

Academic forum briefing: Version 1.12



GRCSE and BKCASE: what a load of codswallop; the how and the why!

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<http://therightrequirement.com>

DISCLAIMERS:

1. Anything I say may or may not reflect my opinion. Apologies in advance if I offend anybody.
2. References to organizations and people are to hypothetical organizations and people.



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Standard Type II systems engineering approach



- Following the process (sort of), ignoring the problem
- Focusing on wrong things
- Focusing on easy things
- Not tackling the hard questions
- Building in excessive complexity
- Not grounded in research
 - See lack of citations in GRCSE
 - Been there done that, Kasser-Hitchins Fellows effort , 2008-9
- Inward looking
 - Limited to functional perspective, ignores operational and temporal
 - Typical engineering partial solution
- Doomed to failure unless something changes
 - Waste of time and resources

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Systems engineering (SE) – the hard questions



- “DoD recognizes that their own SE success depends on having a **well-accepted robust SE BoK** on which standard practice, certification, and workforce competency and education can be based”
 - (Art Pyster, Fellows Briefing, INCOSE Singapore, 2009)
- How can it be a **well-accepted robust SE BoK** without answering the following questions?
 1. **Why** is there no universal agreed-to definition of SE?
 2. **Why** are there differing views on nature of SE?
 3. **Why** are there dichotomies?
 - SOS and complex systems
 - In general, Defense has problems, industry copes
 4. **Why** does SE work well sometimes?
 5. **Why** does SE fail miserably (and expensively) other times?
 6. **Why** is there no widely accepted body of knowledge?

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Purpose of GRCSE



- *“The principal purpose of GRCSE will be to provide a set of tailorable recommendations for developing and improving curricula that provide systems engineering education at the master’s degree level in systems engineering centric programs. It is not intended to be the basis for accreditation.”*
- Were S/W predecessors supported by academia?
- Who is sponsoring the work?
 - “The U.S. Department of Defense’s (DoD) Office of the Secretary of Defense (OSD) is the principal iSSEc sponsor, ”
- Are we talking about a future “Standard” for Education?
 - What will it contain?
 - Knowledge, pedagogy, etc.?
 - How detailed will it be?

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DoD: Focus on systems engineering process Standards



- “The **successful implementation of proven, disciplined systems engineering processes** results in a total system solution that is--
 - Robust to changing technical, production, and operating environments;
 - Adaptive to the needs of the user; and
 - Balanced among the multiple requirements, design considerations, design constraints, and program budgets.”*

- “A **single process**, standardizing the scope, purpose and a set of development actions, **has been traditionally associated with systems engineering.****

* United States Department of Defense 5000 Guidebook 4.1.1

** Arnold, 2000 quoting (MIL-STD-499B, 1993) and (IEEE 1220, 1998)

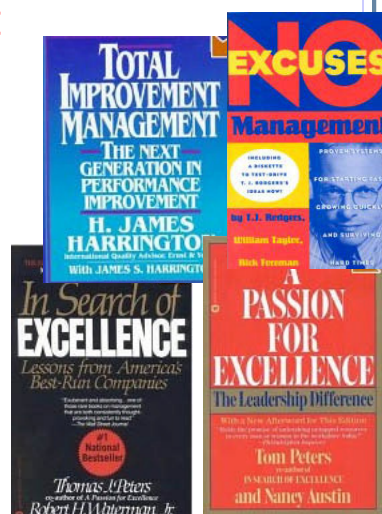
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The focus is on **people** not process



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



Kasser, J. E., "The Certified Systems Engineer - It's About Time!" proceedings of The 10th Annual Symposium of the INCOSE, Minneapolis, MN, 2000.

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Generic-temporal-scientific perspective



So, how did we get into this situation?

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Failures: USAF: systems approach fails



- 68 systems @ \$10 Billion from 1955 to 1969*
 - B-70 manned supersonic bomber
 - F-111A and B fighter-bomber
 - C5A heavy transport
 - Cheyenne jet combat helicopter
 - Air Force Manned Orbital Laboratory
 - Etc.

* *Congressional Record*, Vol 115, no 59, April 15, 1969 quoted in Kenyon B. De Greene (Ed), *Systems Psychology*, McGraw-Hill Book Company, 1970 reprinted in *Systems Behaviour*, 3rd Edition 1988, Geoff Peters (Ed), Open Systems Group, Paul Chapman Publishing Ltd, 1972

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DoD Reaction- create Standards



- Myth*
 - There are Standards for systems engineering
- Reality
 - There are no such Standards
 - Standards cover
 - Process for engineering systems
 - » different parts of the process
 - Engineering Management
 - Moreover, Standards focus on wrong aspect

* J. E. Kasser, "Seven systems engineering myths and the corresponding realities," the Systems Engineering Test and Evaluation Conference, Adelaide, Australia, 2010.

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

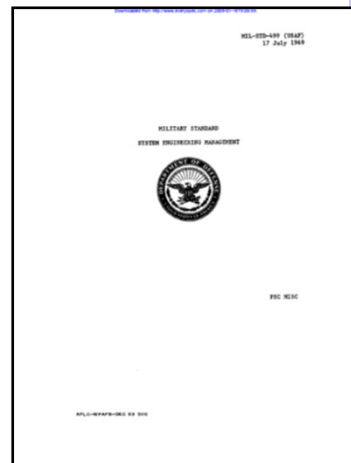
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499 Systems engineering management



- Purpose to develop a Systems Engineering Management Plan
 - Not to do systems engineering
- Two templates
 - Generally not tailored
- MIL-STD-499A Systems Engineering Management



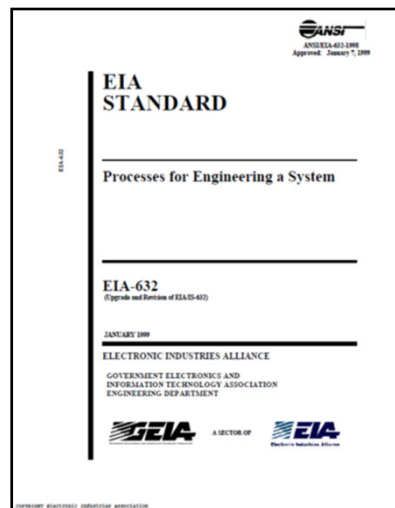
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EIA-632



- **Process** for engineering a system
- Not process for systems engineering



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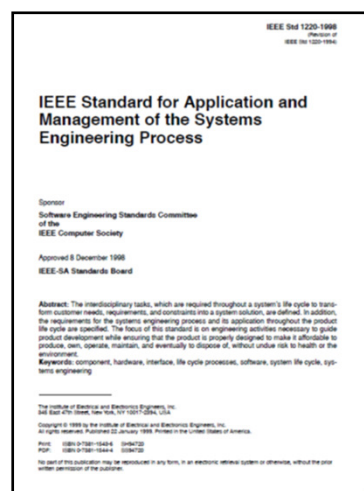
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IEEE-1220



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

The systems engineering process provides a focused approach for product development that attempts to balance all factors associated with product life cycle viability and competitiveness in a global marketplace.”



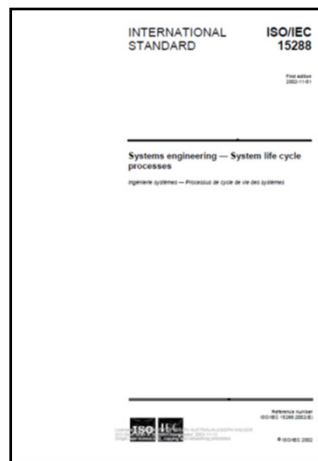
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ISO-IEC 15288



- Systems Engineering Process
- Purchase price*
 - CHF 168,000
- Current version 15288:2008
- Revised from 2002 version



* http://www.iso.org/iso/catalogue_detail?csnumber=43564

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Where should standards focus?

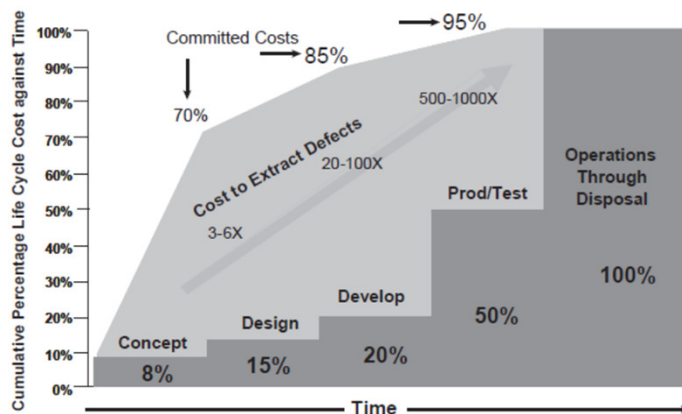


Figure 2-3 Committed Life Cycle Cost against Time¹⁰

DAU, 1993 quoted in INCOSE Systems Engineering Handbook 3.1 (2nd Printing) modified

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Focus of Standards – chronological perspective



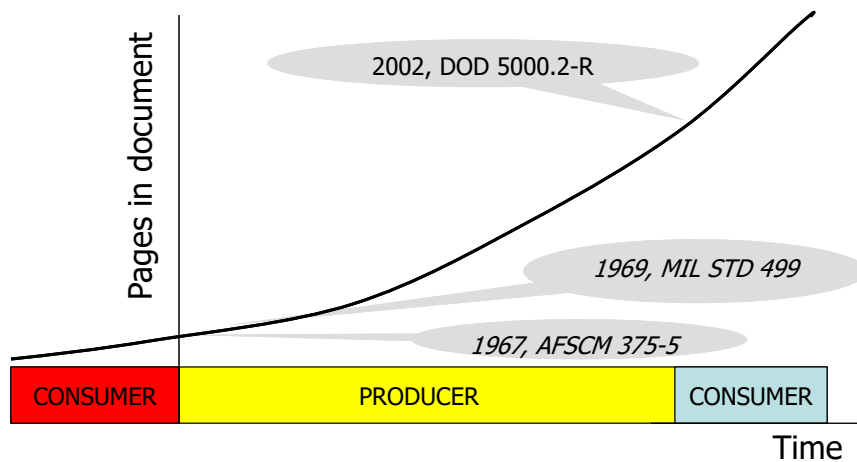
SE Categories	MIL-STD-499[C]	ANSI/ EIA 632	IEEE-1220	CMMI	ISO-15288
Conceptualizing problem and alternative solutions	No	No	No	No	No
Mission/purpose definition	No	No	✓	✓	✓
Requirements engineering	✓	✓	✓	✓	✓
System architecting	✓	✓	✓	✓	✓
System implementation	No	✓	No	✓	✓
Technical analysis	✓	✓	✓	✓	✓
Technical 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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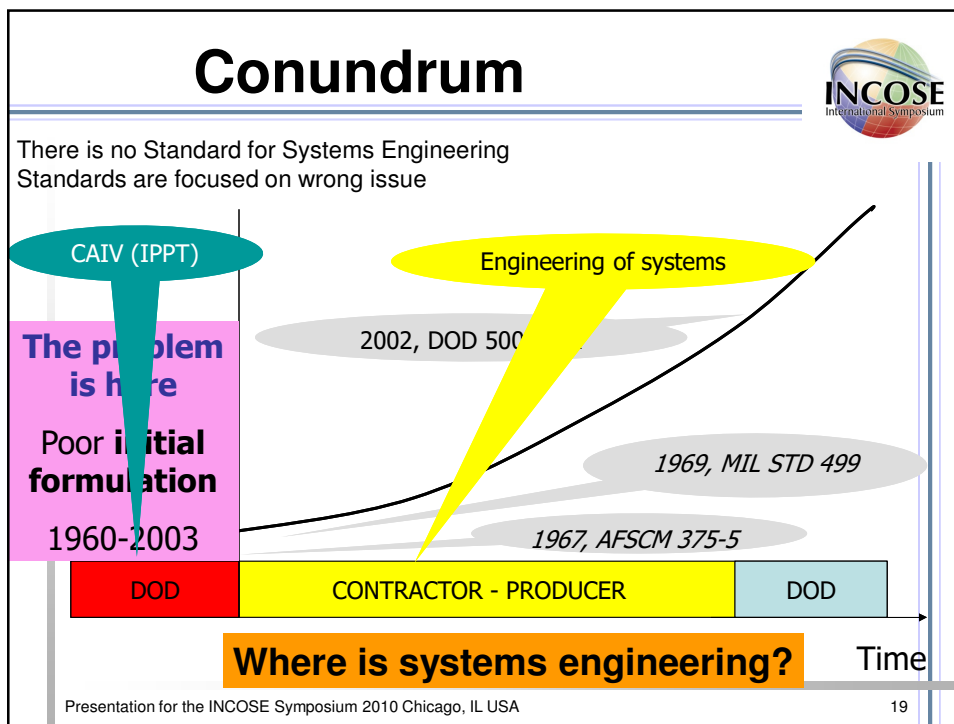
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Degree of micromanagement in Standards




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Standards produced



- **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, Office of national
- In the ...
acting ...
Schaefer ...
the USD ...
Departm ...
... of a sampling of major acquisition programs show

Conclusion
Standards might help you produce the wrong system more effectively

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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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).

^aCost growth is expressed as the percent change in program development cost estimates in 2005 base year dollars.

Data from GAO Report 06-368, 2006

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**.

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DOD Reaction: produce more standards



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

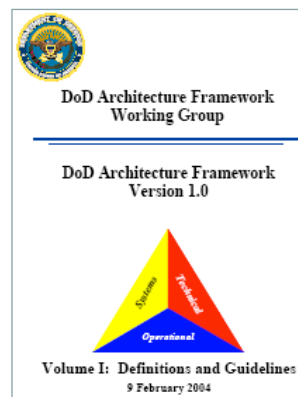
Volume I: **83** pages
Definitions, Guidelines, and Background

Volume II: **249** pages
Product Descriptions

Deskbook: **256** pages
Supplementary information to Framework users

CADM **696** pages
core data model

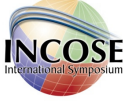
Over 1200 data elements



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DoDAF OV-1?

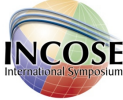


OV-1 Describes use of system

Use of DODAF with help from Dilbert

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Purpose of systems engineering



- Joe's impression
 - Producing the right product at the right time to provide the right solution to the right problem even if the problem changes
- **Wrong!** Standards ensure that it is:
 - To create more work for more systems engineers by
 1. Making things excessively complicated
 2. Giving them lots of forms to fill out instead of doing something productive

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Systems engineering evolves



- Text books follow US DOD
 - Systems engineering began when he received a requirements specification (Todaro, 1988).
 - Requirements are one of the inputs to the 'systems engineering process'
 - (Martin, 1997) page 95), (Eisner, 1997) page 9), (DOD 5000.2-R, 2002), pages 83-84) and (Wasson, 2006) page 60)
- Focus is on following a process (Type II) not providing a solution to the problem (Type V)
- Stevens proposed INCOSE Reference curriculum follows US DOD approach (2007)
 - Written as a 'B' spec (MILD-STD-490)
 - Basis for GRCSC

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Systems engineering tools - evolution



- | | |
|--|---|
| <ul style="list-style-type: none"> ➤ 1950's and 1960's <ul style="list-style-type: none"> – Probability – Single thread – system logic – Queuing theory – Game theory – Linear programming – Group dynamics – Simulation – Information theory | <ul style="list-style-type: none"> ➤ 2000's* <ul style="list-style-type: none"> – Databases <ul style="list-style-type: none"> ▪ DOORS ▪ CORE – Drawing tools <ul style="list-style-type: none"> ▪ PowerPoint ▪ Visio – Word processors – Spreadsheets – Etc. |
|--|---|



* Jenkins, S., A Future for Systems Engineering Tools, *PDE 2005*, The 7th NASA-ESA Workshop on Product Data Exchange (PDE),
<http://www.marc.gatech.edu/events/pde2005/presentations/0.2-jenkins.pdf>
 Eisner, H., *Computer Aided Systems Engineering*, Prentice Hall, 1988.

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GRCSE Guiding principles



- “[1] *Systems engineering is a distinct discipline with a rich body of knowledge, practice, and theory.*”
 - True from a systems engineering perspective
 - **False from an external perspective**
 - Nothing in systems engineering is unique to systems engineering
 - » Except perhaps interface management and requirements management
 - Roles and activities overlap with
 - » Problem solving, project management, configuration management, ILS, design, etc.

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GRCSE Guiding principles

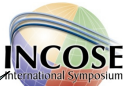


- “[2] *There is no generally recognized graduate reference curriculum for SE and there is a wide variation in existing programs.*”
 - *Two independent observations*
 - *Lack of understanding of root cause – usual cause of failure*
- The SE community, employers, practitioners, and academe have a sense that a reference curriculum for SE would be useful, **but there is no such reference curriculum which has been broadly accepted.**
- Questionable conclusion at best
 - Depends on how question is posed
 - Systems engineers tend to speak solution language, not problem language
 - **A curriculum is a design (a solution)**

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Benchmarking Master's degrees (2000-2006)



- Process to create Master's degree in systems engineering
 - Knowledge component
 - Systems engineering process, Requirements Architecting
 - Remainder varies according to institution
 - » Faculty expertise
 - Seem to be teaching cookbook approach, not an understanding of the basics
 - Process-based

Key operational constraint

Never give an order unless you are sure it is going to be carried out

- Students graduate with different knowledge and skills from each institution

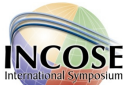
- Reinforces need for
 - Teaching modules
 - Derek Hitchcock Commons license

Why create a nugatory Standard?


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Populating the SEBOK



- Systems engineering approach is not being used
 - Writing knowledge before developing requirements
- Rearrangement of existing knowledge
- Process (Type II) focus
- No traceability of knowledge to on-the-job requirements
- Subjective
- Non-systems engineering knowledge lacking



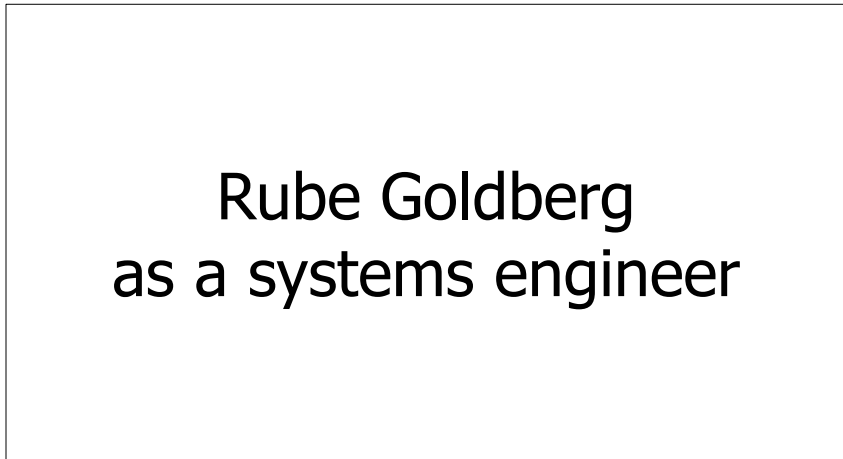
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Excessively complicated



System for sharpening a pencil

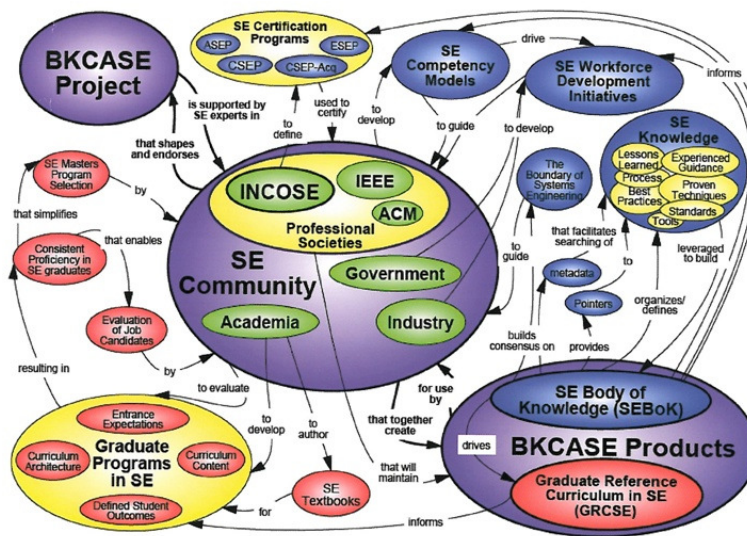


Rube Goldberg as a systems engineer

http://www.rubegoldberg.com/gallery_02.php

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Building artificial complexity



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Building artificial complexity



- Concept map illustrates thought
 - Fuzzy thinking
- At least 4 layers in hierarchy
- Violates Miller's rule for comprehension
 - 7 ± 2
- Lack of abstraction
 - Hierarchies – structural perspective
- Internal links undefined
- Links?
 - e.g. SE competency models not connected to job evaluation
- Etc.

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In summary: flawed project



- Following the process (sort of), ignoring the problem
- Focusing on wrong things
- Focusing on easy things
- Not tackling the hard questions
- Building in excessive complexity
- Not grounded in research
 - See lack of citations in GRCSE
 - Been there done that, Kasser-Hitchins Fellows effort , 2008-9
- Inward looking
 - Limited to functional perspective, ignores operational and temporal
 - Typical engineering partial solution
- Doomed to failure unless something changes
 - Waste of time and resources

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Your choices



- Follow DOD Type II paradigm and fail
 - Rearrange existing knowledge
 - Create a new Standard
 - Produce a nugatory product, ineffective systems engineers and consequently, more failing projects
 - Systems engineering follows, MBO, TQM and BPR into oblivion
- Focus on creating Type V systems engineers
 - Follow the TDSI approach in Singapore
 - Tackle the difficult questions
 - Tackle the difficult problem of teaching cognitive skills
 - Develop a SEBoK based on the knowledge and skills systems engineers actually need
 - See presentation for J. E. Kasser and M. Frank, "A Maturity Model for the Competency of Systems Engineers," the 20th International Symposium of the INCOSE, Chicago, IL., 2010.
 - J.E. Kasser and D. Hitchins, Report to INCOSE Fellows, 2009

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Choice 1: INCOSE IS 2020?



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