

## Day 1 Introduction to workshop topic

### **Abstract: Fail-Fast Rapid Innovation Concepts**

*Bill Schindel, ICTT Systems Science, CSEP. [schindel@icct.com](mailto:schindel@icct.com)*

Innovation delivers new stakeholder value, and includes discovery of new system configurations—including those which are insufficient or inadequate. The value of well-organized exploration efforts is that they will, on the average, produce higher-value results for a given investment of resources than other approaches. But “Fail-Fast Rapid Innovation” cannot simply mean quickly producing a series of rejected options. The discovery and experimental aspects of engineering are sometimes overshadowed by a belief that engineering proceeds only by syllogistic reasoning from a known place and first principles to a new place, but that is not the nature of innovation, which is itself not always so well understood.

If we must organize and direct resources into completely unknown territory, what roadmap can we use for planning, budgeting, and scheduling? How can we optimize use of our resources so that these investments are well-justified and understood?

This workshop will explore the nature and properties of the innovation process as related to effectiveness of experimentation and discovery as key parts of innovation.

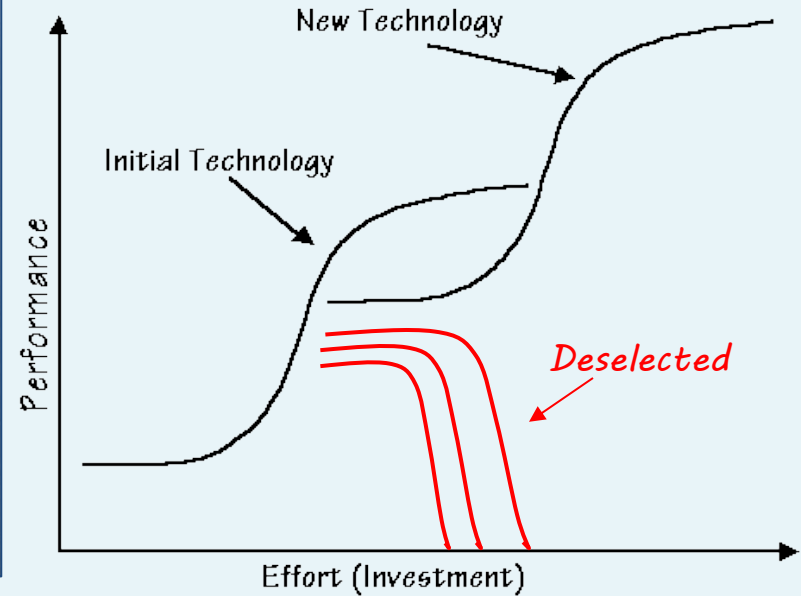
Bill is president of ICTT System Sciences, where he has pioneered the strengthening of Model-Based Systems Engineering (MBSE), and its extension to Pattern-Based Systems Engineering (PBSE), applying it across automotive, communications, mil/aero, health care, construction, consumer product, and advanced manufacturing domains. Bill co-lead a project on Systems of Innovation in the INCOSE System Science Working Group, co-leads the Patterns Working Group, and is a member of the lead team of the INCOSE Agile Systems Engineering Life Cycle Discovery Project. In addition to founding several systems enterprises, he has been active in advancement of engineering education for over thirty years, including collegiate engineering faculty and board of trustees service. Bill is an INCOSE CSEP and the current president of the INCOSE Crossroads of America Chapter.



# *Fail-Fast* Rapid Innovation Concepts



From: Richardson, A., "Prototyping That's Less Prone to Failure", *Harvard Business Review*, Dec 7, 2015.



V1.2.6

# This session – 90 minutes

<ul style="list-style-type: none"><li>• Quick introductions</li><li>• Brief topical background sampler</li></ul>	30 mins
<ul style="list-style-type: none"><li>• Around the room:<ul style="list-style-type: none"><li>• Why are you / your organization interested?</li><li>• In what aspects, issues, problems?</li><li>• What have been your related experiences?</li></ul></li></ul>	30 mins
<ul style="list-style-type: none"><li>• What Objectives for the Saturday workshop?</li></ul>	30 mins

# Fail-fast: Brief background sampler

- What do we mean by “fail fast”?
- Examples of late stage “surprises”
- Traditional perspectives
- Agile perspectives
- Learning
- Planned experiments
- How many experiments?
- System configuration trajectories
- Decision-making’s connection to experiments
- Points of synthesis—what hypotheses are we testing?
- Discovery vs. Hypotheses
- Fear versus Incentives
- When is “too late” to fail?
- Challenges to “fail fast”
- Your interests and experiences
  
- References sampler

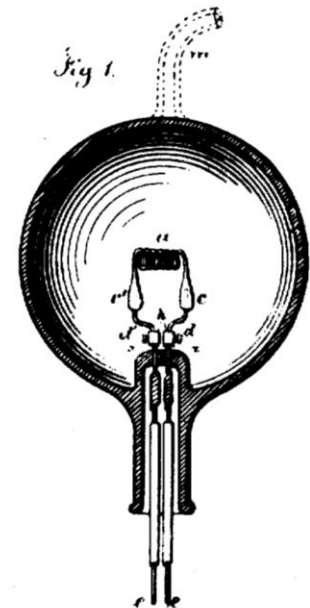
# What do we mean by “fail fast”?

**I have not failed.  
I've just found  
10,000 ways  
that won't work.**

*~ Thomas Edison*



T. A. EDISON.  
Electric-Lamp.  
3,898. Patented Jan. 27, 1880.



*Fig. 2*



# Examples of late stage “surprises”



There may be such a thing as “too late to fail”.

Pfizer Exubera Inhaled Insulin  
(Withdrawn after factory built)

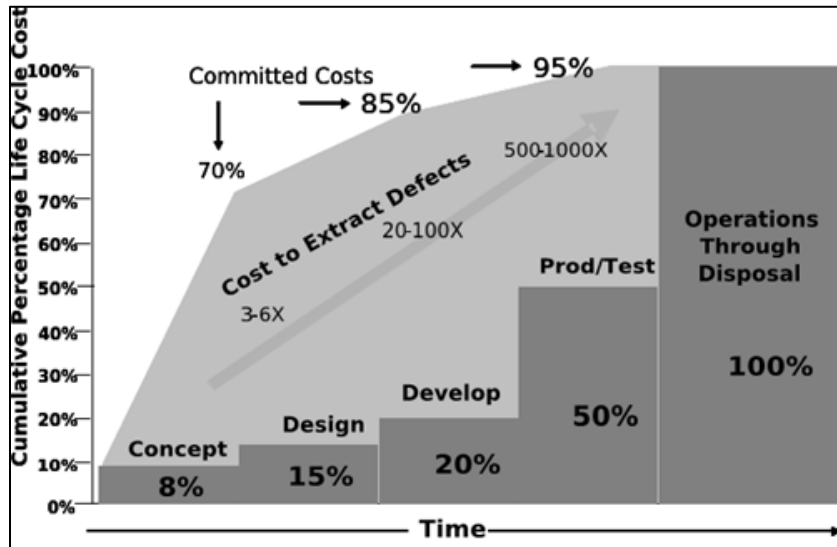


Keurig Kold Platform  
(Withdrawn from market)

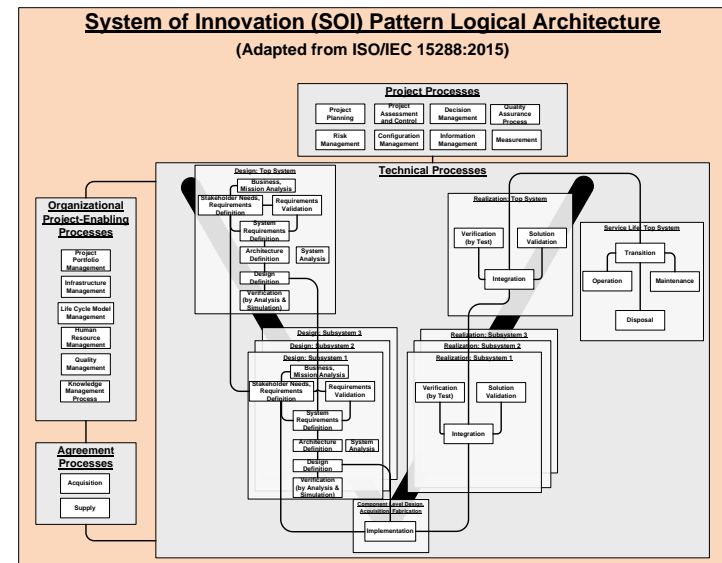


ACA Enrollment Web Site  
(Rebuilt after public rollout)

# Traditional Perspectives



INCOSE SE Handbook



ISO 15288 Processes

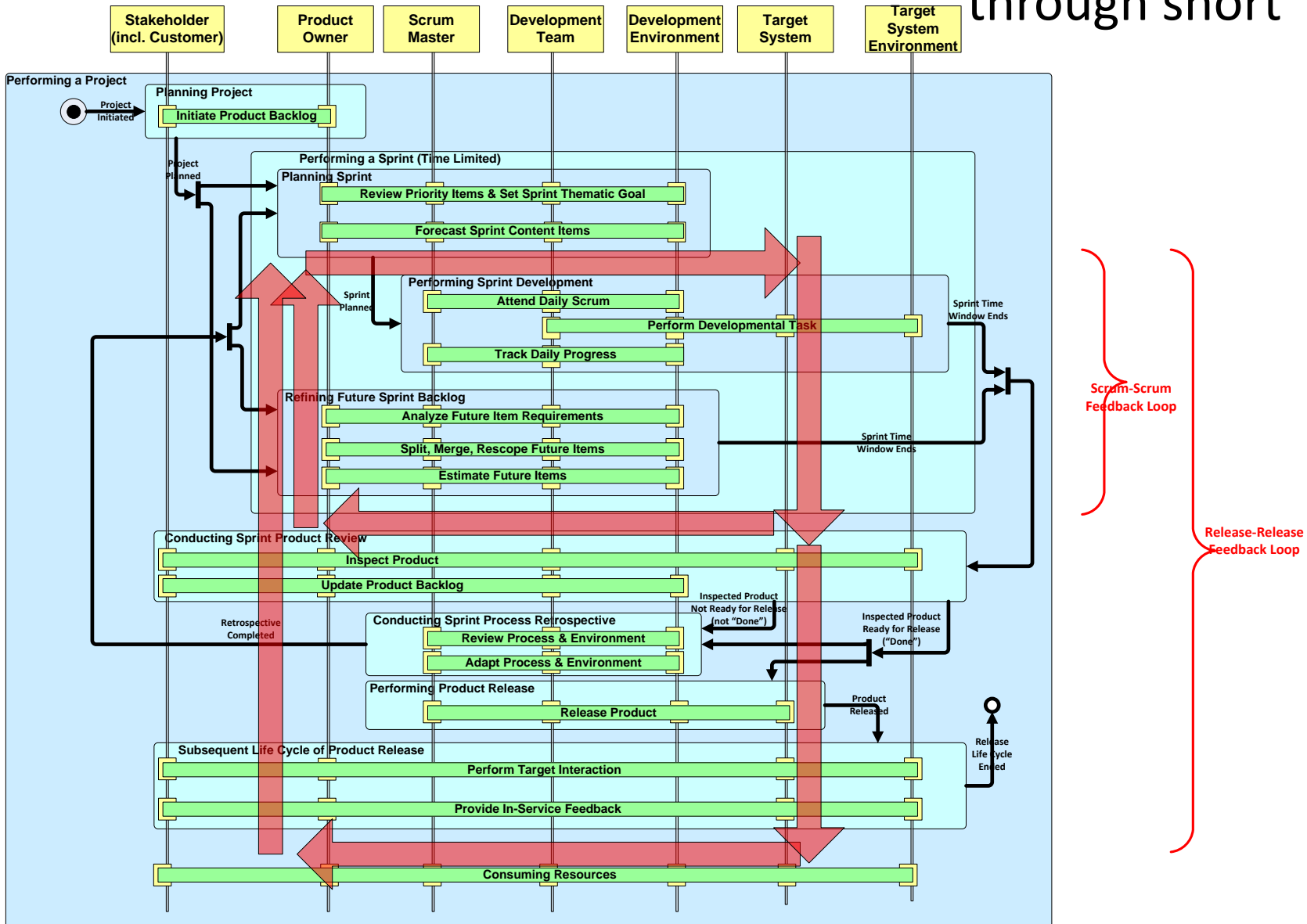
- Emphases on managed life cycle processes
- Early decisions are known to have most impact on later cost, schedule, performance—but can we know enough early to optimize those?
- Where in these pictures is what we already knew?



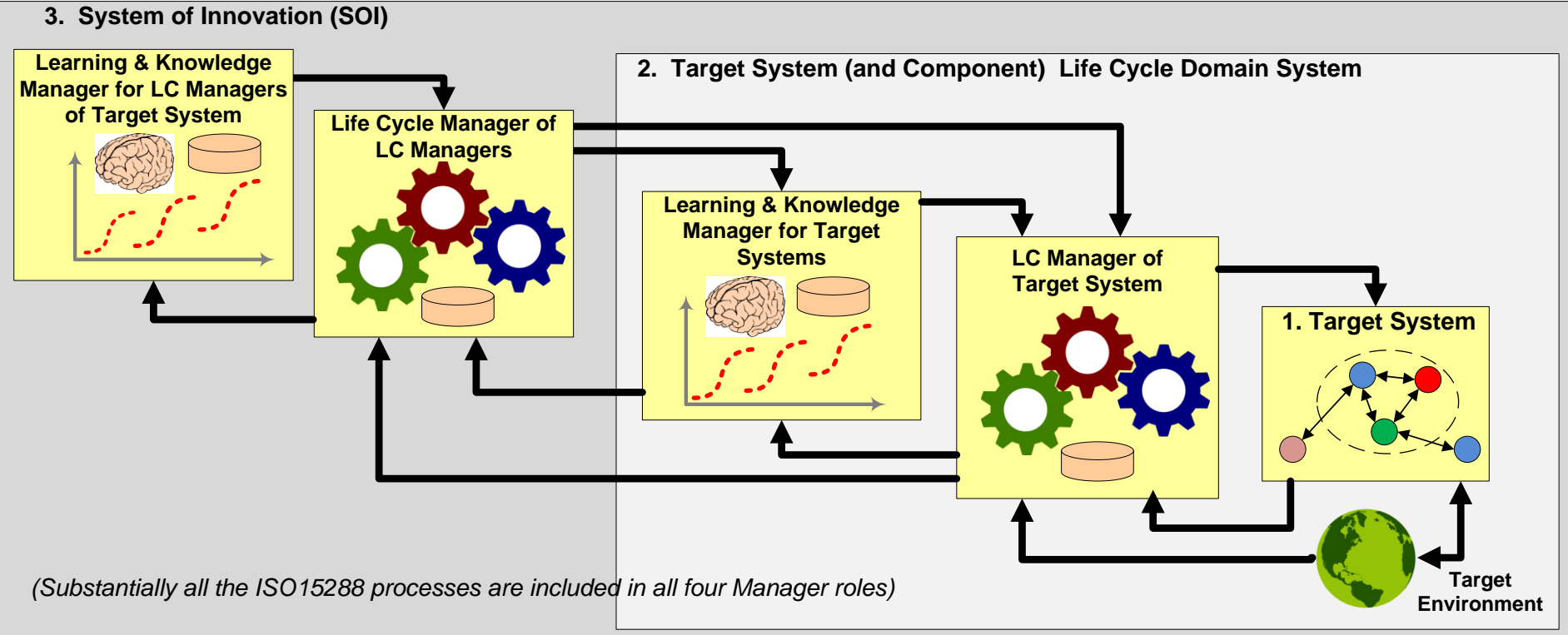
# Agile Perspectives

Traditional Scrum Sprint Perspective  
(Activity Diagram, with Swim Lane Roles)

Incremental discovery,  
experiments, learning,  
through short “sprints”



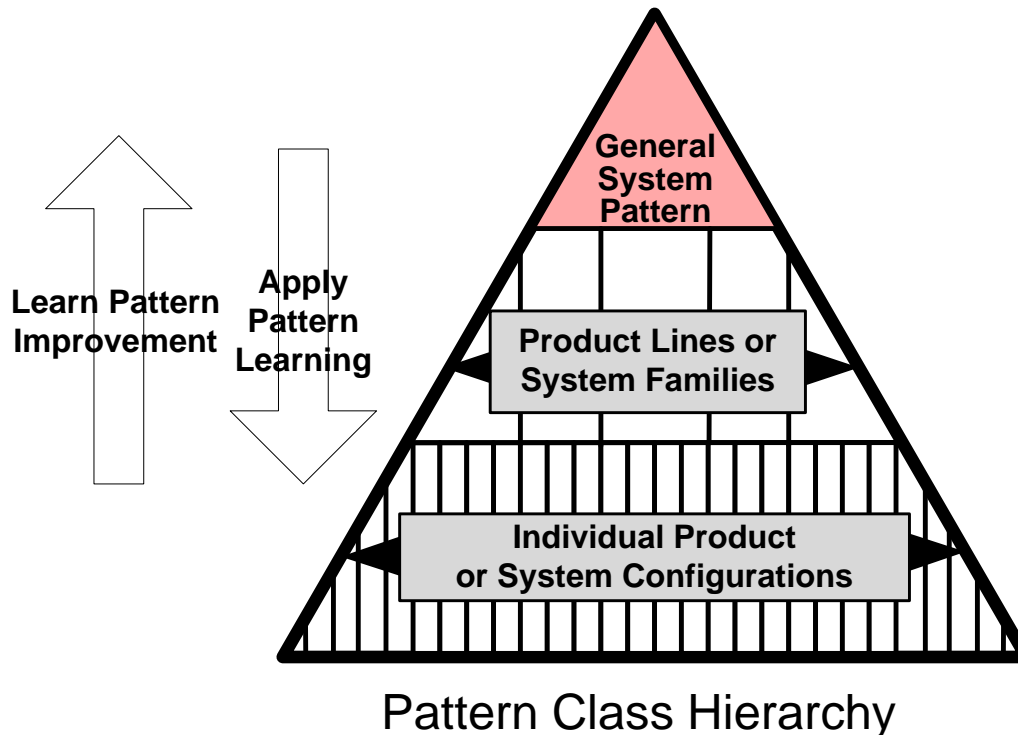
# Learning



## ASELCM Pattern

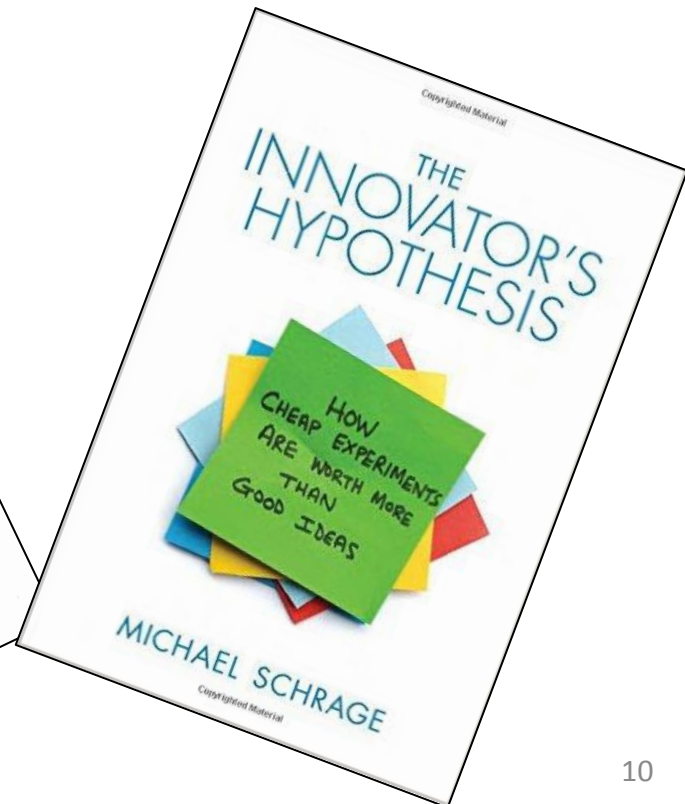
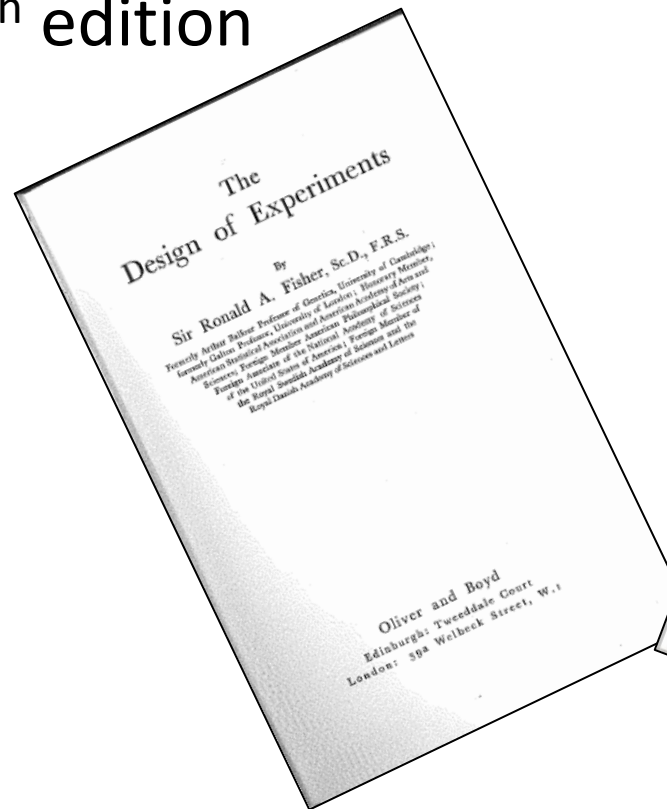
# Learning

- What do we do with what we learn?
- If it doesn't go where we will start from next time, we lose the right to call it "learning"



# Planned experiments

- Fisher: Mathematics of experiment design
  - First published 1935
  - Now in 9<sup>th</sup> edition

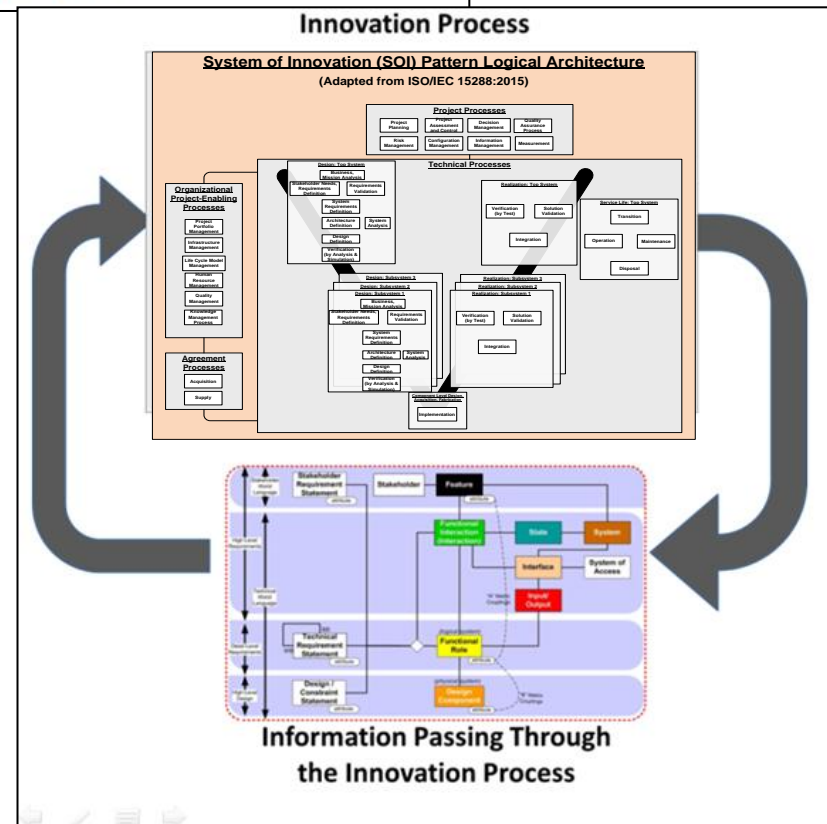
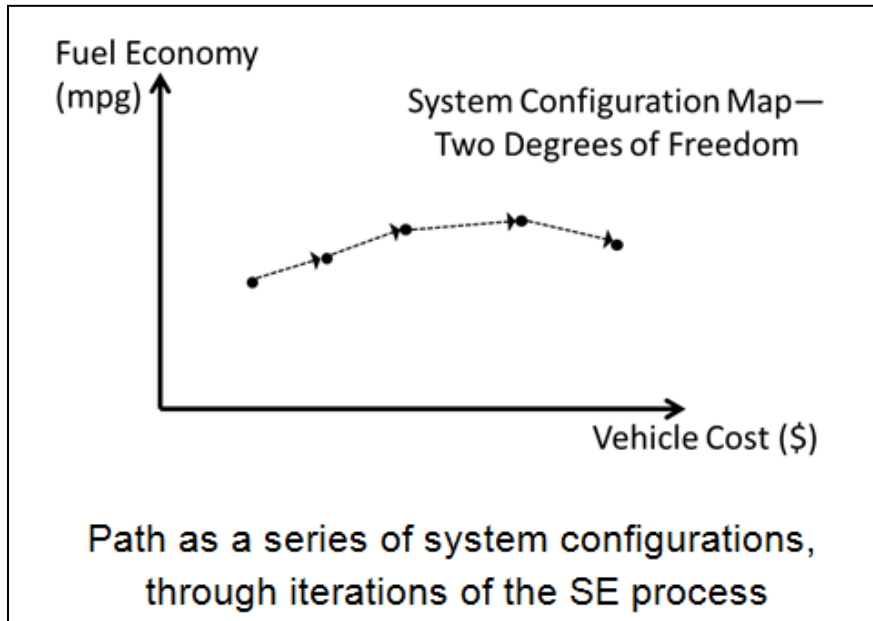


# How many experiments?

- Remember Fisher's Design of Experiments (DOE) spaces, to find smallest number of experiments?
- Schrage: 5 x 5 framework
- "Today, the most innovative businesses run thousands—Intuit: 1,300, P&G: 7,000–10,000, Google: 7,000, Amazon: 1,976, and Netflix: 1,000
  - Instead of making ideas trickle up through a long process of approvals, meetings, egos, and politics, junior level decision makers can perform low risk, low cost experiments." - Ben Clark, *Fast Company*

# System configuration trajectories

- System space is not process/procedure space



# Picking Spatial Directions:

- Picking the hardest item next, by making it the path of least resistance, rewarding (bonus) finding evidence that project will fail:
  - Ted Talk by Astro Teller, retrieved from [www.ted.com/talks/astro teller the unexpected benefit of celebrating failure](https://www.ted.com/talks/astro_teller_the_unexpected_benefit_of_celebrating_failure)

# Decision-Making— Connection to Experiments

- “Some decisions are consequential and irreversible or nearly irreversible – one way doors – and these decisions must be made methodically, carefully, slowly, with great deliberation and consultation. If you walk through and don’t like what you see on the other side, you can’t get back to where you were before. We can call these Type 1 decisions.
- But most decisions aren’t like that – they are changeable, reversible – they’re two way doors. If you’ve made a suboptimal Type 2 decision, you don’t have to live with the consequences for that long. You can reopen the door and go back through. Type 2 decisions can and should be made quickly by high judgment individuals or small groups.”

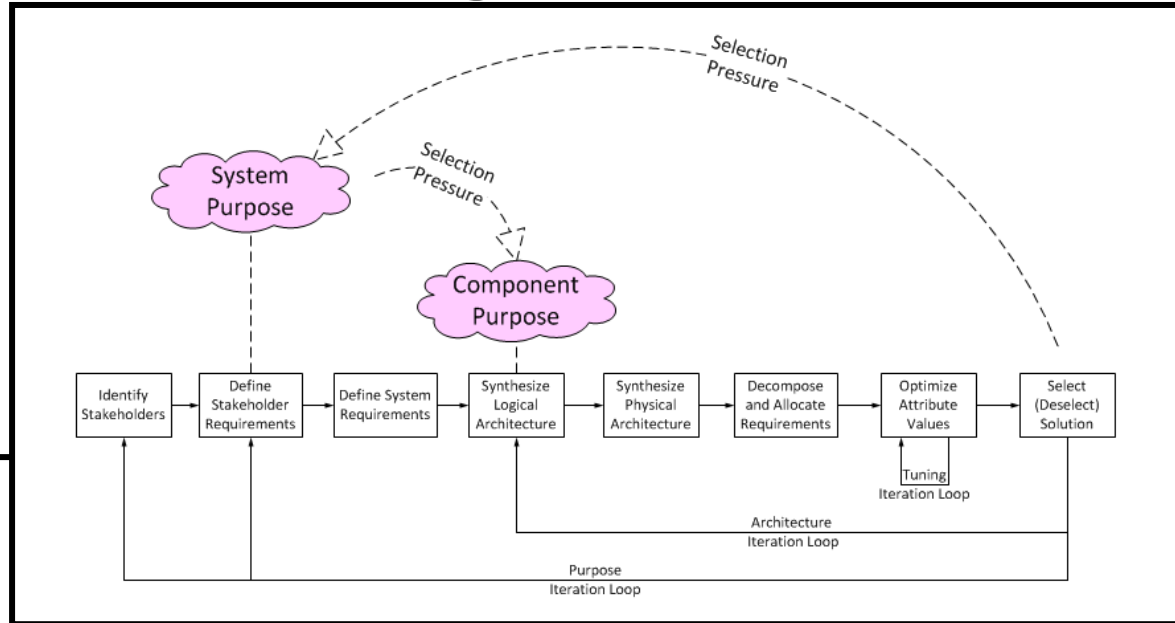
– Jeff Bezos





# Points of Synthesis—what hypotheses are we testing?

Includes Purpose-Discovery Loop



## Systems of Innovation II: The Emergence of Purpose

William D. Schindel

ICTT System Sciences

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**Abstract.** Engineers design mindful of the purpose of a system. So, engineering conceptual definitions of the concept of “system” frequently include the idea of purpose.

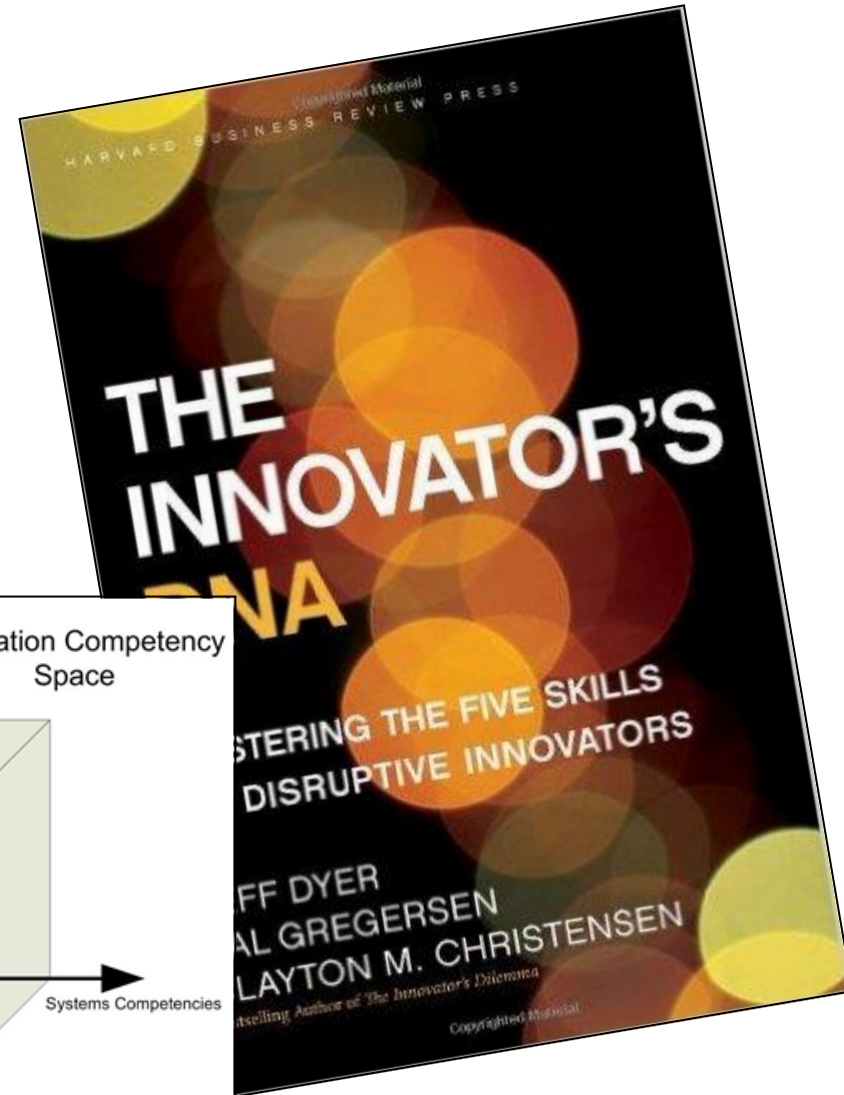
However, we also use “system” to describe things not human-designed. We might refer to purpose in living systems, as in the immune system, but biologists use “function” to avoid this. What about inanimate natural systems? Do Saturn’s rings have a purpose, or function? And what about pathologies, when systems don’t work as they “should”? Do all these “systems” terms and concepts serve us well across these different domains, or are some force-fit?

Using the language of Model-Based Systems Engineering (MBSE) and Pattern-Based Systems Engineering (PBSE), this paper describes a framework in which “system” and “purpose” emerge at different levels, apply uniformly, naturally, or not at all, and inform. The framework is the Systems of Innovation (SOI) Pattern. Practical benefits include insights into the nature of innovation across these domains, improving ability to perform innovative systems engineering.

“Pivoting” is not just for entrepreneurs.



# Discovery vs. Hypotheses



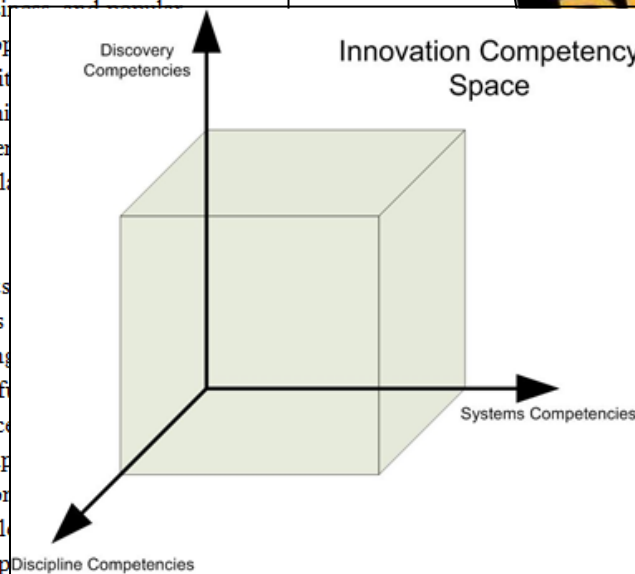
## **All Innovation Is Innovation of Systems: An Integrated 3-D Model of Innovation Competencies**

J. Ahmed, J. Hanson, W. Kline, S. Peffers, W. Schindel  
To appear in *Proceedings of the ASEE Annual Conference, 2011*  
Copyright 2011, American Society for Engineering Education

### **Abstract**

The development of the future generations of innovators is of central interest to engineering educators. What are the competencies of innovation and how do we develop them? There is a considerable body of scholarly, business, and engineering literature concerned with the characteristics of innovative people, including personality traits, organizational cultures, and other non-technical factors. We argue here that the typical descriptions of innovation competencies are incomplete, lacking critical dimensions that are essential for planning a curriculum and assessing progress within it.

The foundation of our model of innovation competencies rests on three dimensions of innovation: The ability to develop novel solutions to problems that significantly enhanced stakeholder satisfaction. As engineering educators, we believe that innovation is only effective when it includes the full delivery of improved stakeholder outcomes, and this introduces an initial creative mental leap. We accept that (1) certain discipline competencies traditionally addressed by engineering education are important to innovation, and (2) we likewise accept that a collection of traits are also vital to successful innovators. However, in this paper



# Fear vs. Incentives

- Regina Dugan, discouraging fear of failure, retrieved from:

[https://www.ted.com/talks/regina\\_dugan\\_from\\_mach\\_20\\_glider\\_to\\_humming\\_bird\\_drone?language=en](https://www.ted.com/talks/regina_dugan_from_mach_20_glider_to_humming_bird_drone?language=en)

# When is “too late to fail”?



Pfizer Exubera Inhaled Insulin  
(Withdrawn after factory built)



Keurig Kold Platform  
(Withdrawn from market)



ACA Enrollment Web Site  
(Rebuilt after public rollout)

(Is there also a too soon / too fast?)

# Challenges to “fail fast”

- How to budget, schedule, plan?
- How to justify failing?
- What balance of failures to successes?
- Whose failure? Who owns the loop?
- What do we reward?
- Signals and hype—are we hearing the data?
- Can we always afford to fail? When not?
- Your experiences and interests?

# Your Interests and Experiences

- More about your related interests
- What are your concerns, experiences?
- What are the obstacles?
- What are the possibilities?
- What is required to succeed?
- What does success look like?

# References Sampler

1. Ronald A. Fisher, *The Design of Experiments*, Ninth Edition, Macmillan, 1971.
2. Michael Schrage, *The Innovator's Hypothesis: How Cheap Experiments Are Worth More Than Good Ideas*, MIT Press, 2014.
3. Clarke, Ben, "Why These Tech Companies Keep Running Thousands of Failed Experiments", *Fast Company*, Sep 26, 2016.
4. Ronny Kohavi, Thomas Crook, Roger Longbotham, Brian Frasca, Randy Henne, Juan Lavista Ferres, Tamir Melamed, "Online Experimentation at Microsoft", retrieved from:  
<http://www.exp-platform.com/documents/expthinkweek2009public.pdf>
5. Ted Talk by Astro Teller, Alphabet X, retrieved from:  
[www.ted.com/talks/astro\\_teller\\_the\\_unexpected\\_benefit\\_of\\_celebrating\\_failure](http://www.ted.com/talks/astro_teller_the_unexpected_benefit_of_celebrating_failure)
6. Ted Talk by Regina Dugan, DARPA, on discouraging fear of failure, retrieved from:  
[https://www.ted.com/talks/regina\\_dugan\\_from\\_mach\\_20\\_glider\\_to\\_humming\\_bird\\_drone?language=en](https://www.ted.com/talks/regina_dugan_from_mach_20_glider_to_humming_bird_drone?language=en)
7. J Dyer, C Christensen, and H. Gregersen, *The Innovators DNA: Mastering the Five Skills of Disruptive Innovators*, HBR Press, 2011.
8. Schindel, W.D., S.N. Peffers, J.H. Hanson, J. Ahmed, and W.A. Kline, "All Innovation is Innovation of Systems: An Integrated 3-D Model of Innovation Competencies," in *Proc. of American Society for Engineering Education Annual Conference and Exposition*, Vancouver, Canada, 2011.
9. Sorvino, C., "The Reinvention Factory, *Forbes Magazine*, September 13, 2016
10. Johnson, A., "Insulin Flop Costs Pfizer \$2.8 Billion," *The Wall Street Journal*, October 19, 2007.
11. Walden, D. et al, eds., *Systems Engineering Handbook: A Guide for System Life Cycle Processes and Activities*, Fourth Edition, INCOSE, 2015.
12. Schindel, W., and Dove, R., "Introduction to the Agile Systems Engineering Life Cycle MBSE Pattern", in *Proc. of INCOSE 2016 International Symposium*, Edinburgh, UK, 2016.

# **Fail-Fast Rapid Innovation Concepts**

**Moderator: Bill Schindel**

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

## **Workshop Issues to Explore: (Not yet sorted into Primary vs. Secondary)**

- 1. Alignment of experiments to the development & life cycle phases & gates**
- 2. Connection to “culture of courage” and “decision support” also required, to act on what experiments tell us, along with other cultural and role dependencies**
- 3. Connection to MBSE, and validation and verification of models**
- 4. Fail fast concept applicability to safety critical or mission critical systems**
- 5. Measures of effectiveness of fail fast**
- 6. “Fail” may be the wrong branding (“experiments”, “learning”)**
- 7. How to connect experiment outcomes to funding continuation decisions in a constructive way that avoids distorting the data from experiments**
- 8. Scheduling, budgeting, project planning for for experiments**
- 9. Experience by others in using experiments**
- 10. Connection to stakeholder requirements, technical requirements, designs**

## **Objectives (for Saturday session)**

- 1. Identify which ISO 15288 processes are most critically connected to this.**
- 2. Define an INCOSE working group project related to this.**



# **Fail-Fast Rapid Innovation Concepts**

**Moderator: Bill Schindel**

**Day-2 Brief Out**

# Fail-Fast Rapid Innovation Concepts

Moderator: Bill Schindel, [schindel@icctt.com](mailto:schindel@icctt.com)

Workshop Issues to Explore, from team: **(Items 11-13 added during Day 2 discussion)**

1. Alignment of experiments to the development & life cycle phases & gates
2. Connection to “culture of courage” and “decision support” also required, to act on what experiments tell us, along with other cultural and role dependencies
3. Connection to MBSE, and validation and verification of models
4. Fail fast concept applicability to safety critical or mission critical systems
5. Measures of effectiveness of fail fast
6. “Fail” may be the wrong branding (“experiments”, “learning”)
7. How to connect experiment outcomes to funding continuation decisions in a constructive way that avoids distorting the data from experiments
8. Scheduling, budgeting, project planning for for experiments
9. Experience by others in using experiments
10. Connection to stakeholder requirements, technical requirements, designs
11. *How to effectively capture incremental learning in a flow regime*
12. *How to represent incremental learning*
13. *Roles for automation, including learning technologies and otherwise*

Objectives (for Saturday session)

1. Define an INCOSE working group project related to this.
2. Identify which ISO 15288 processes are most critically connected to this.



## INCOSE Working Group Project Planning Worksheet

**Project Summary Name:** Fail-Fast and Recover Early (FFaRE)

**Project Summary Concept:** Examine aspects of fail fast rapid innovation in order to design a demonstration of the value of failing fast and recovering early, for the purpose of promulgating awareness of FFaRE and its benefits and applications to stakeholders.

**Project Stakeholders:**

1. Corporate change agents and practitioners
2. Corporate officers and program managers
3. INCOSE working groups including agile, risk, system science, patterns, and transformations
4. INCOSE CAB, academic council, outreach committee
5. Team participants
6. Investors

**Project Deliverables:**

1. A demonstration of FFaRE concept
2. Case studies demonstrating value
3. Demonstration of fast learning capture about this INCOSE working group project
4. Identify components of a training/communication package
5. An engagement event
6. Possible research topics for students

**Project Tasks:**

1. Familiarize team members with relevant operational frameworks (agile, lean, fast-fail, systems engineering)
2. Create a business canvas for this project
3. Construct a formal description including ontology
4. Select an example
5. Build a minimum viable example
6. Characterize our time box
7. Communicate to each other individual personal values
8. Identifying obstacles (organization and structure)
9. Identifying patterns and anti-patterns
10. Consider suitability for SEBoK

**Project Resources:**

INCOSE globalmeet



**Project Timing:**

January 2017 IW event

**Potential Project Participants:**

Name	Affiliation	Email

# INCOSE F.F. MBSE Impact Roadmap: An Assessment and Planning Aid

(Adapted from ISO/IEC 15288:2015)

## INCOSE F.F. MBSE Impact Roadmap: An Assessment and Planning Aid

What is already impacted by this? What future opportunities?

- Use this instrument to assess the industry, your segment, or your company, and to make future plans.

### Directions:

Please attach “Sticky Dots” on the 15288 “Vee” Diagram, to mark:

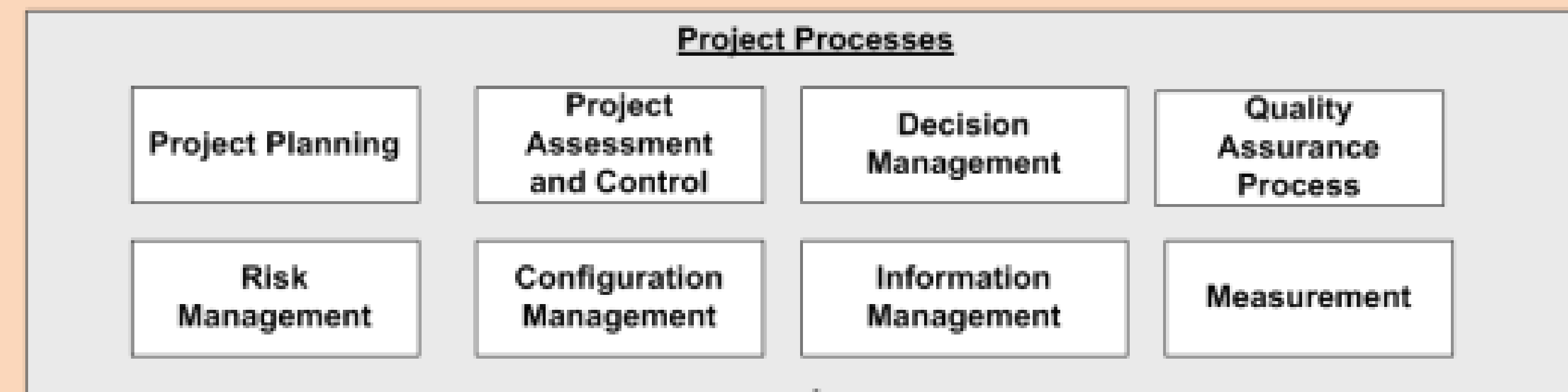
- Needs for improved future F.F.MBSE use (even if most difficult)
- Opportunities for improved future F.F.MBSE use (low-hanging fruit)
- Already accomplished cases of F.F.MBSE -aided progress

Please mark your “Sticky Dots” with letters to indicate specific domain of interest to you (Aero, Auto, Education, etc.)

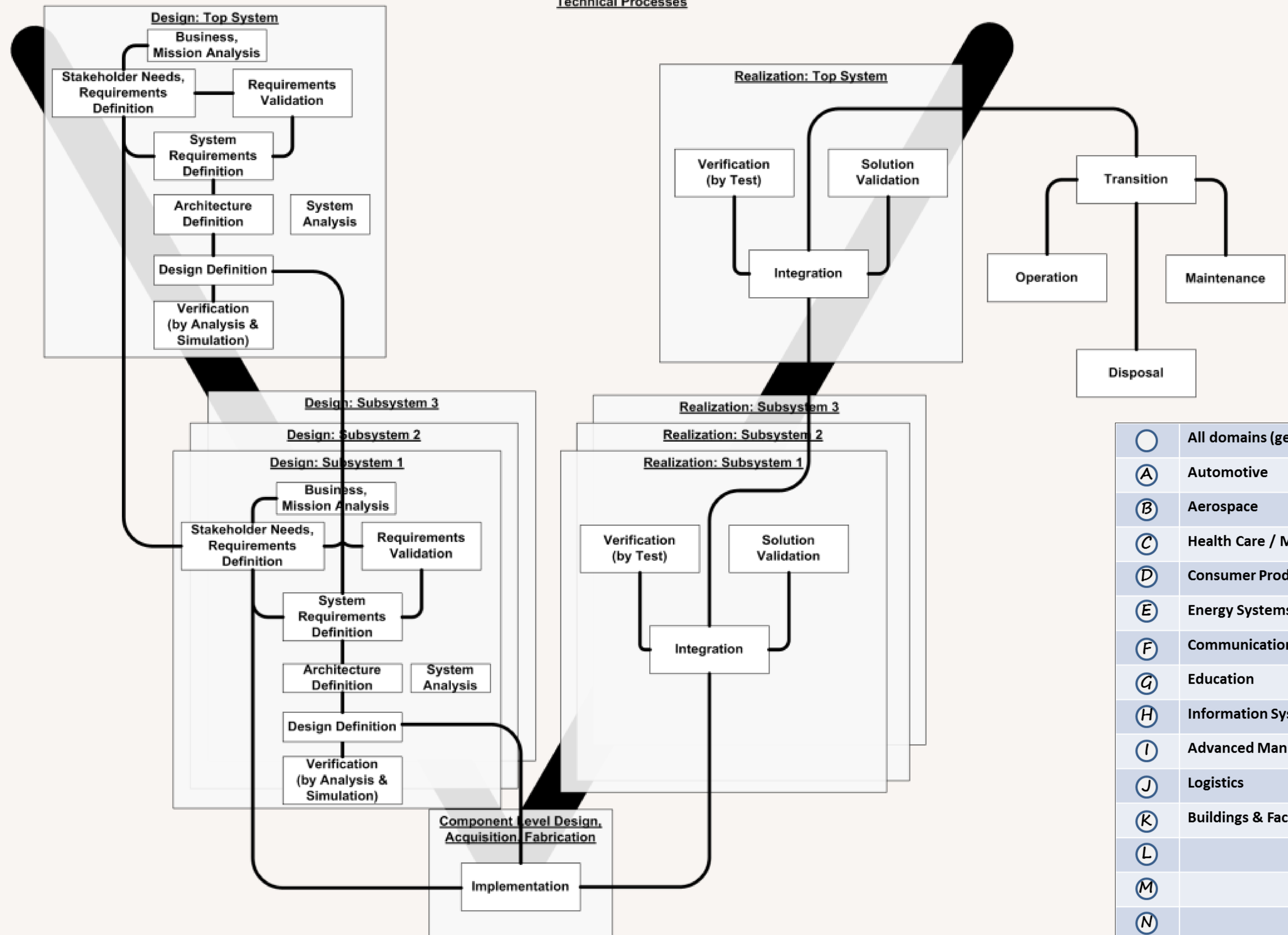
Please add “Sticky Notes” to make additional observations.

Sticky note

To obtain your own MBSE Planning Aid for local use, contact Troy Peterson [peterston@systemxi.com](mailto:peterston@systemxi.com) or Bill Schindel [schindel@icct.com](mailto:schindel@icct.com)



### Technical Processes



### Organizational Project-Enabling Processes

Project Portfolio Management

Infrastructure Management

Life Cycle Model Management

Human Resource Management

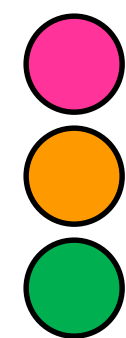
Quality Management

Knowledge Management Process

### Agreement Processes

Acquisition

Supply



○	All domains (general)
(A)	Automotive
(B)	Aerospace
(C)	Health Care / Medicine
(D)	Consumer Products
(E)	Energy Systems
(F)	Communications
(G)	Education
(H)	Information Systems
(I)	Advanced Manufacturing
(J)	Logistics
(K)	Buildings & Facilities
(L)	
(M)	
(N)	
(O)	

## Fail Fast and Recover Early Break-Out Session Participants, Saturday, October 29

	Name		Affiliation	email
1	Bill	Schindel	ICTT System Sciences (facilitator)	<a href="mailto:schindel@icct.com">schindel@icct.com</a>
2	Virginia	Aguilar	Bendix King/Honeywell	<a href="mailto:virginia.aguilar@honeywell.com">virginia.aguilar@honeywell.com</a>
3	Carlos	Rodriguez	Northrop Grumman	<a href="mailto:carlos.v.rodriguez@ngc.com">carlos.v.rodriguez@ngc.com</a>
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7	Celeste	Drewien	Sandia National Labs	<a href="mailto:cadrewi@sandia.gov">cadrewi@sandia.gov</a>
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9	Thomas	Kilgore	Travelport	<a href="mailto:thomas.kilgore@travelport.com">thomas.kilgore@travelport.com</a>
10	Samuel	Terrazas	University of Texas, El Paso	<a href="mailto:sterrazasquezada@miners.utep.edu">sterrazasquezada@miners.utep.edu</a>
11	Peter	Tuddenham	Intl Society for System Sciences & The College for Exploration	<a href="mailto:peter@coexploration.net">peter@coexploration.net</a>
12	Raj	Bhakta	New Mexico Tech (session support)	<a href="mailto:raj.bhakta@student.nmt.edu">raj.bhakta@student.nmt.edu</a>

## Attached:

Fail Fast Workshop, INCOSE Summit Oct 2016 V1.2.6.pdf  
 Day 1 Outbrief -- Fail Fast, with Day 2 supplement.pdf  
 FFaRE Workshop Outbrief, 10.29.16.pdf  
 Fail Fast and Recover Early -- 10.29.16 Session Participants V1.1.2.xlsx  
 Planning and Survey Instrument V1.2.4 FF Version.pptx

**From:** William Schindel [mailto:schindel@icct.com]

**Sent:** Sunday, October 30, 2016 8:45 PM

**To:** virginia.aguilar@honeywell.com; carlos.v.rodriguez@ngc.com; griegor@sandia.gov; nathan\_devilbiss@msn.com; romeo.figueroa@ngc.com; cadrewi@sandia.gov; ken.crismon@travelport.com; thomas.kilgore@travelport.com; sterrazasquezada@miners.utep.edu; peter@coexploration.net; raj.bhakta@student.nmt.edu

**Cc:** rkdove@earthlink.net

**Subject:** FFaRE Team--Initial materials from INCOSE Socorro Systems Summit "Fail Fast and Recover Early" break out session

Dear FFaRE Team,

Thanks for your great participation during the October 29 "Fail Fast and Recover Early" break out session at the INCOSE Socorro Systems Summit.

Availability of overall materials from the Summit will come through the Summit leadership. This email is to provide an interim copy of only the session-specific materials from our FFaRE session of Saturday, Oct 29, as we had promised. Attached are:

1. An electronic copy of the slides used during the Day 1 (Friday, Oct 28) short introductory session, distributed in hard copy for to the attendees
2. A copy of the Day 1 "out brief" used to describe the subjects that the Day 1 attendees appeared to be interested in for Day 2 (since you added three subjects to this list at the beginning of the Day 2 session, these have been appended to this out brief, as the three italicized lines near the bottom of the page)
3. A copy of the Day 2 "main output" of our team's workshop—the preliminary follow-on project definition. During the first half of this workshop, you discussed a subset of the identified Day 1 issues, then spent the second half of the Day 2 creating the attached INCOSE Working Group Project planning worksheet, as a preliminary indication of a project to be further defined and organized in order to pursue the priority "after Summit" goals.

4. A list of team participants at the longer Day 2 session, to which this email is directed, and including affiliations and email addresses as you agreed/requested
5. A copy of the planning instrument that we distributed at the Day 2 session, but did not spend time on, for future pursuit.

Your continued engagement will be highly valued, to help plan and execute the project we began defining together. As we discussed, please reflect on how this project can be defined to produce outcomes of value to you and your organization, sufficient to justify the investment of your time. This project is for you, and needs to be defined by you with that in mind. As we discussed, there are several INCOSE Working Groups that are natural targets to engage and see if they'd like to collaborate in the project that we defined together. Many INCOSE WG projects are now collaborations across the WGs, so it seems likely that we will be able to pursue this as an INCOSE Working Group Project.

The INCOSE 2017 International Workshop (IW) will occur at the end of January in Torrance, CA, and that would be a good time for a kick-off if we can engage enough before then to hammer out some additional specifics and interested parties. One of these is the Business Canvas that Ken Crismon offered to draft for the team's review. I hope that we can schedule a web conference meeting with you before that IW event, to make some additional progress toward defining this project further. Please review the initial project description we created together, attached, and let me know your questions, concerns, and suggestions.

I would especially like to hear from you as to whether:

- A. You are considering possible involvement in this project (not a commitment at this time), or
- B. You would like to be kept informed of the project

I am looking forward to talking with you more about this interesting subject in the near future.

Warmest regards,

Bill

William D. (Bill) Schindel, INCOSE CSEP

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