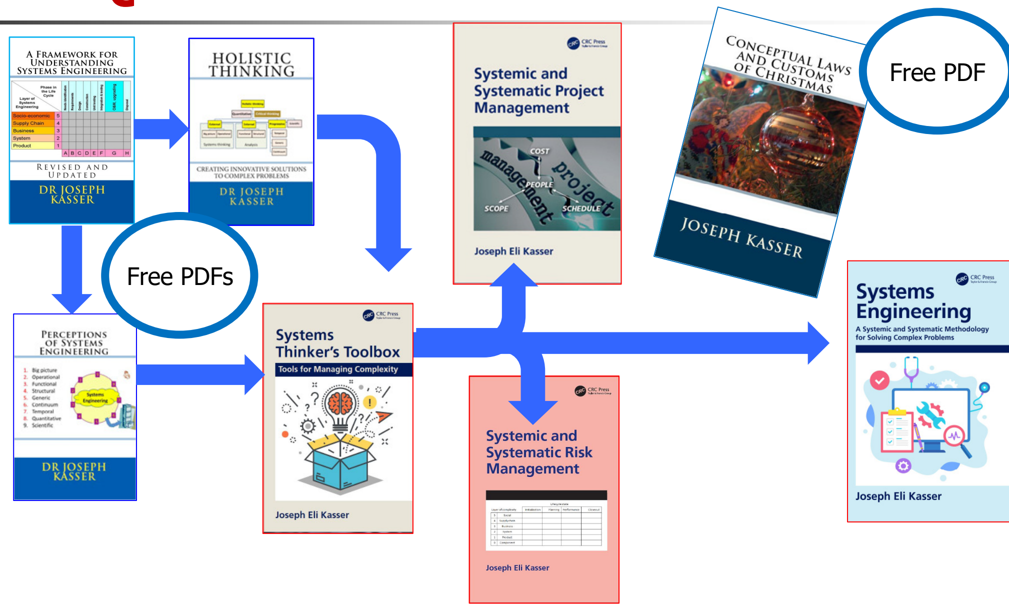
Questions and comments?



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