Day 1 Introduction to workshop topic

Abstract: SE as Multidiscipline Enabler / Art / Science

Dr. Regina Griego, Sandia Nat'l Labs, INCOSE Fellow. griegor@sandia.gov

The branding of systems engineering in many companies and with too many systems engineers is that systems engineering is about developing good process and enabling that process in an organization to achieve systems that are delivered on time, within schedule, and meets requirements. While process is an enabler, it is like the score of music that a good conductor interprets with talented musicians and instruments to deliver a system that not only meets customer expectations, but indeed delights the customer and has an enduring quality. The conductor (systems engineer) knows how to adjust the score for the effect they are trying to achieve and integrates the musicians effectively based on their unique abilities.

Think about the systems that you are most proud of, or the times that you have been a part of a system development effort that felt exciting, even exhilarating. Would you say they are works of art, or simply science, process, and project management? Systems architecture and design are the most obvious areas where the art of systems engineering is applied, but it is equally important to apply the art of understanding people and teaming. In systems engineering you are working with at least two systems, the system you are delivering and the system that is delivering. When have you experienced the flow as a systems engineer? How would you characterize systems engineering in your organization: process and project management or a blend of art and science?

This workshop will explore the art and science of systems engineering and the notion of the systems engineering brand.

Regina Griego

Regina is a Principal R&D Systems Engineer at Sandia National Laboratories and has extensive experience leading multi-agency and multidisciplinary teams in various domains. She is a teacher, mentor, and coach and recognized for her ability to elicit a common conceptual basis for realizing solutions. Regina is a Fellow of the INCOSE, past Technical Director, and the Enchantment Chapter Founding President."

Socorro Summit: Topic Introduction Systems Engineering as Multidiscipline Enabler / Art / Science

Regina M Griego, Ph.D.
Sandia National Laboratories
INCOSE Fellow

October, 28, 2016

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SE as Multidiscipline Enabler/Art/Science

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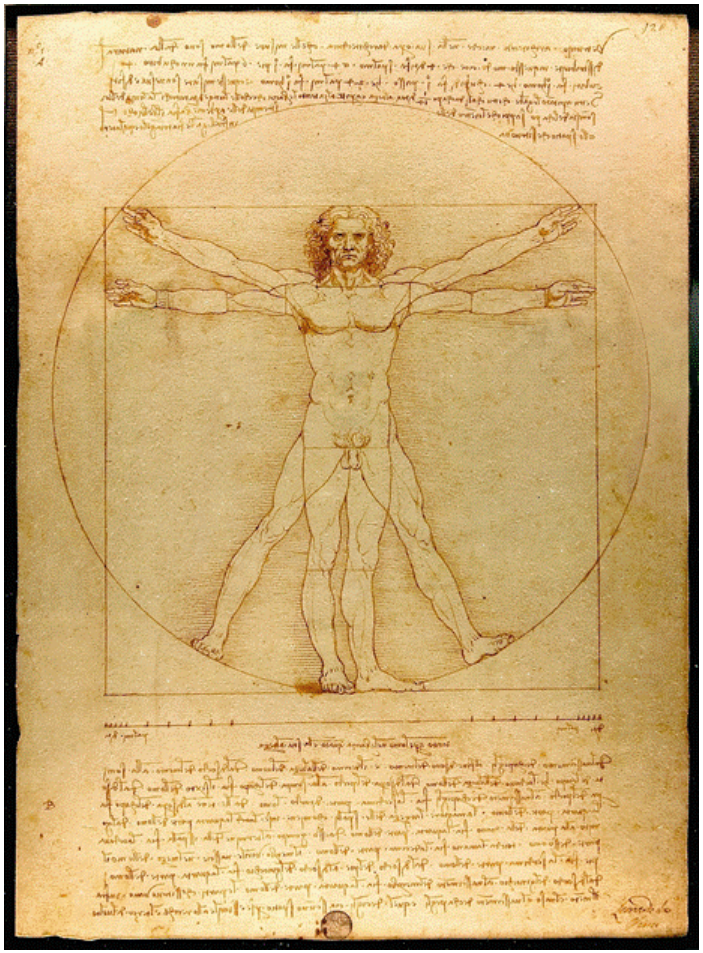
Workshop participants will own the agenda

"A Letter To Incoming Art School Freshman", K. Capasso, Odyssey, 2016

Art is a diverse range of human activities in creating visual, auditory or performing artifacts (artworks), expressing the author's imaginative or technical skill, intended to be appreciated for their beauty or emotional power.

(Wikipedia/Oxford Dictionary/Merriam-Webster)



Leonardo da Vinci
15 April 1452 - 2 May 1519
Artist or Scientist?

Are systems art?

in·no·va·tion

/ˌinəˈvāSH(ə)n/

noun
noun: **innovation**

the action or process of innovating.
synonyms: change, alteration, revolution, upheaval, transformation, metamorphosis, breakthrough; More

- a new method, idea, product, etc.
  plural noun: innovations
  "technological innovations designed to save energy"

"Try spending 15 to 30 minutes each day writing down questions that challenge the status quo in your company."

"The Innovator's DNA", J. H. Dyer, H. Gregersen, C. M. Christensen, HBR December 2009

Corning's Breakthrough Innovations

During its more than 160 years, Corning has leveraged its expertise in glass and materials science to produce a long list of highly successful products, including the following.

1800s

1879 Glass envelope for Thomas Edison's lightbulbs

1900s

1912 Glass for railroad lanterns that could withstand extreme temperature changes

1915 Heat-resistant Pyrex glass for cookware and laboratory equipment

1926 Ribbon machine for the mass production of lightbulbs

1932 High-purity fused silica—the foundation of other Corning innovations, such as telescope mirrors and optical fiber

1934 Silicones, a class of materials that are a cross between glass and plastic

1947 Process for mass-producing television picture tubes

1952 Heat- and break-resistant glass-ceramic material used in Corning Ware cookware and missile nose cones

1964 Fusion overflow process for producing flat glass

1970 Low-loss optical fiber used in telecommunications networks

1972 Cellular ceramic substrates used in automotive catalytic converters and today's diesel engines

1982 Active matrix liquid crystal display (LCD) glass for high-quality flat-panel displays

2000s

2007 Gorilla Glass—thin, lightweight glass with exceptional damage resistance for smartphones, tablets, and other consumer electronics

2012 Ultraslim, flexible, lightweight glass for consumer electronics and architectural and design applications

SOURCE CORNING; GARY P. PISANO FROM "YOU NEED AN INNOVATION STRATEGY," JUNE 2015

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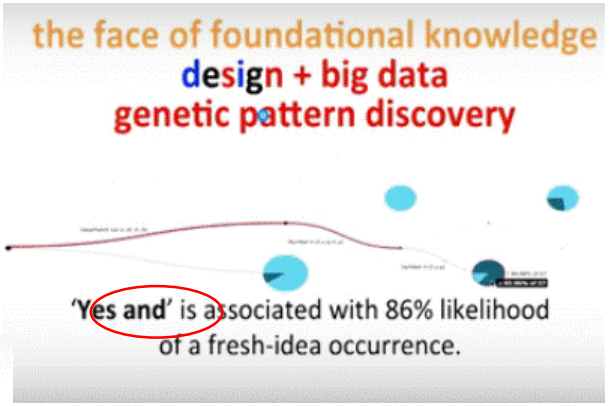
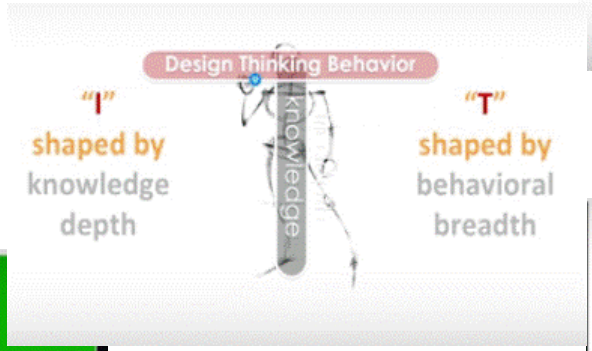
Design Thinking at Stanford - Prof Larry Leifer Keynote IS2016

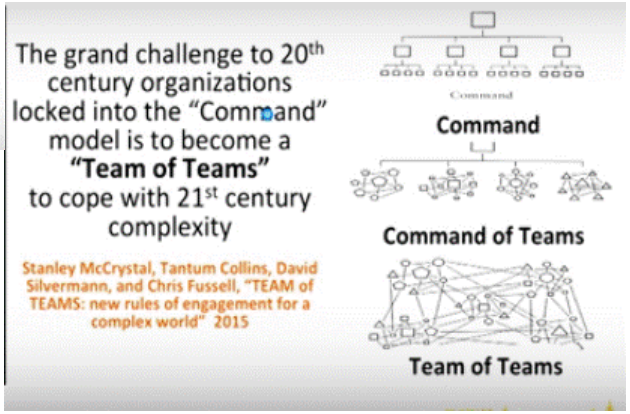
"How do systems engineers do what they do?"

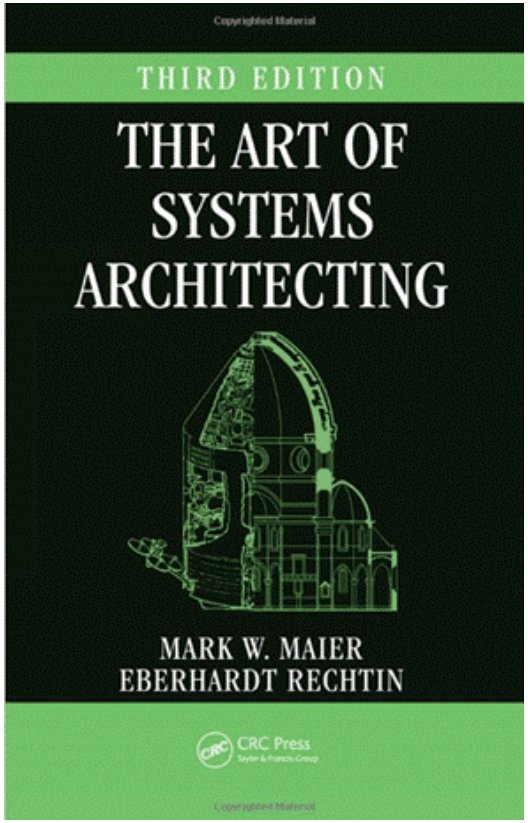


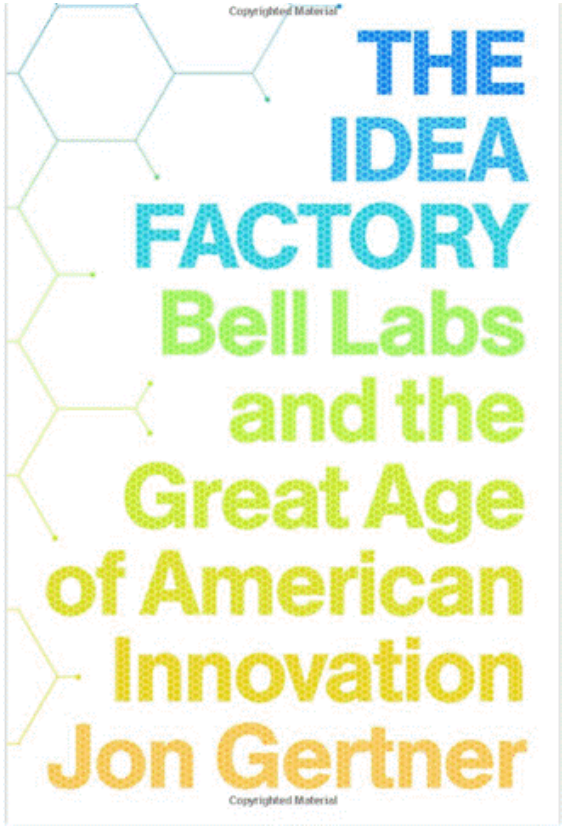
*"**but** word, very bad"*



"Need to balance the equation"



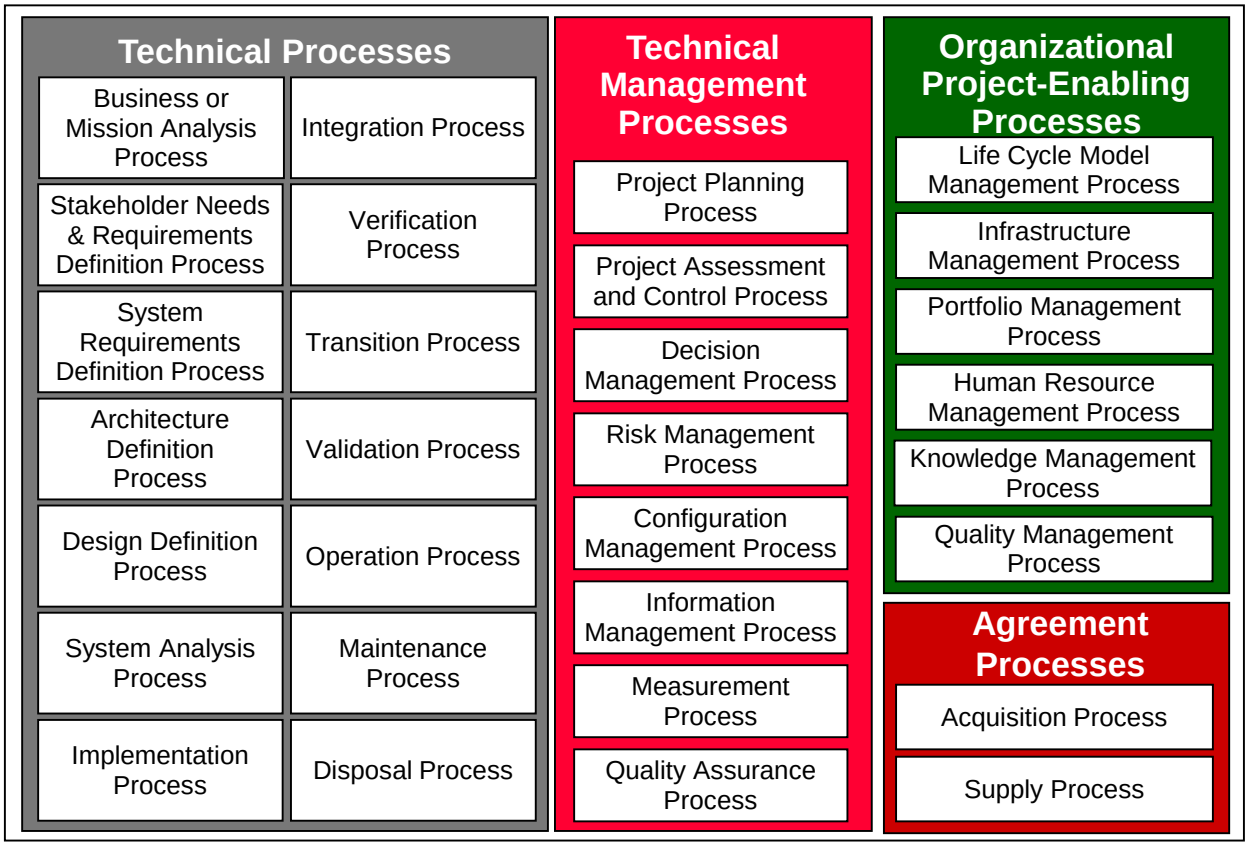




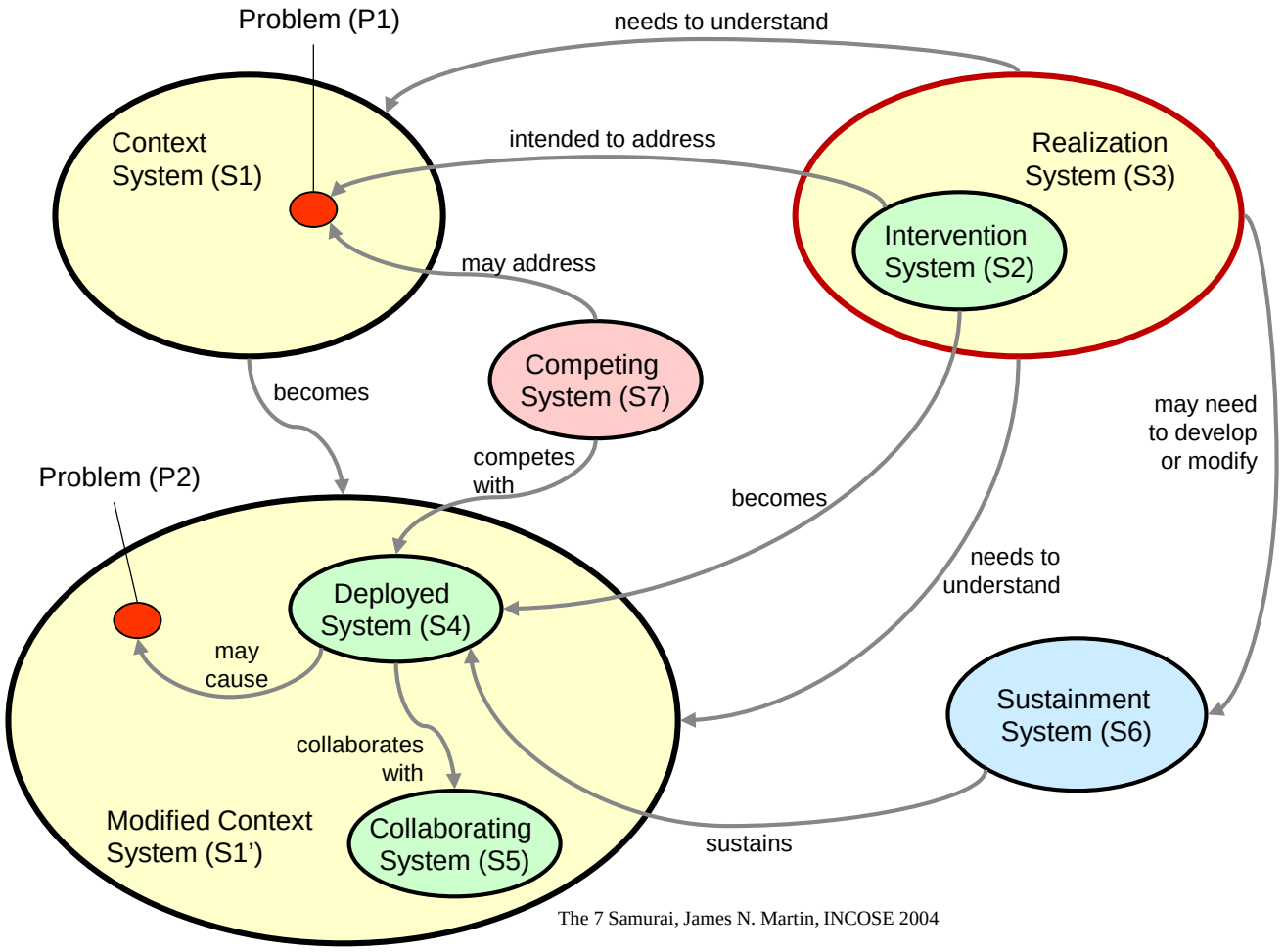
Is systems engineering an artistic endeavor?

ISO/IEC 15288 Processes

Or is systems engineering about applying good process in a systematic analytic way?



What about the system that realizes the system?



The 7 Samurai, James N. Martin, INCOSE 2004

And the people and teaming...

Definition of a Team

A team is a group of people
who work in collaboration
and hold each other
mutually accountable
to achieve a
common purpose
and set of performance goals.

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The Five Components of Emotional Intelligence at Work

	Definition	Hallmarks
Self-Awareness	the ability to recognize and understand your moods, emotions, and drives, as well as their effect on others	self-confidence realistic self-assessment self-deprecating sense of humor
Self-Regulation	the ability to control or redirect disruptive impulses and moods the propensity to suspend judgment – to think before acting	trustworthiness and integrity comfort with ambiguity openness to change
Motivation	a passion to work for reasons that go beyond money or status a propensity to pursue goals with energy and persistence	strong drive to achieve optimism, even in the face of failure organizational commitment
Empathy	the ability to understand the emotional makeup of other people skill in treating people according to their emotional reactions	expertise in building and retaining talent cross-cultural sensitivity service to clients and customers
Social Skill	proficiency in managing relationships and building networks an ability to find common ground and build rapport	effectiveness in leading change persuasiveness expertise in building and leading teams

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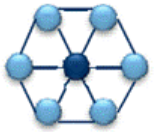
Source: BEST OF HBR 1998 - What Makes a Leader? by Daniel Goleman

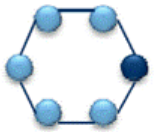
Team Types

What is your best teaming style?

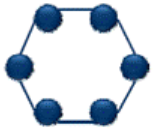
Leader-directed: The leader is essentially external to the group and interacts with people individually, managing separate agendas. The group members do not really interact or work closely together. This is not really a team as it represents a classic command and control structure. It can work powerfully in certain circumstances.



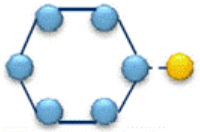
Working Group: The leader participates with the group and exercises command and control functions Group members work toward a common charter and in a common direction. They have some interaction to ensure the alignment and coordination of individual agendas, but interaction with the leader is primary.



Leader/Member: The leader sits as first among equals in terms of the team's work while still exercising some leadership roles. The team works collaboratively toward its goals and authority and decision-making is shared. There is some differentiation in rank between the team leader and team members.



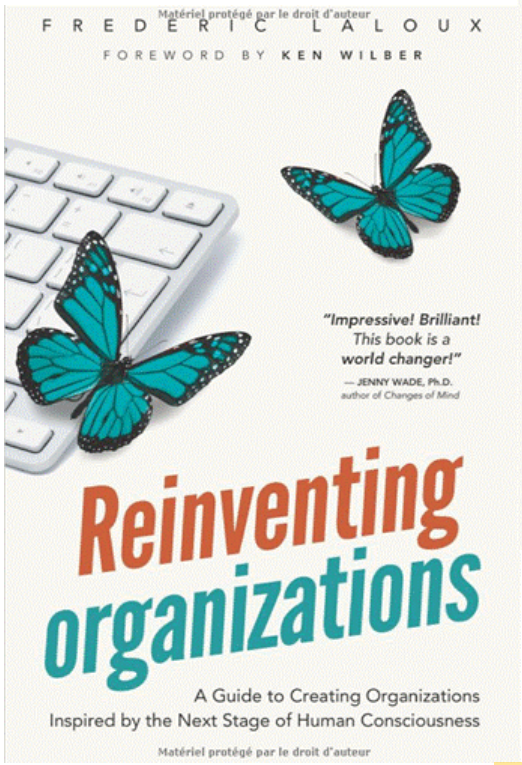
Rotating/Shared Leadership: There is no formal leader as all leadership roles are either shared amongst the members or members rotate through the leadership role. This design is typically used in transition situations or for short term teams.

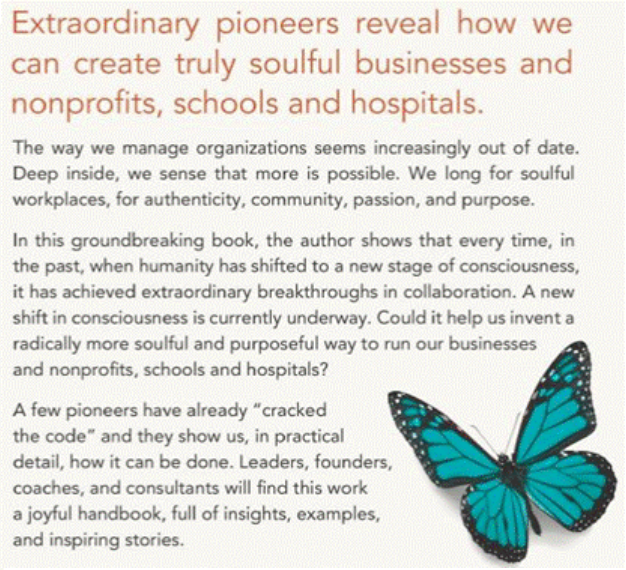


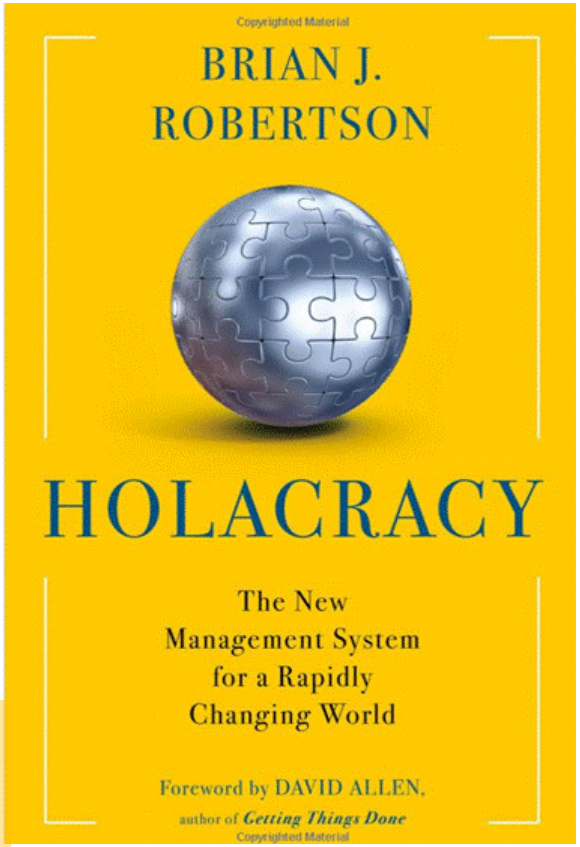
Self-Directed: There is no official leader role. All team members are empowered and accountable, and work collaboratively. A facilitator typically works with the team with a hands-off approach and serves as a liaison between the team and the organization.

© Accompli 2011

Organizations as incubators for Leanordo?







Holacracy is a revolutionary management system that redefines management and turns everyone into a leader.

Holacracy distributes authority and decision-making throughout an organization, and defines people not by hierarchy and titles, but by roles. Holacracy creates organizations that are fast, agile, and that succeed by pursuing their purpose, not following a dated and artificial plan.

This isn't anarchy it's quite the opposite. When you start to follow Holacracy, you learn to create new structures and ways of making decisions that empower the people who know the most about the work you do: your frontline colleagues.

Enchantment Chapter
INCOSE
International Council on Systems Engineering

brand

/brand/

verb
gerund or present participle: **branding**

1. mark (an animal, formerly a criminal or slave) with a branding iron.
   synonyms: mark, stamp, burn, sear
   "the letter M was branded on each animal"
   - mark indelibly.
     "an ointment that branded her with unsightly violet-colored splotches"
     synonyms: engrave, stamp, etch, imprint
     "the scene was branded on her brain"
   - describe (someone or something) as something bad or shameful.
     "the do-gooders branded us as politically incorrect"
     synonyms: stigmatize, mark out; More
2. assign a brand name to.
   "branded goods at low prices"
   - the promotion of a particular product or company by means of advertising and distinctive design.
     noun: branding

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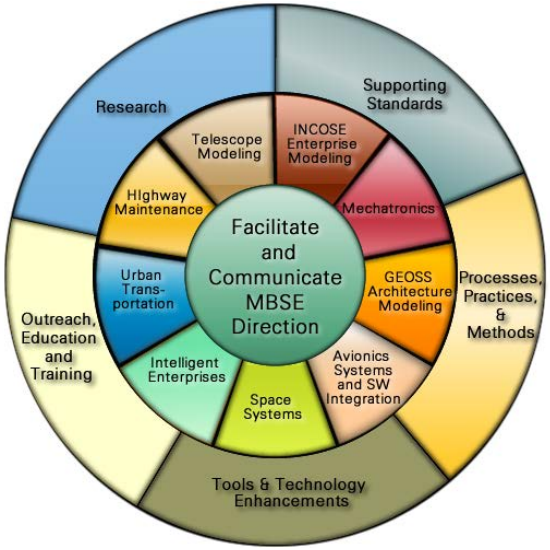
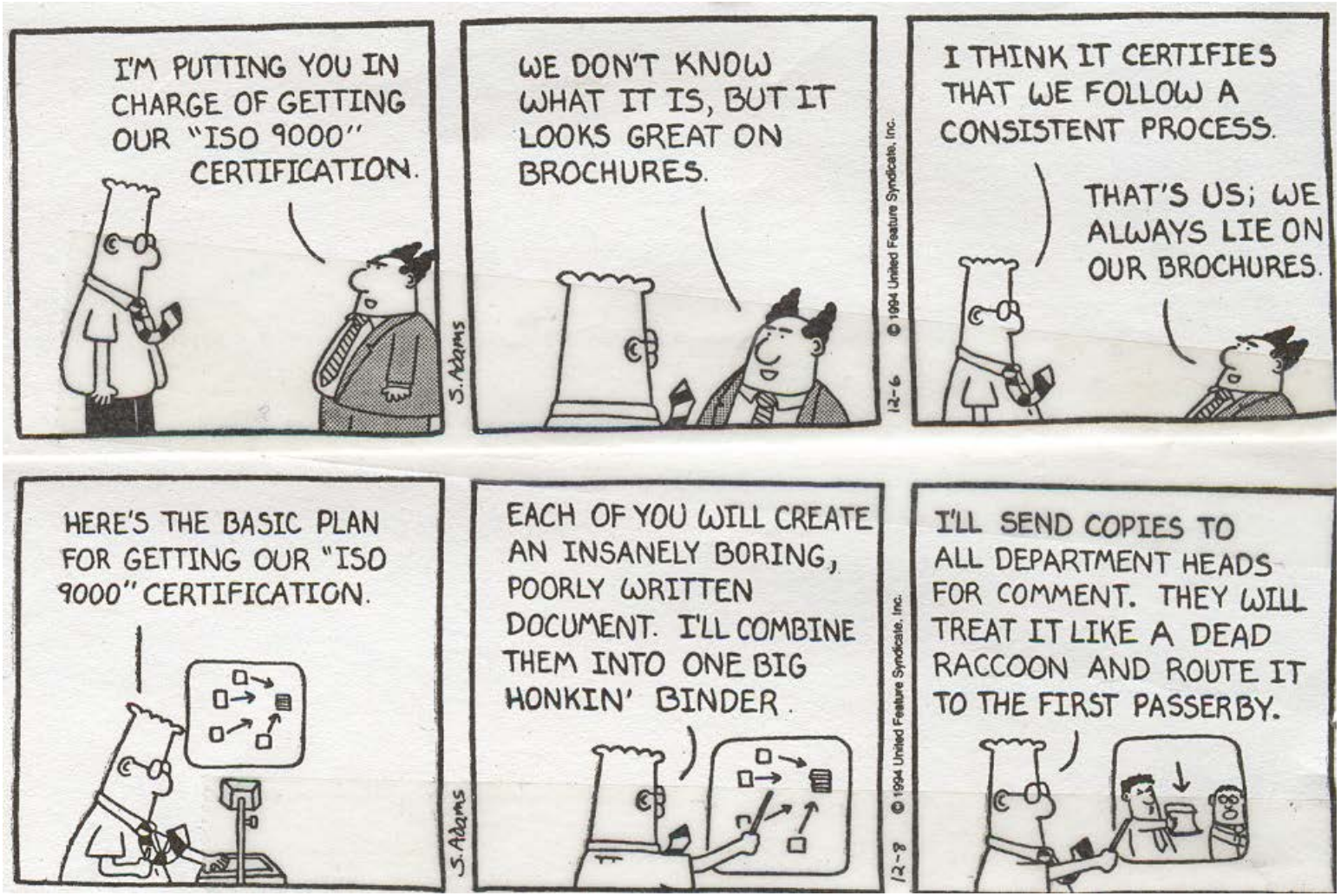


What is the Systems Engineering Brand?
What is the branding for Systems Engineers?

Sandia National Laboratories

Is this the "brand" we want for Systems Engineering



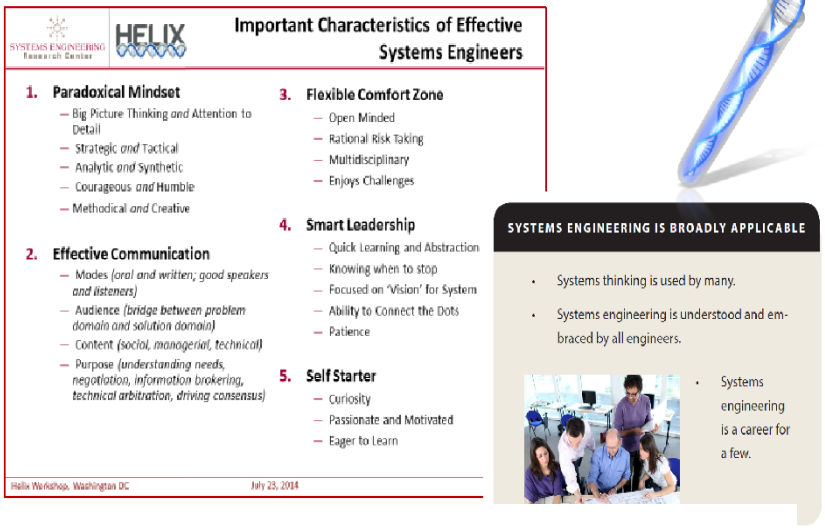
Systems Engineer Brand?

"One of my 'Hot Buttons' that I'm not only passionate about personally, but I think is critical for INCOSE and critical for this community called Systems Engineering, is elevating the sense of the contribution of the systems engineer. …a credentialed systems engineer is someone who the senior immediately wants to turn to because there is a faith that they will be a driving element in a solution. Now the reason why I think this is important and I believe it's a fundamental brand issue." John Thomas, INCOSE Past-President, IS2015

I believe a successful personal brand is cultivated from the inside out. By that, I mean, your personal brand *must* be rooted in that which is authentically you. Your brand is your unique promise of value. It is your individual stamp that reflects the unique combination of strengths, skills, passions, values and creative abilities that define you and differentiate you from others.

Rasheryl McCreary, Tao Leadership Development

Practitioners in Transition: Systems Engineers and Systems Engineering



Advancing our Competency

- Systems engineer is the linchpin
- Must lead/influence decision-making
- Balance hard & soft skills
- "T-shaped" individual

- Competency is key
  - Specialist SE skills
  - Wider general understanding
  - Leadership and soft skills

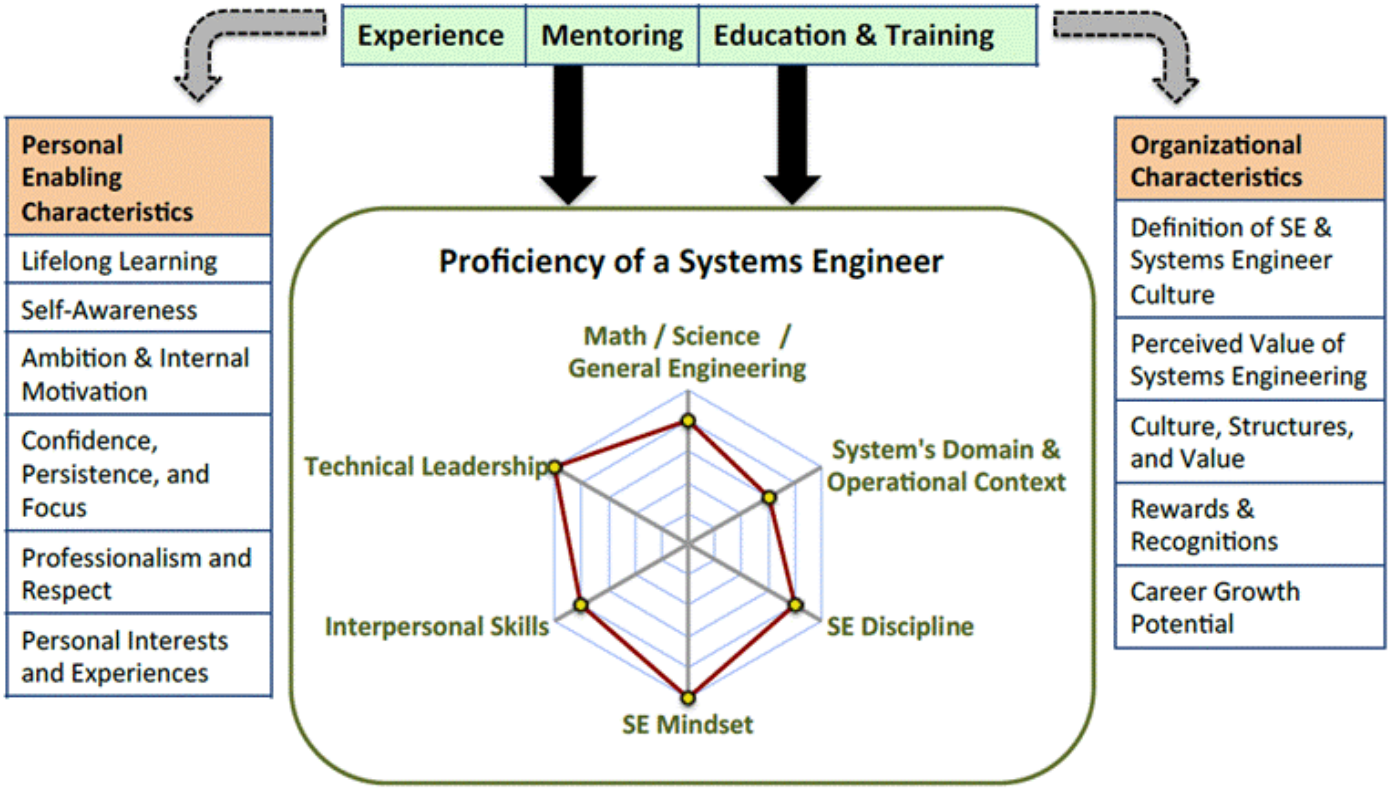
SE Vision 2025. Copyright © 2014 by INCOSE. All rights reserved.

SE Mindset

- Big-Picture Thinking - Also referred to as 'systems thinking' and 'holistic thinking', this includes the ability to step back and take a broader view of the problem at hand.
- Paradoxical Mindset - The ability to hold and balance seemingly opposed views that are critical to providing value for systems engineers.
- Flexible Comfort Zone - The overall ability to deal with ambiguity and uncertainty, this involves the abilities to be open-minded, understand multiple disciplines, deal with challenges, and ability to take rational risks.
- Inquisitive and Self-Driven - The ability to ask the right questions without hesitation, and to self-initiate and complete work with little to no supervision or external impetus.
- Quick Learning and Abstraction - The ability to synthesize new information from separate pieces of data with multiple sources, e.g. to realize that a problem an electrical engineer faces in one component is related to a problem that a mechanical engineer faces in another component and address the root causes instead of just the symptoms.
- Foresight and Vision - The ability to foresee the remaining lifecycle of the system, the impact of current decisions, and to visualize possible scenarios.

Atlas: The Theory of Effective Systems Engineers, Version 0.25; SERC November 2014 (HELIX Project)

The beginning of a “brand”



Atlas: The Theory of Effective Systems Engineers, Version 0.25; SERC November 2014 (HELIX Project)

Questions

- Think about the systems that you are most proud of, or the times that you have been a part of a system development effort that felt exciting, even exhilarating. Would you say they are works of art, or simply science, process, and project management?
- When have you experienced the flow as a systems engineer?
- How would you characterize systems engineering in your organization: process and project management or a blend of art and science?
- What is fun about engineering?
- How do you regard your personal brand as a Systems Engineer?

Objectives:

- What is the SE Brand and how does agility add value?
- How can we best interface with other disciplines and merge creativity with innovating efficiency?
- How to balance learning and innovation that is driven the business value.
- How to create capabilities and competence in SE for the next generation?
- How do we apply SE to meet the goal in interdisciplinary way?

Questions during dialogue:

- How can we grow Leonardo in current education system?
- Understanding of the problem in piece
- How can we creatively involve users/customers in the design of a system?
- What do system engineers need to do to improve
- How do we innovate ourselves as SEs
- How do we re-innovate ourselves?
- What should we do to be responsive in a disruptive environment?
- What do they want in next three years and what do we want to be in three years?

Question from Sticky Note:

- How do we effectively introduce systems concept and analysis into all disciplines?
    - How do we leverage this for better communication/exchange/solutions/
- What success stories or best approaches are there in using SE practices, to integrate multidiscipline data tools? i.e.: CAD models, Monte Carlo analysis, Human Factor, User Experience
- Why don't school tech SE as an art? Where is the Julliard Schools for Systems Engineering?
- Multi-discipline component seems trivial (no problems exists in a silo) so why is that often difficult for other to see this as well?
- System-thinking/designing thinking: can systems engineering and creative efforts (UI Design, graphics, visualization) coexists/work in harmony?
- How do we remove the art/intuition aspect and better define the process of systems engineering?
- How do we ensure SE understand " imagineering" if they have only standard systems engineering?
- Is there a better metaphor to describe system engineering than orchestra?
- How do we tailor SE communicators to include Art and other none engineering fields?
- How does one recognize or define system engineering in an organization that may not explicitly embrace SE?
- Art, science, engineering as enablers to successful system. How do successful system occur?
- Now that SE is becoming more model-based, why do we still emphasize work process over the model (of the target)
- When does the SE belief system break down? One if the three fails, does the other two pick up the slack (process, art, science)?
- How do you get young engineers to accept their role within SE when they just want to build stuff?
- What is the necessary skillset of system engineers to become successful?

- Is standardization in MBSE leading to poverty in genetics of visualization as an enabler for creativity and concept development? Where free-form visualization are left out?
- How is system engineer incorporating its discipline into a non-engineer discipline?
- What are the models for reduction to practices of SE as the multi-discipline enabler? Assumption: SE is an art, science, behavior changes.
- SE can be used as pivot point for the discipline to hold to (revolve around)
- How did Disney able to merge art and science on the imagineering group?
- How do metaphors limit or help our understanding of system engineering?
- What is the impact of applying SE to the arts, where there is not a strict procedure to follow?
- The art brings passion to engineering, is systems engineering a performance art?
- How do art and SE interact as cognitive process (es)? Note: “flow” cognitive process

Observation:

- Design and Thinking is System Engineering

Example:

- University of Stanford introduced the art of system engineering
- Georgia Tech creates multi-disciplinary experience

Reference:

- Creative Confidence - David Kelly and Thomas Kelly (Stanford University)
- Educating The reflective Practitioner - Donald SchönIs

SE as Multidiscipline Enabler/Art/Science

Moderator: Regina Griego

Day-1 Brief Out (as decided Friday, subject to change during Saturday)

Planned Primary Workshop Issues to Explore

- How do art and SE interact as cognitive process(es)? Note: "flow" cognitive process
- Is standardization in MBSE leading to poverty in genetics of visualization as an enabler for creativity and concept development; where free-form visualization are left out?
- When does the SE belief system break down? What if one of the three fails, does the other two pick up the slack (process, art, science)?
- How do metaphors limit or help our understanding of system engineering? Is there a better metaphor to describe system engineering than orchestra conductor?

Potential Secondary Workshop Issues to Explore

- Why don't school teach SE as an art? Where is the Julliard Schools for Systems Engineering?
- Art, science, engineering as enablers to successful system. How do successful systems occur?
- The art brings passion to engineering, is systems engineering a performance art?

Objectives

- What is the SE Brand and how does agility add value?
- How can we best interface with other disciplines and merge creativity with innovating efficiency?
- How to balance learning and innovation that is driven the business value.
- How to create capabilities and competence in SE for the next generation?
- How do we apply SE to meet the goal in interdisciplinary way?

SE as Multidiscipline Enabler/Art/Science

Moderator: Regina Griego

Day-2 Brief Out

- **Systems Literacy – key principals, key concepts**
  - What's important in systems
  - Next generation – science standards, cross-cutting themes
  - Totality of presence - flow

    Go to SE references and pick a section that
- **Choice is directive or open ended (even say as a unique contribution)**
- **Comes from art, differences in critical thinking**
  - In SE, be obedient to the requirement – waiting for the next note of music
  - Behavior adjustment to suggestion
- **Passionate about music and poetry**
  - "Promote the curating of beautiful code"
  - Design principals that define aesthetic or artistic concepts
  - Create the experience of art / music in engineering design and has the emotional response
- **What I run into, understand business and supply chain**
  - Business architecture – picture in EASparx

Emergence and teams

Team wholes have behaviors and properties arising from the organization, capabilities, and values of their members and their relationships, which only become apparent when the team is placed in different environments.

What kinds of teams exhibit different kinds of emergence and under what conditions?

To what extent can emergence in teams be predicted and whether emergent behavior is beneficial or detrimental to a team?

How do we account for emergence in the development and purpose of teams? Related to the notion of intentionally creating a team or self-forming teams.

- Can emergence be planned for? How?
- How does process beneficially or detrimentally influence emergence?
- What should we consider in formation of teams to maximize creative emergence in teams?
- Are adaptability and resilience emergent properties of a team?
- How can we construct a team with the chemistry and capabilities that create a delightful emergent experience?

Overview:

Emergent team behavior can be viewed as a consequence of the interactions and relationships between team members and the behavior of individual members. It emerges from a combination of the behavior and properties of the members and the team structure or norms for interactions between the members, and may be triggered or influenced by a stimulus from the teams environment.

What we refer to as "team-awareness" results from the combined effect of the interconnected interactions based on the make up the team.

Next Steps

- **Miguel**
  - Explore new instruments of modeling to promote the creativity in development.
- **Mary:**
  - Frame Research Question
  - Sharing principles+ feedback in practice @ my company
- **Harsha(harshabl701@gmail.com):**
  - Going to explore more on thus field gain theoretical experience by receiving /sharing some papers and sharing the summary and idea, wisdom with team.
- **Peter (peter@coexplovation.net)**
  - Create a virtual space to enable design of “system literacy and partner + practice team emergence.