Systems Engineers Я Us

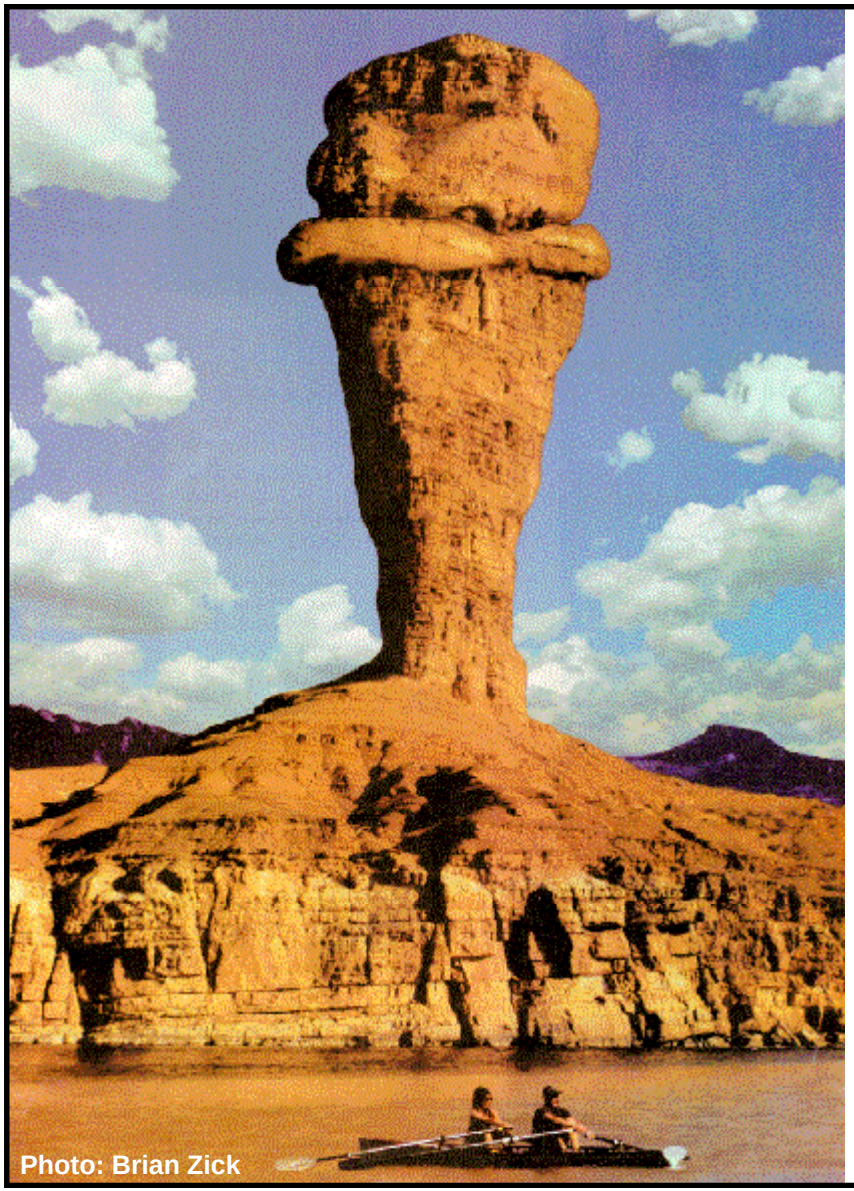
(The Oldest Profession in the World)

Teacher Institute Week

AFRL La Luz Academy

Rick Dove, dove@parshift.com

Keynote, July 19, 2010



Rick Dove

- Adjunct Professor, Stevens Inst. of Tech.
- Partner, Kennen Technologies
- Chairman, Paradigm Shift International

35+ years of start-ups, turnarounds and interim executive management

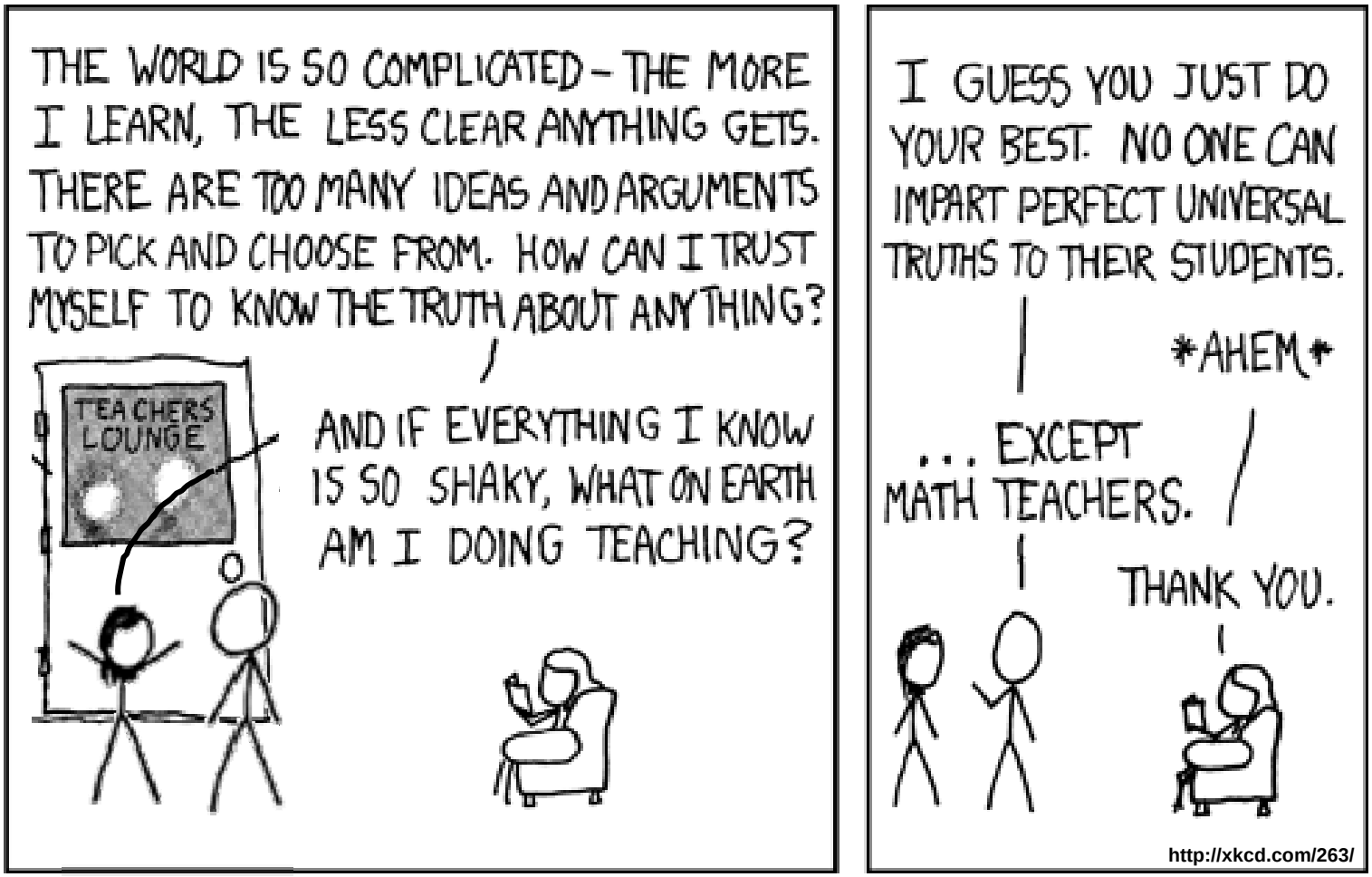
Carnegie Mellon: BSEE
UC Berkeley: graduate work in CompSci

Co-founder of *Agile Enterprise* concept in '91 at Lehigh University

Director of Strategy/Research, Sr. Fellow, Agility Forum, Lehigh University

Author: "Response Ability: The Language, Structure, and Culture of Agile Enterprise"

Lives in Taos County, NM, at 8200 feet .....Land of Enchantment (and thin air).



(One should remember that life is pointless w/o geometry)

Topics Covered

Context – time marches on

What is a system?

What is sySTEM engineering and What do SysEs do?

Being a sySTEMs Engineer

Systems with Large Effects – Happening Faster

Knowledge builds on knowledge

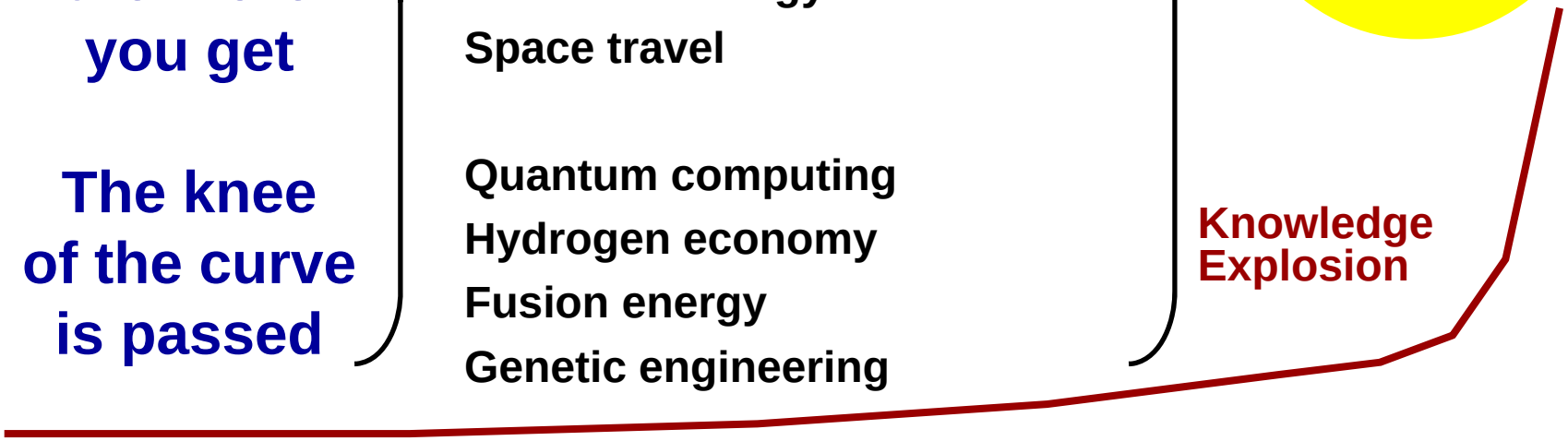
The more you have the more you get

The knee of the curve is passed

- Nuclear physics
- Personal computer
- Semiconductors in everything
- Internet
- Globalization
- Genetic engineering
- Cloning
- Nano-technology
- Space travel
- Quantum computing
- Hydrogen economy
- Fusion energy
- Genetic engineering

Decisions must be made faster…

…and implemented immediately



Who is concerned about Unintended Consequence?

Change and Uncertainty

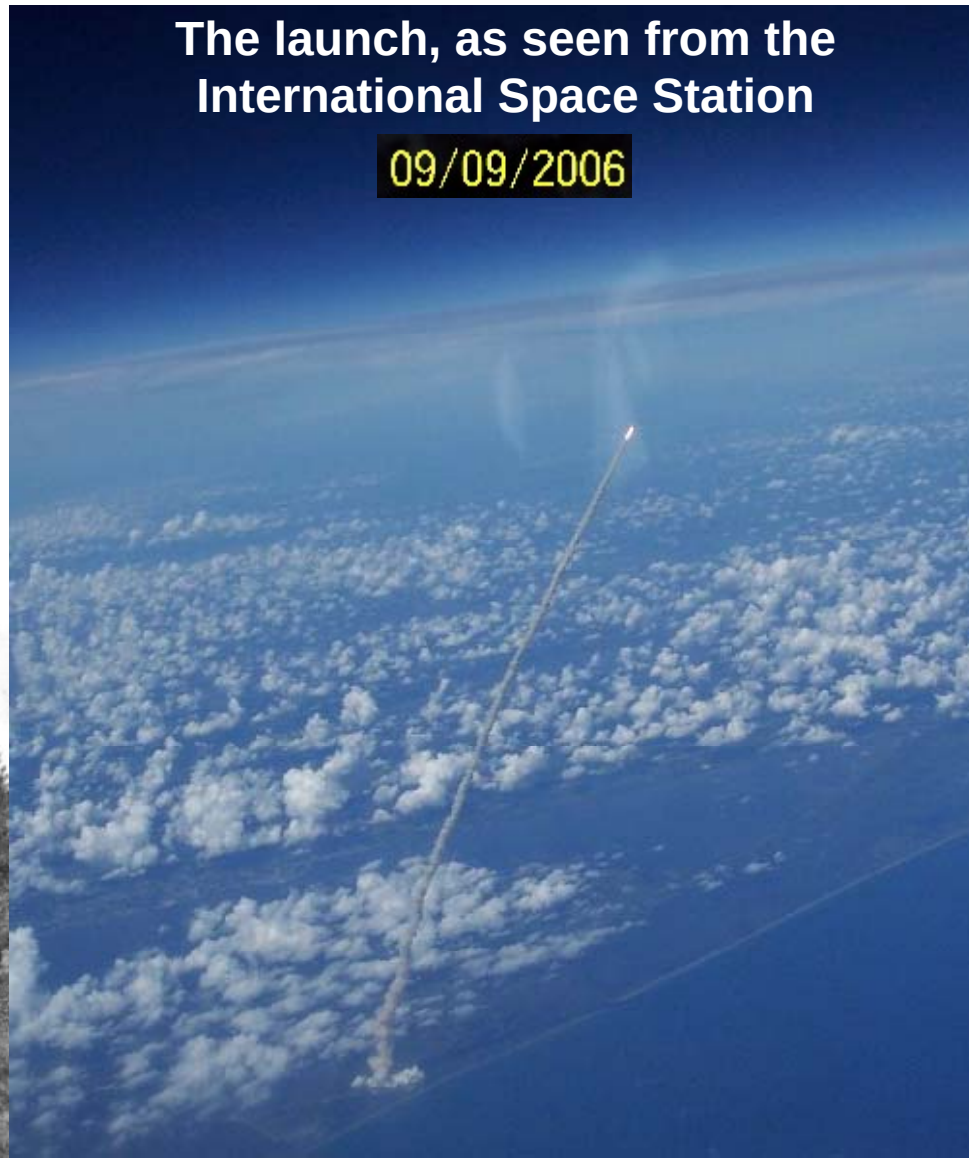
100 years later – one life time

The Paris edition of the *New York Herald* summed up Europe's opinion of the Wright brothers in an editorial on February 10, 1906: "The Wright have flown or they have not flown. They possess a machine or they do not possess one. They are in fact either fliers or liars. It is difficult to fly. It's easy to say, 'We have flown.'"

On November 12, 1906, Alberto Santos-Dumont flew 220 meters (726 feet), capturing the 1500 franc Aero-Club de France prize from the Aero-Club for the first 100-meter flight.

www.first-to-fly.com/History/Wright%20Story/prizepatrol.htm

The launch, as seen from the International Space Station



Entrance to Croydon Aerodrome, 1920

Imperial Airways airliner 'Hannibal' flying over Croydon Airport, early 1930s

Opened 29 March 1920.

Regular scheduled flights were introduced,

carrying passengers, mail and freight

to Paris, Amsterdam and Rotterdam.

90 Years Later … Las Cruces, New Mexico
Spaceport Completion targeted end of 2010

Virgin Galactic's commercial space operation

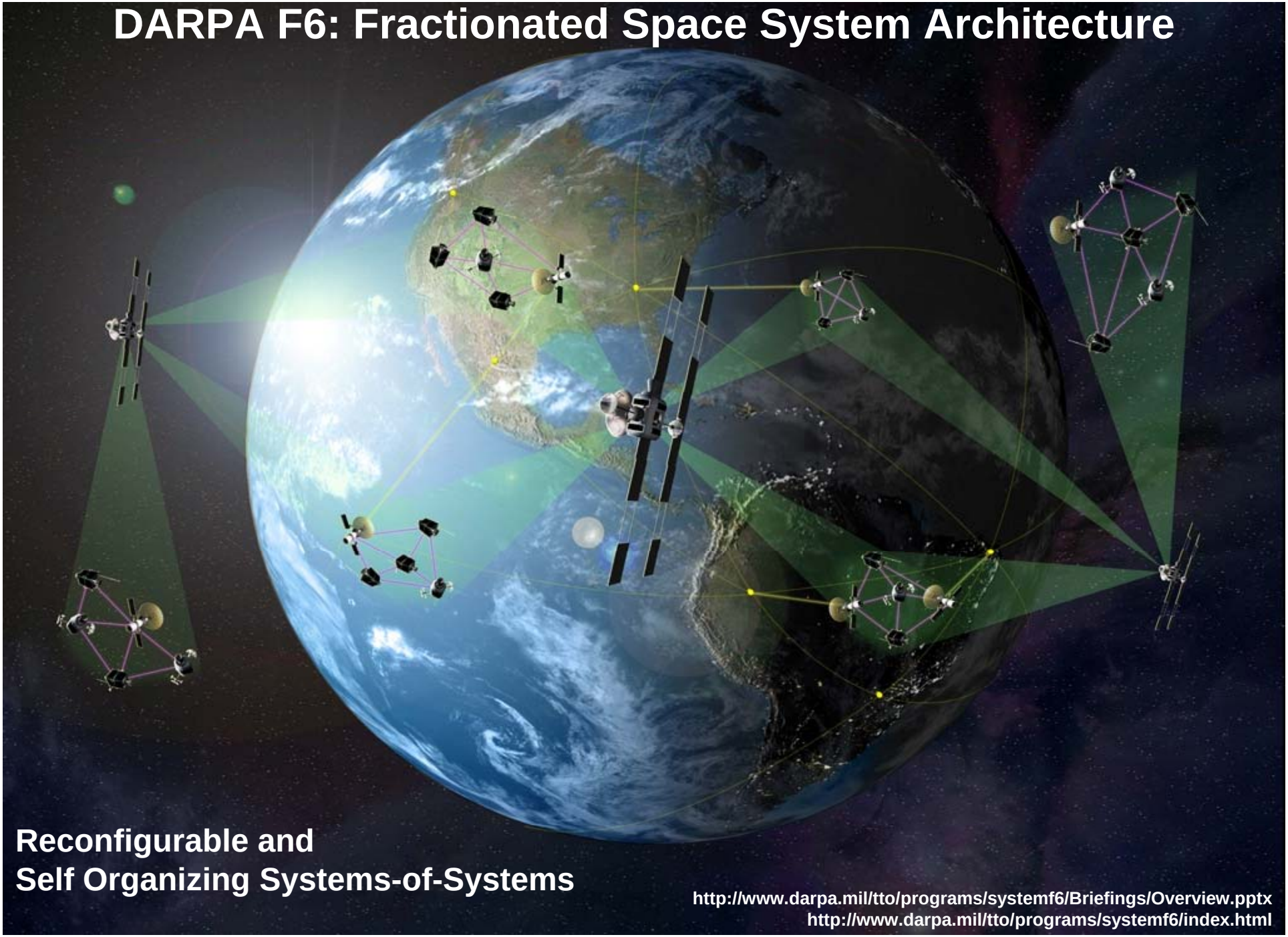
Paying passengers going up in 2011

$40 million in deposits collected by June 2009

Five spaceships ordered to meet the demand

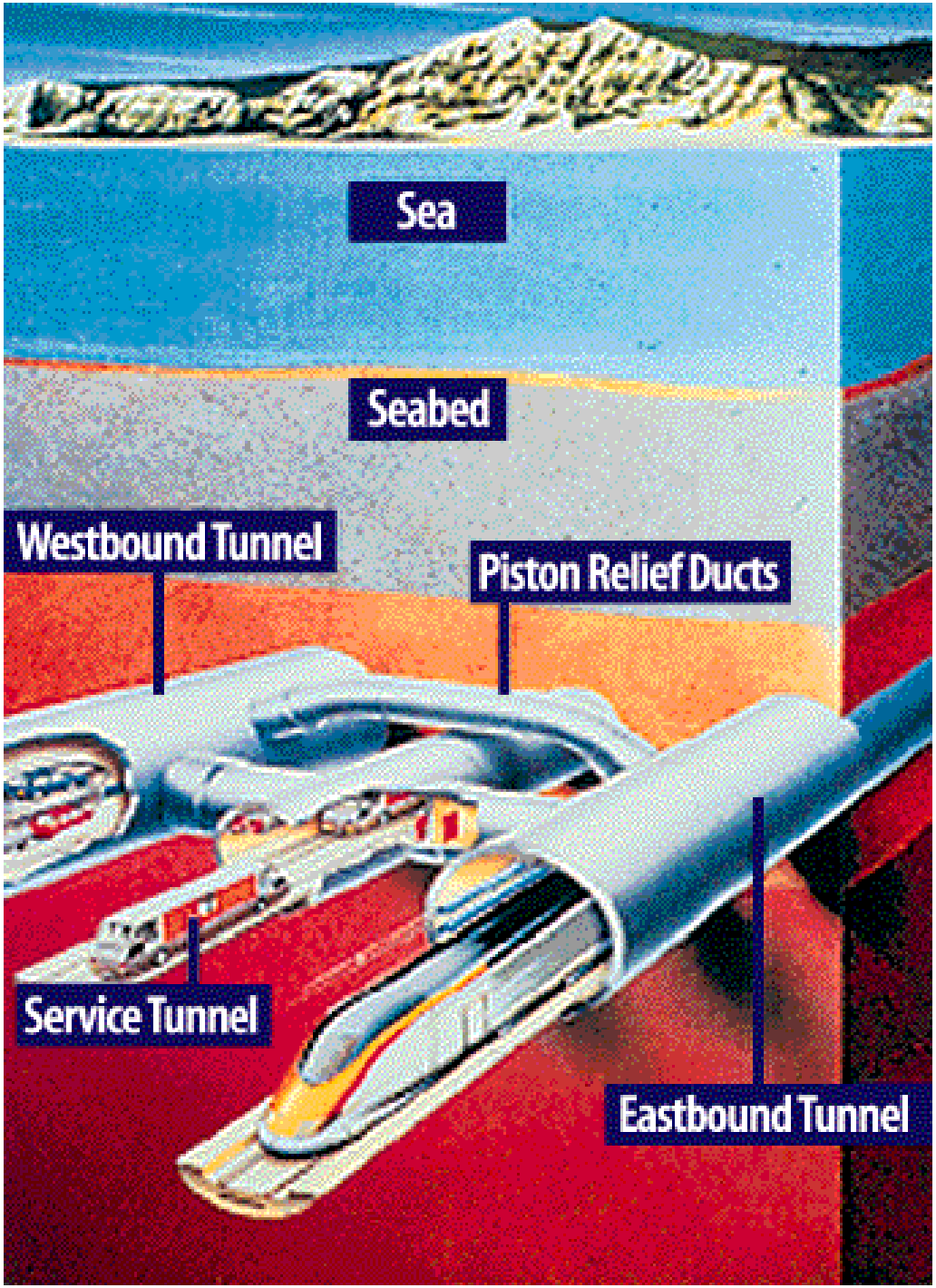
What is a system?

DARPA F6: Fractionated Space System Architecture



Reconfigurable and
Self Organizing Systems-of-Systems

http://www.darpa.mil/tto/programs/systemf6/Briefings/Overview.pptx
http://www.darpa.mil/tto/programs/systemf6/index.html

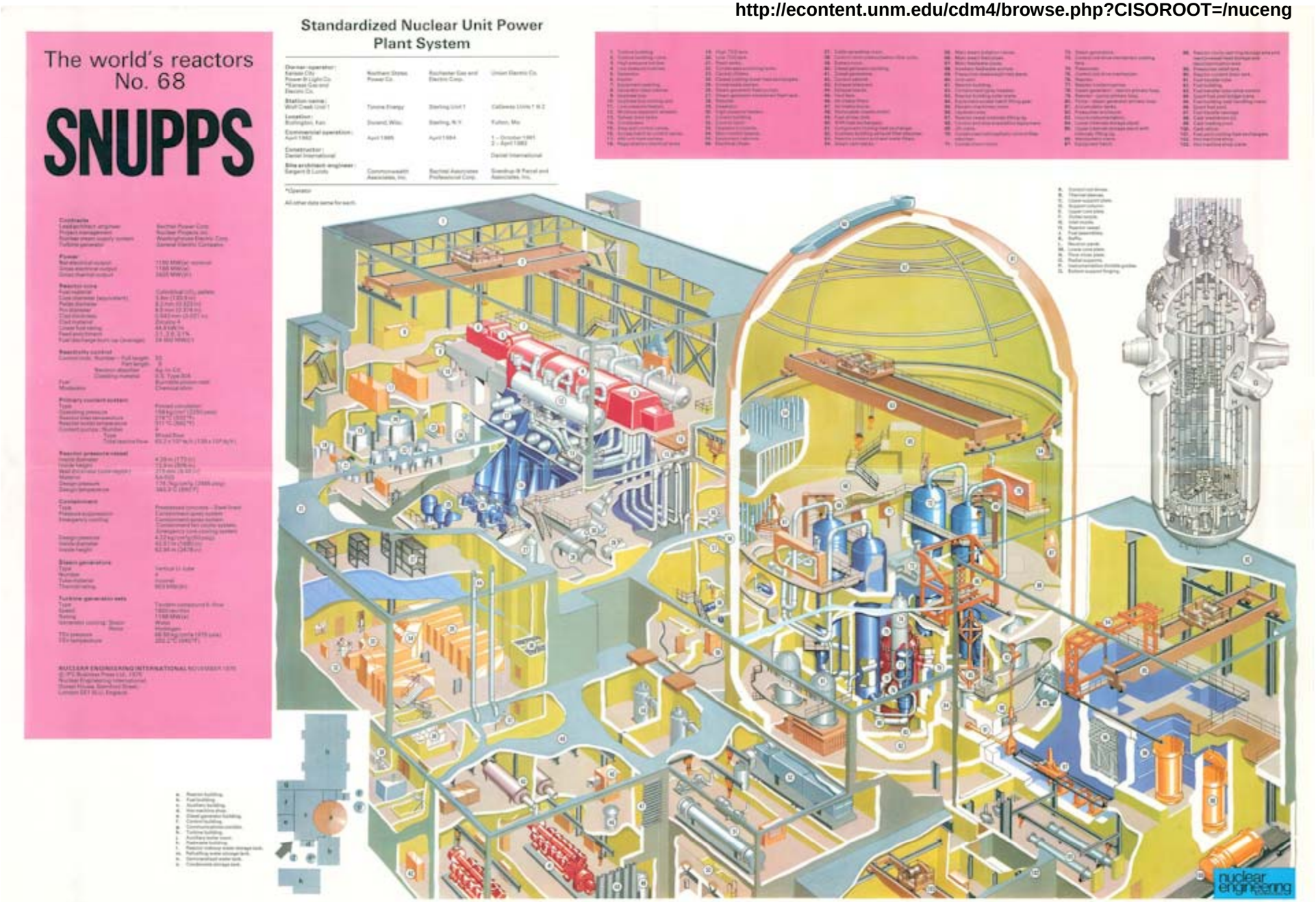


Big Systems

Thinking (a conscious activity) about your engineering tools and your engineering processes and the goals of your piece of the project is necessary – but not sufficient .

You must also think about the context – its intent and its values.

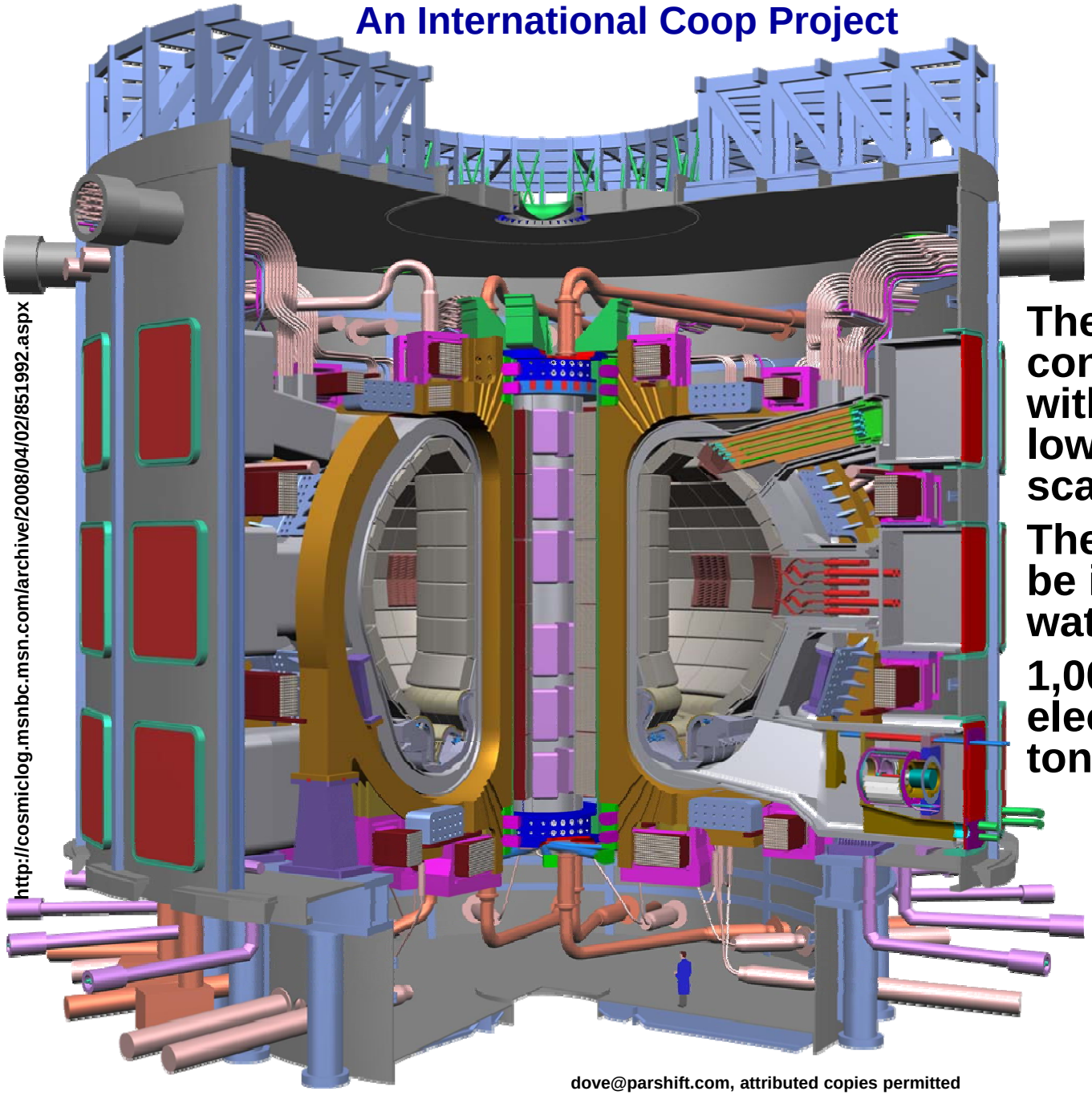
"We are not constructing a tunnel – we are creating a transportation system." [Allen Fairbairn, System Engineer on the Chunnel Project]



Snupps: Standardized Nuclear Unit Power Plant System. Creator: Nuclear Engineering International. Kansas City Power & Light Co., Burlington, Kansas. Original: 1975-11. http://econtent.unm.edu/cgi-bin/showfile.exe?CISOROOT=/nuceng&CISOPTR=5&filename=8.pdf

Fusion Power in 2016

An International Coop Project



http://cosmiclog.msnbc.msn.com/archive/2008/04/02/851992.aspx

The ITER plasma containment vessel, with a human figure, lower right, providing scale.

The fuel for fusion can be isolated from sea water.

1,000 megawatts of electricity burns 9,000 tons of coal.

Energy of the Future: Igniting a Star With Laser Light

Dave Bullock, 04May09, www.wired.com/science/discoveries/news/2009/05/gallery_nif

Like a scene out of *Half-Life*, the exterior of the NIF facility belies the history-making science conducted within.

Using 192 separate lasers and a 400-foot-long series of amplifiers and filters, scientists at Lawrence Livermore's National Ignition Facility (NIF) hope to create a self-sustaining fusion reaction like the ones in the sun or the explosion of a nuclear bomb — only on a much smaller scale.

"We are well on our way to achieving what we set out to do — controlled nuclear fusion and energy gain for the first time ever in a laboratory setting."

The hope is that this reaction will release more energy than the lasers put into the target isotopes and perhaps redefine the global energy crisis in the process.

prototype that flew to Africa

projected commercial version

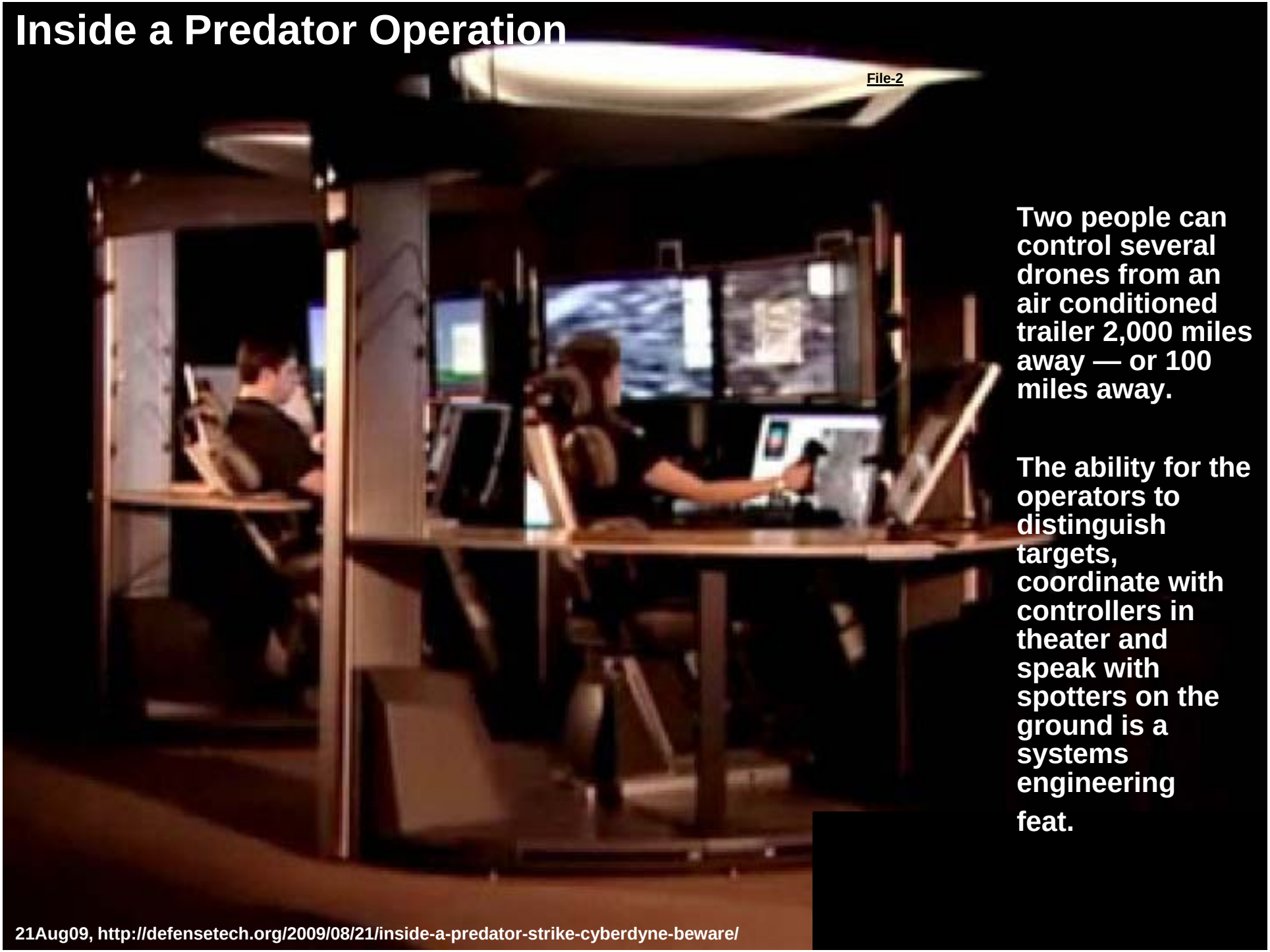
www.parajet.com/index.php?id=138

Flying Car Flies From London To Africa

Slashdot 25Feb09: "It may not be exactly what people have envisioned or tried over the years, but the BBC reports that a flying car has flown from London across into Africa."

Inside a Predator Operation

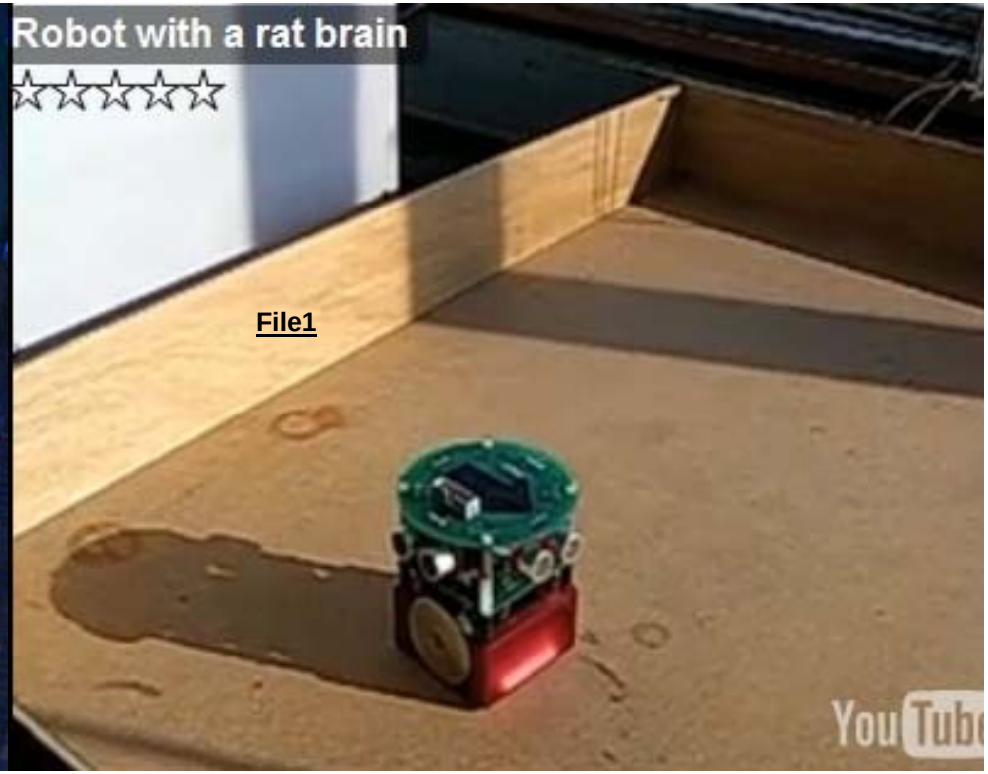
File-2



Two people can control several drones from an air conditioned trailer 2,000 miles away — or 100 miles away.

The ability for the operators to distinguish targets, coordinate with controllers in theater and speak with spotters on the ground is a systems engineering feat.

21Aug09, http://defensetech.org/2009/08/21/inside-a-predator-strike-cyberdyne-beware/



Professor Warwick (who incidentally has a device implanted in his left arm that enables his nervous system to be connected to a computer) and his colleague Ben Whalley from the School of Pharmacy recently created a robot that is controlled by cultured rat neurons.

Rat Brain Robot Now…
Human Brain Cells Next

Fusion of
Biology and Technology

Surfdaddy Orca, 16Oct09, www.hplusmagazine.com/articles/robotics/using-human-%E2%80%9Cwetware%E2%80%9D-control-robots

DIY Life-Forming

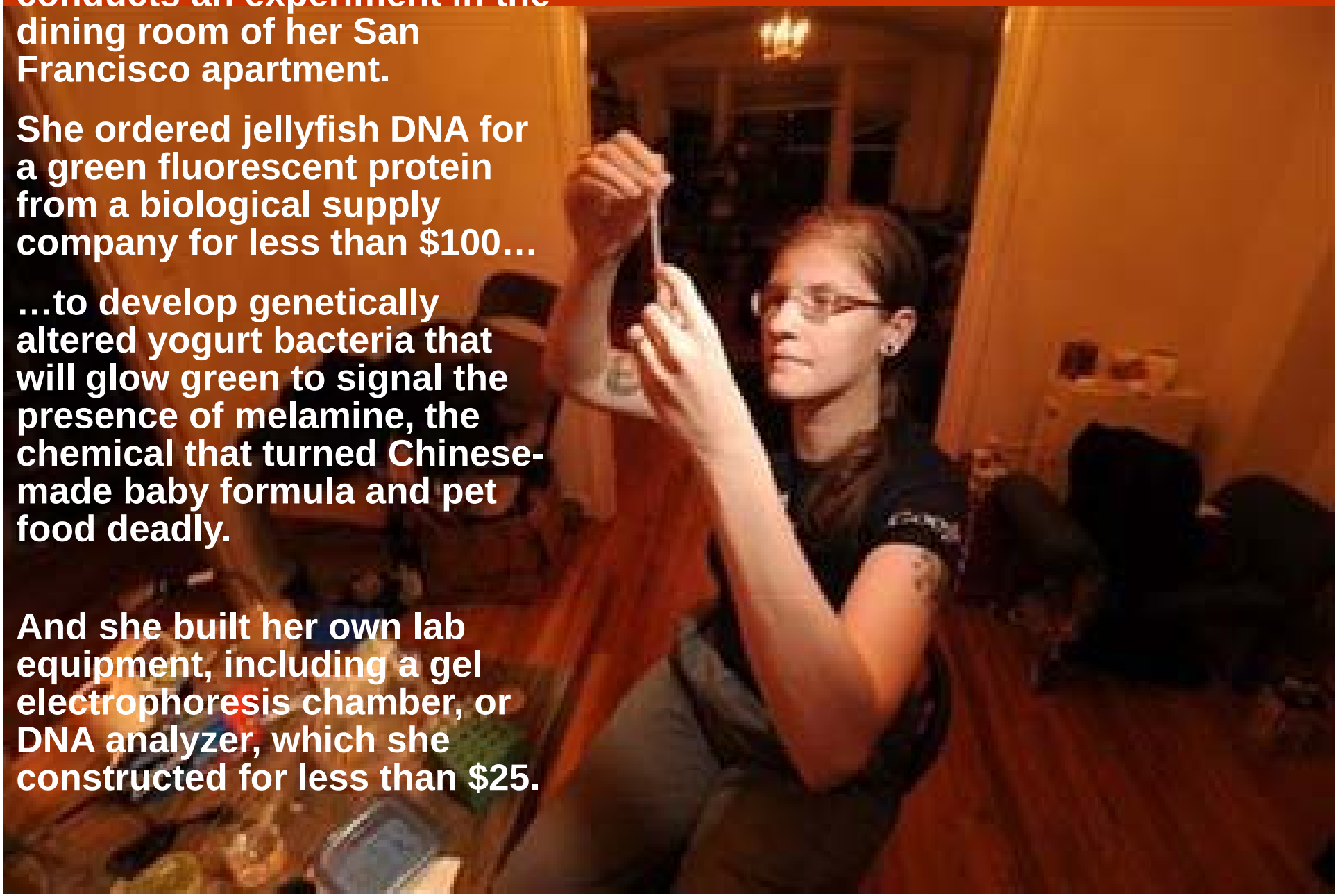
www.huffingtonpost.com/2008/12/25/do-it-yourself-dna-amateu_n_153489.html

Meredith L. Patterson, a computer programmer by day, conducts an experiment in the dining room of her San Francisco apartment.

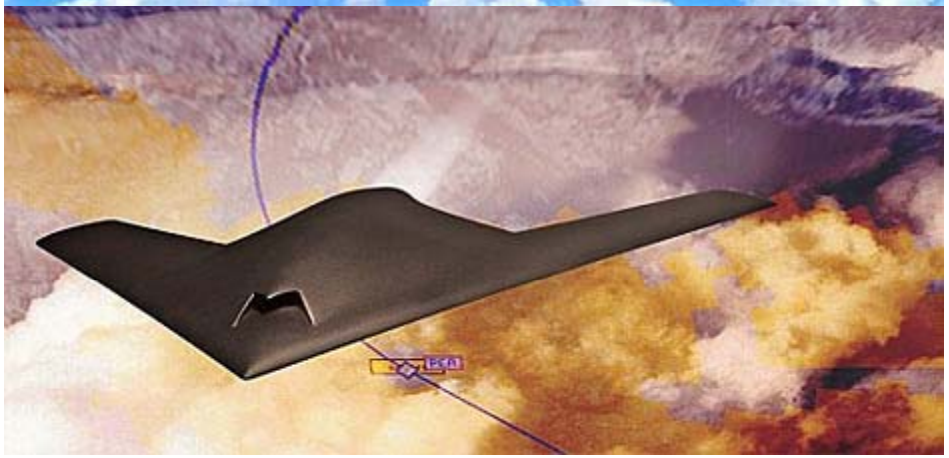
She ordered jellyfish DNA for a green fluorescent protein from a biological supply company for less than $100…

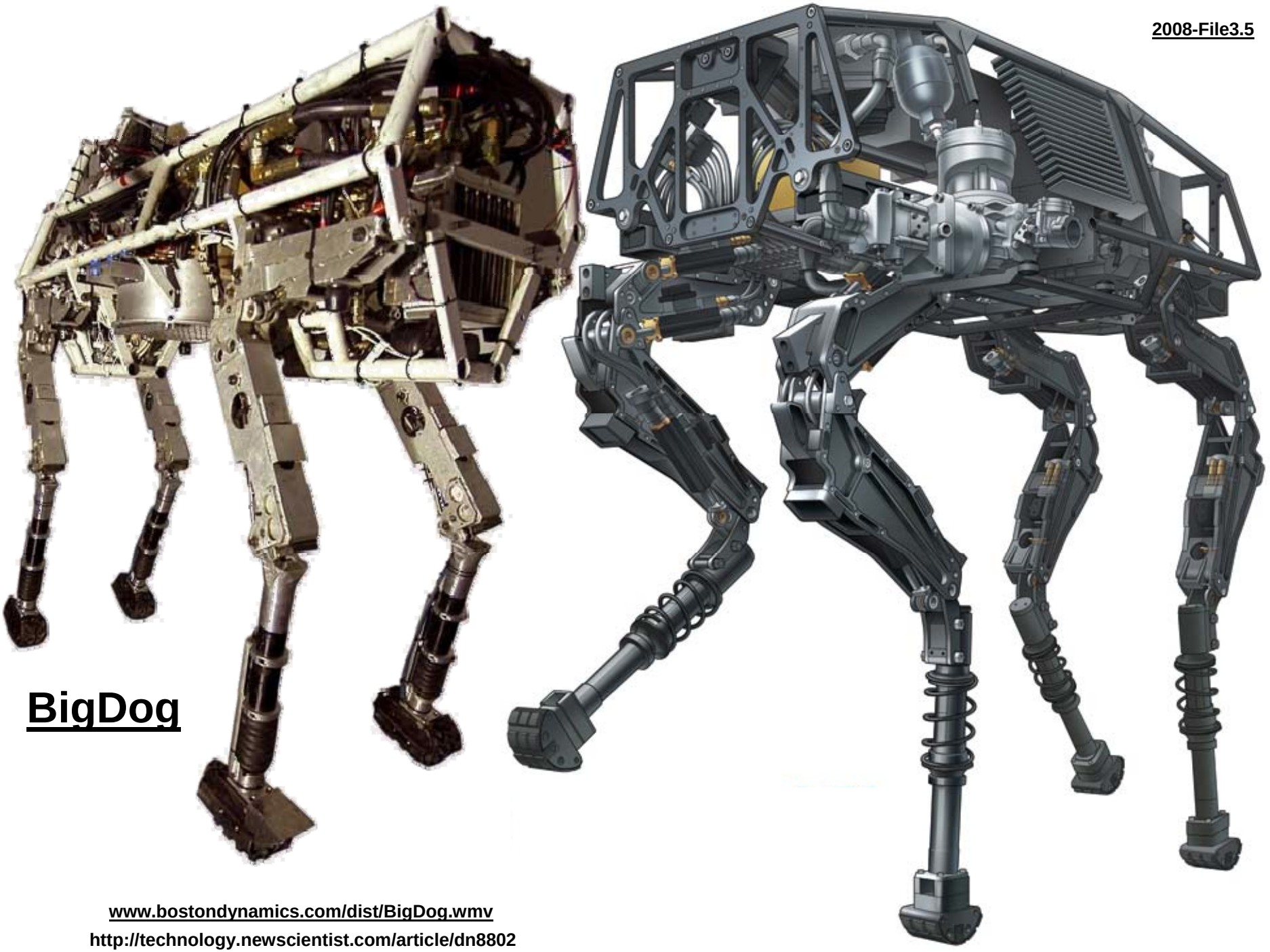
…to develop genetically altered yogurt bacteria that will glow green to signal the presence of melamine, the chemical that turned Chinese-made baby formula and pet food deadly.

And she built her own lab equipment, including a gel electrophoresis chamber, or DNA analyzer, which she constructed for less than $25.



Unmanned (Autonomous) Systems





BigDog

www.bostondynamics.com/dist/BigDog.wmv

http://technology.newscientist.com/article/dn8802

System Engineering Problems Looking for Solutions

Learning how things <u>really</u> work (you…every day from birth)

Baby's are the ultimate SEs, figuring out how it all works, and how to work/beat the system. That never stops.

You're a natural at it.

On the edge of systems engineering interests:

Systems of systems

Multi-agent systems

Gaming systems

Resilient systems

Autonomous systems

Adaptable systems

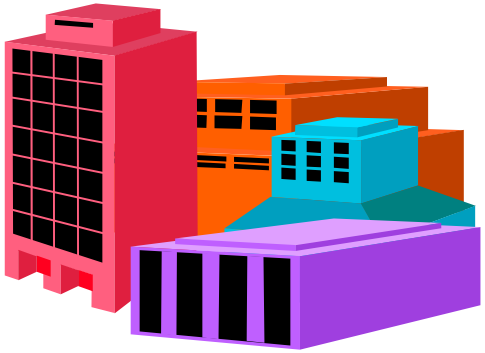
Evolving systems

Natural systems

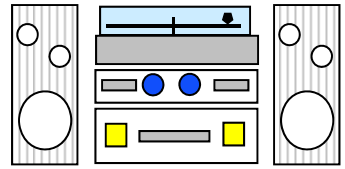
Emergent behaviors

Unintended consequences

Basic Definitions



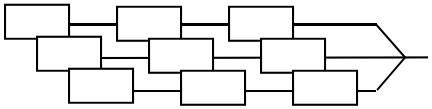
Company of Divisions



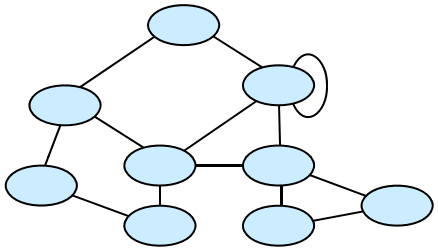
Stereo System of Components

System

A group of modules
sharing a common interaction framework
and serving a common purpose.



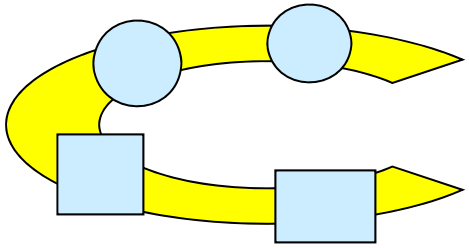
Chain of Suppliers



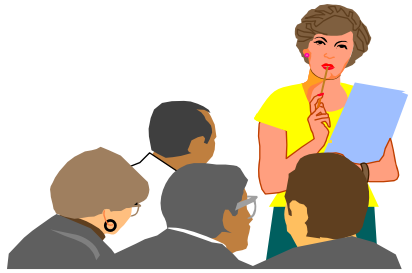
Practice of Procedures

Framework

A set of standards
constraining and enabling the interactions
of compatible system modules.



Cell of Workstations

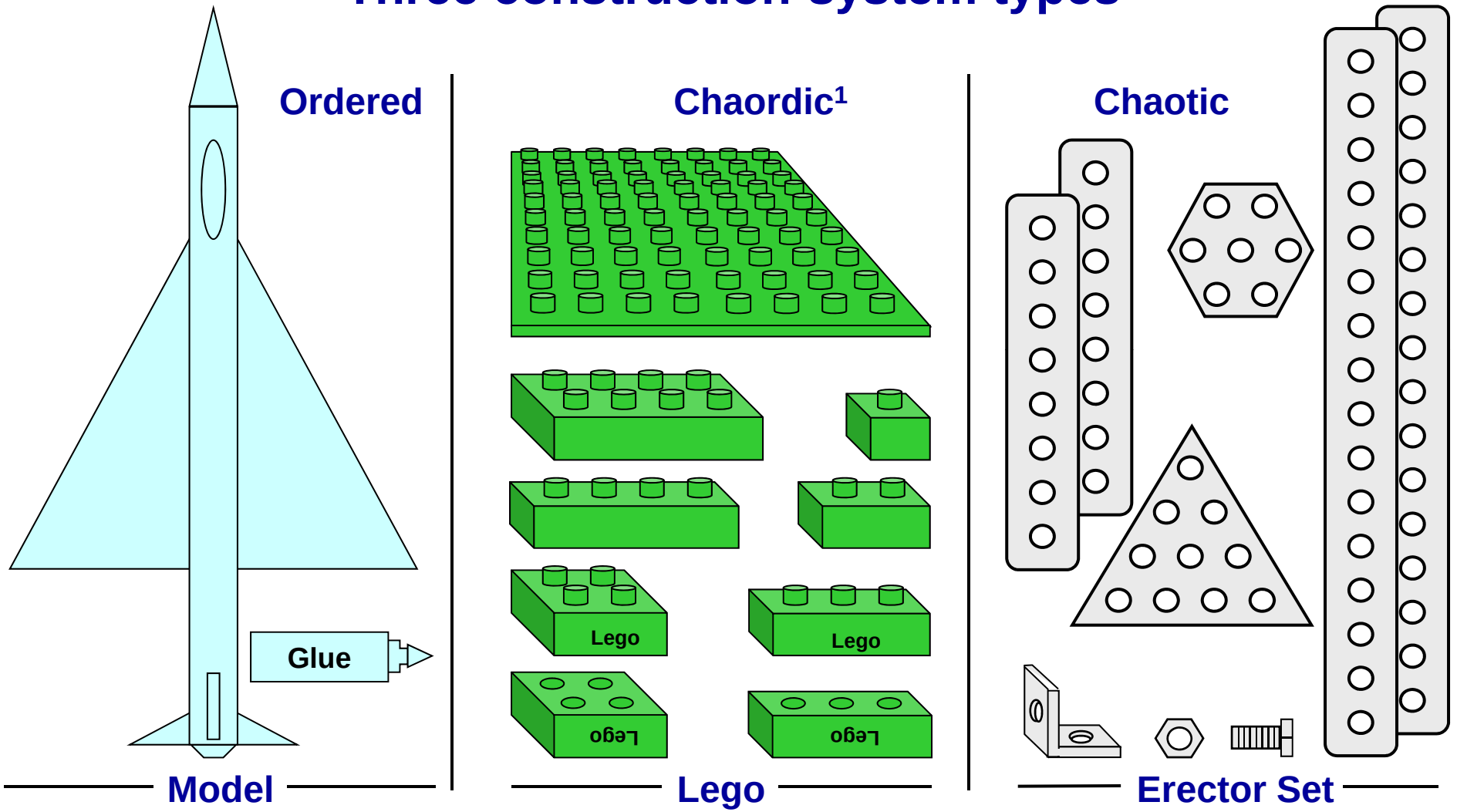


Team of People

Module

A separable system sub-unit
with a self-contained capability/purpose/identity,
and capable of interaction with other modules.

Frameworks/Infrastructures: Three construction-system types



[1] Dee Hock (Visa Corp) coined the word *chaord* for organisms, organizations, and systems which harmoniously exhibit characteristics of both order and chaos.

What is System Engineering
and
What do SysEs do?

Systems Engineering

Niches

- Embedded systems engineering (e.g., electronic on-chip controls)
- Software systems engineering (e.g., OO and SOA)
- Defense systems engineering (e.g., weapon systems, IED defeators)
- Big systems engineering (e.g., aircraft, power plants, power grid)
- Security Systems Engineering (e.g., usable secure systems)
- Open systems engineering (e.g., Wikipedia)
- Everyday systems engineering (e.g., wedding planning)
- Open systems engineering & evolution (e.g., home entertainment)
- Robotic systems engineering (safe functionality)
- … many more

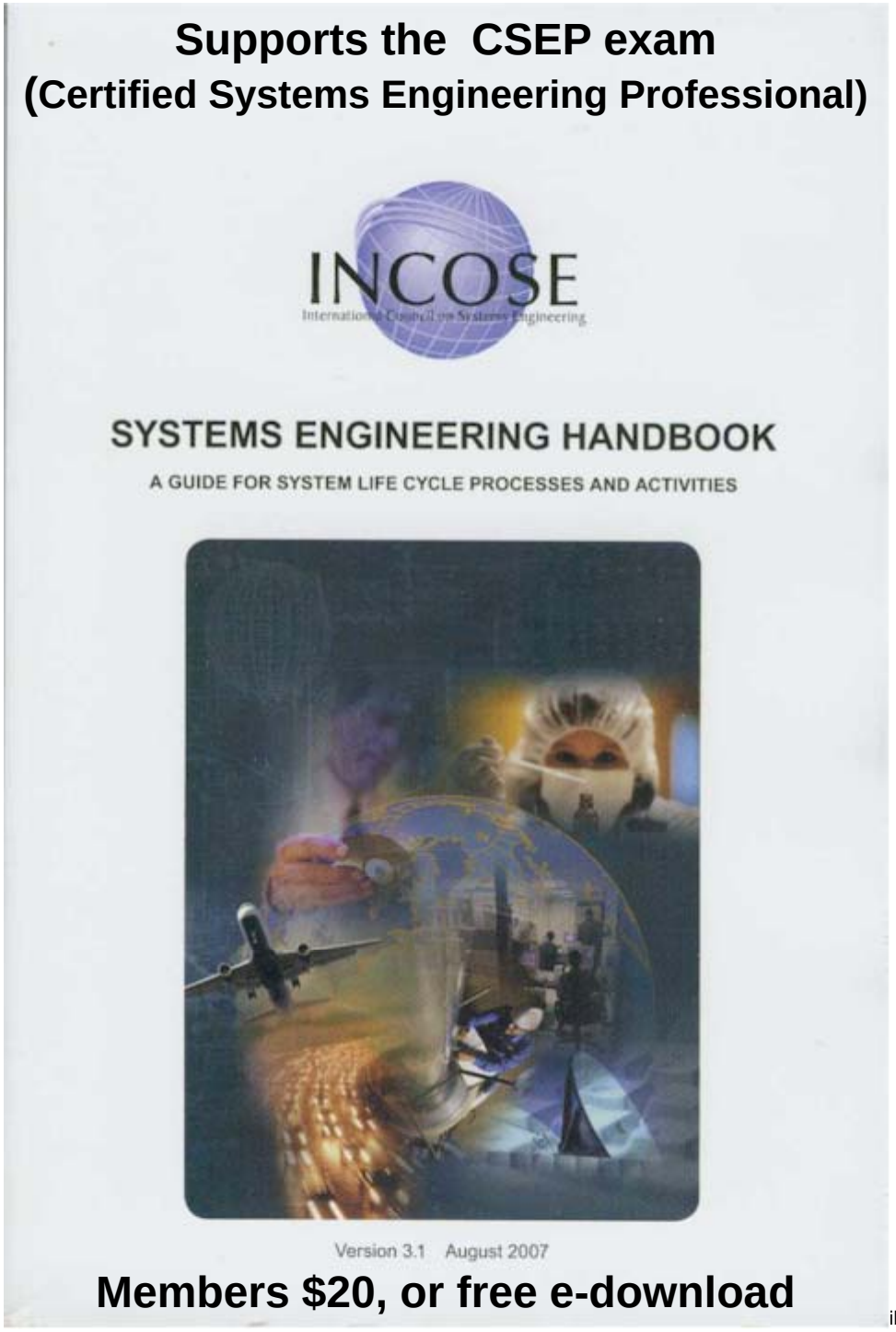
In the Large

- Architecture (structure and strategy)
- Systems Thinking (how does/will/must it <u>really</u> work)
- Trade-off Design Analysis (resolving design value conflicts)
- Trade-off Implementation Management (real-time conflict resolution)

In the Detail

- Best-practice standard processes

Supports the CSEP exam
(Certified Systems Engineering Professional)



Members $20, or free e-download

4. Technical Processes

- 4.1 Introduction.
- 4.2 Requirements Definition Process
- 4.3 Requirements Analysis Process
- 4.4 Architectural Design Process
- 4.5 Implementation Process
- 4.6 Integration Process
- 4.7 Verification Process
- 4.8 Transition Process
- 4.9 Validation Process
- 4.10 Operation Process
- 4.11 Maintenance Process
- 4.12 Disposal Process

Systems engineering is a discipline that concentrates on the design and application of the whole (system) as distinct from the parts. It involves looking at a problem in its entirety, taking into account all the facets and all the variables and relating the social to the technical aspect. (Ramo)

Systems engineering is an iterative process of top-down synthesis, development, and operation.

Conforms to ISO/IEC 15288
System Engineering Standard

70% of cost is committed during Concept Phase …and you can't afford to go back and re-do it

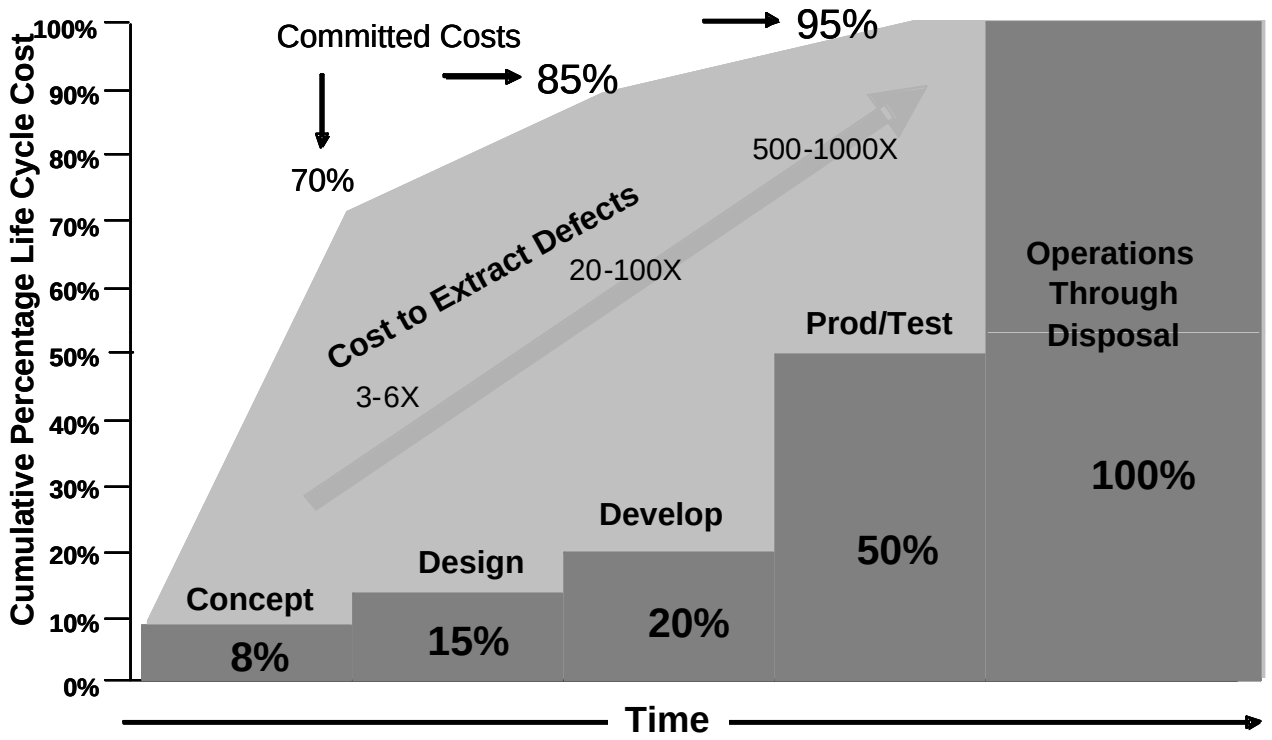


Figure 2-3 Committed Life Cycle Cost against Time

INCOSE Systems Engineering Handbook, V 3.1, p 2.6
From Defense Acquisition University 1993

Corollary: the hardest decisions to question are those made first

So: the most important work happens first

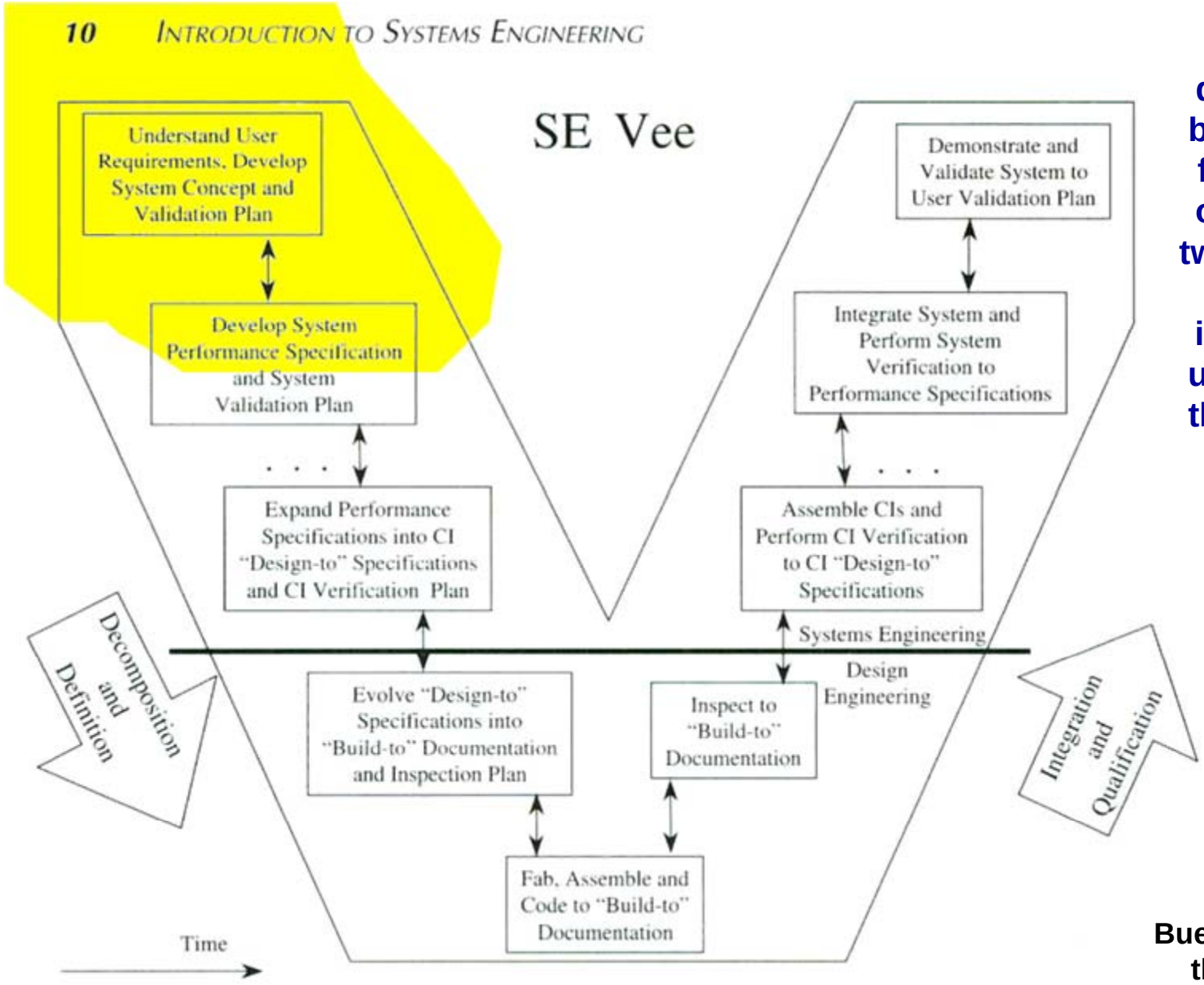


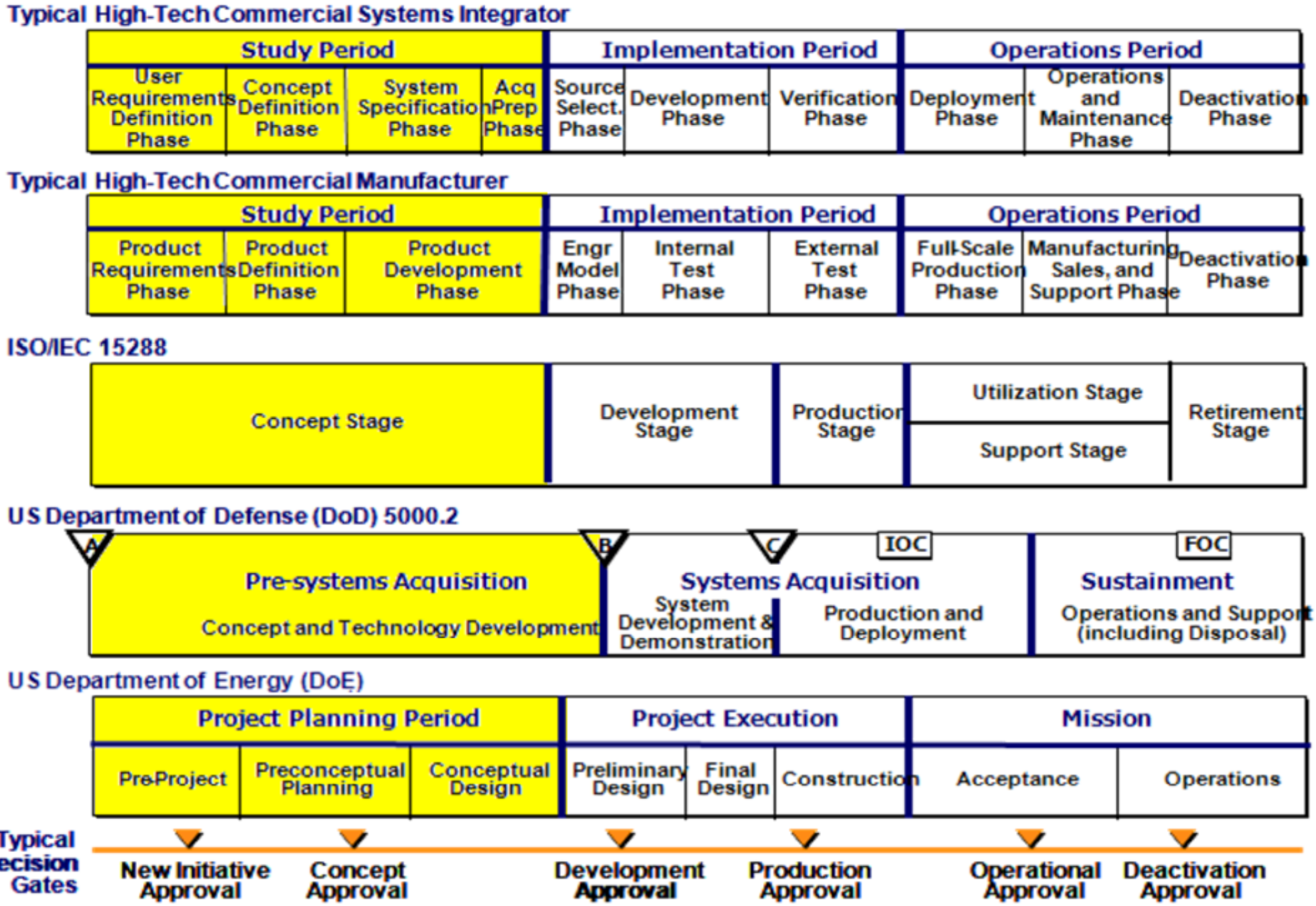
FIGURE 1.3 Systems engineering "Vee" (after Forsberg and Mooz, 1992).

"…the development of a basic idea and the first embodiment of the idea; these two initial activities are often called invention and are usually not part of the engineering of a system…"
Dennis Buede

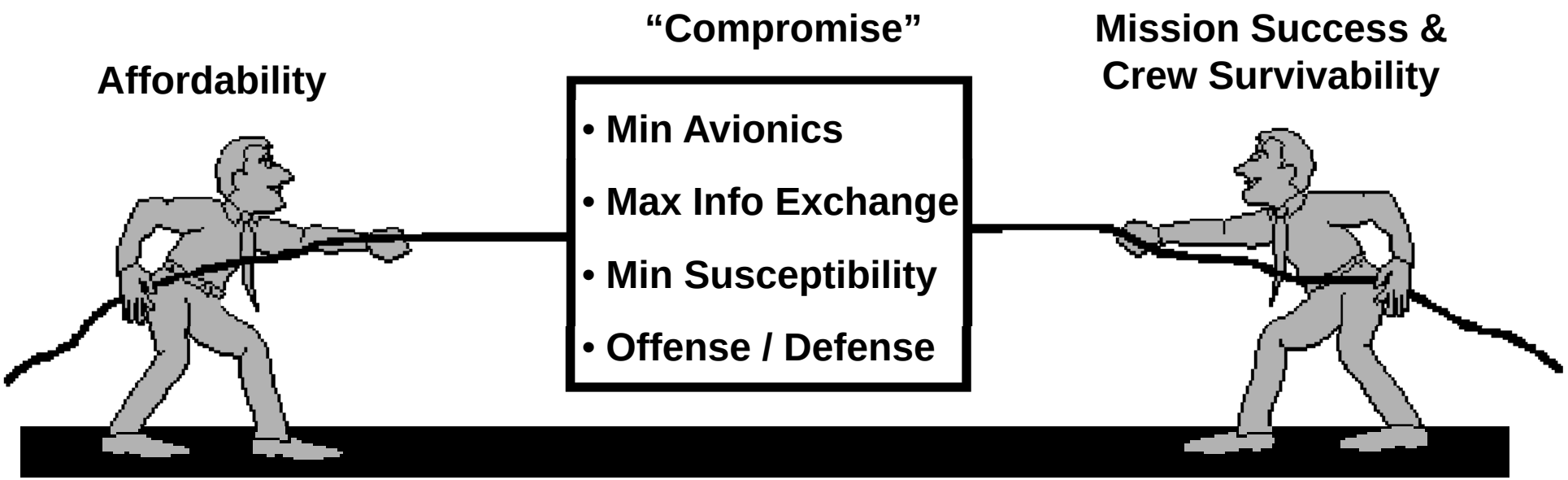
Buede's book addresses the procedures and processes that turn concept into reality. That is the process part of Systems Engineering

Systems Engineering Life Cycle Models

INCOSE Systems Engineering Handbook, V 3.1, p 3.5

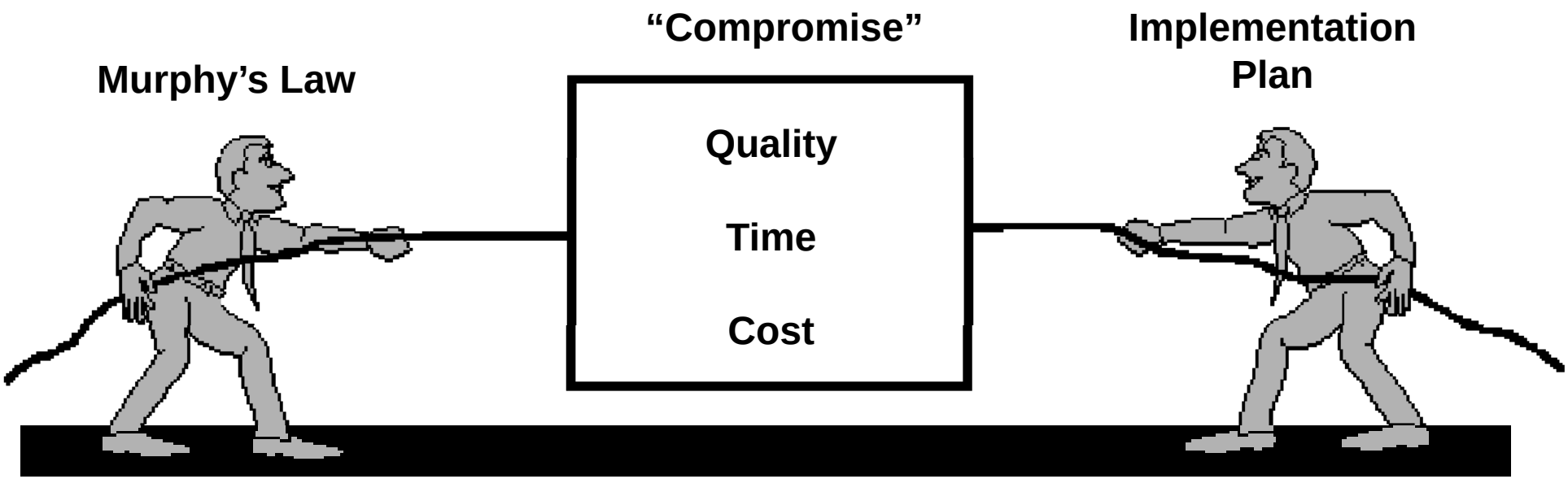


Design Trade-Offs – Conflicting Values



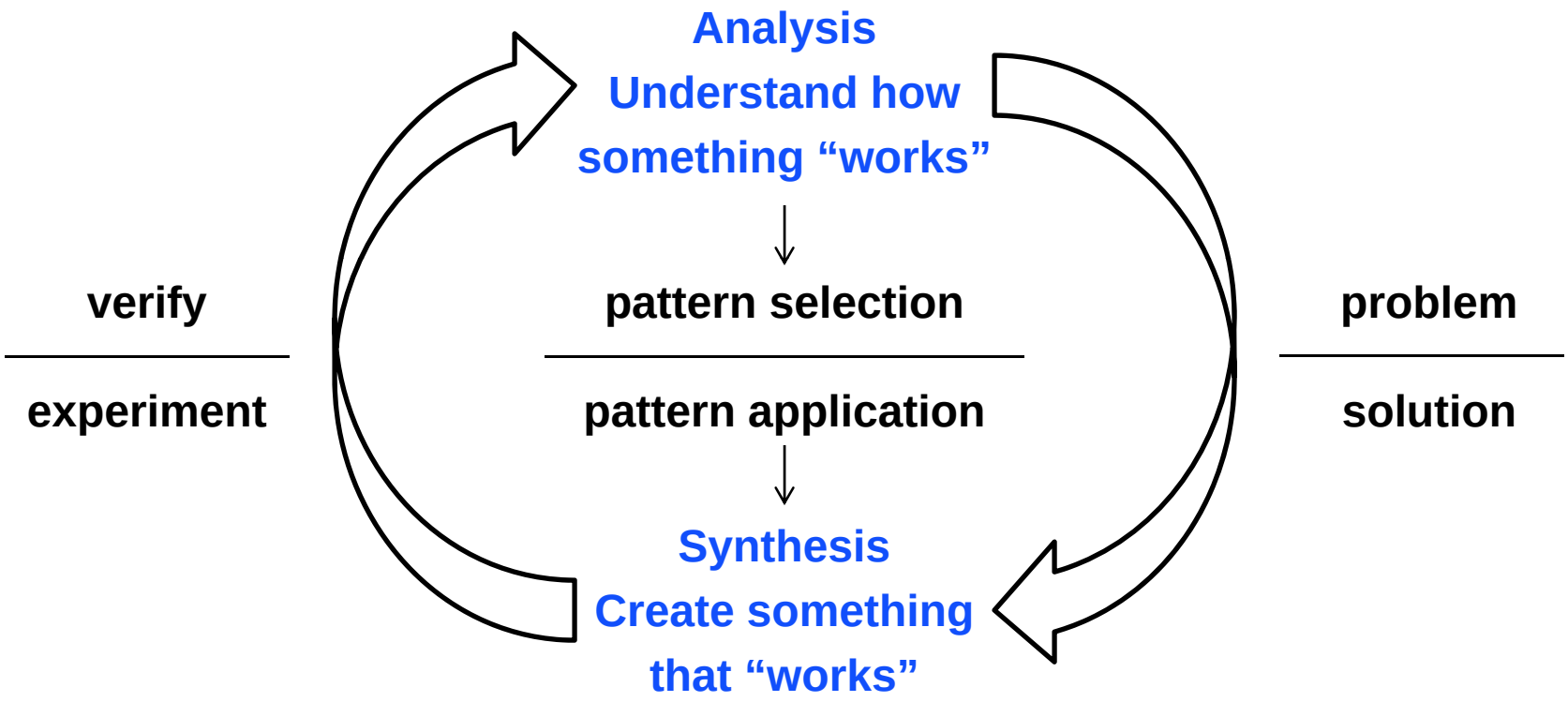
http://www.megasociety.org/noesis/167/9.htm

Real-Time Trade-Offs – Conflicting Events



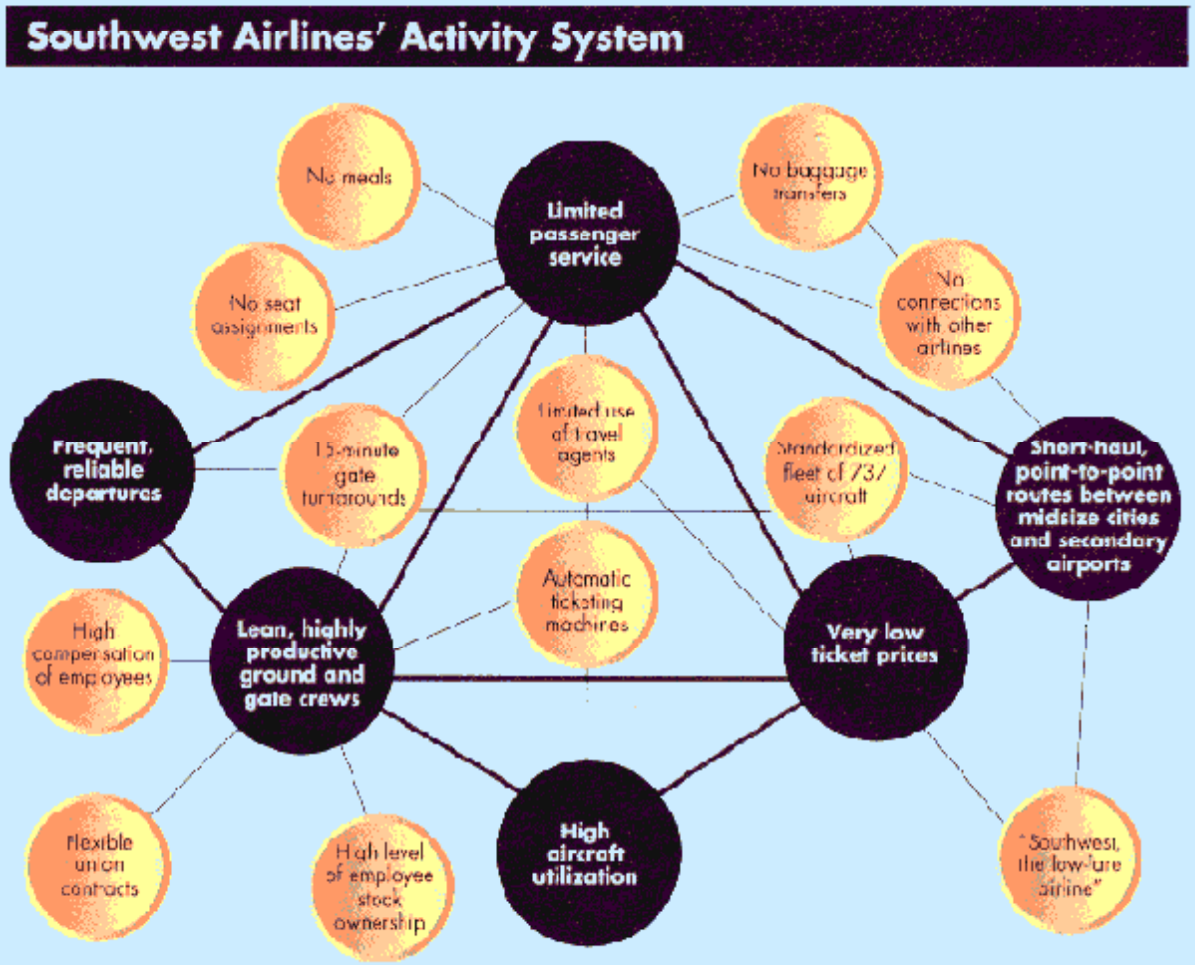
http://www.megasociety.org/noesis/167/9.htm

Two Sides of the Same Coin



Concept of Operations (conceptual)

"What is Strategy?", Michael Porter, Harvard Business Review, Nov-Dec '96

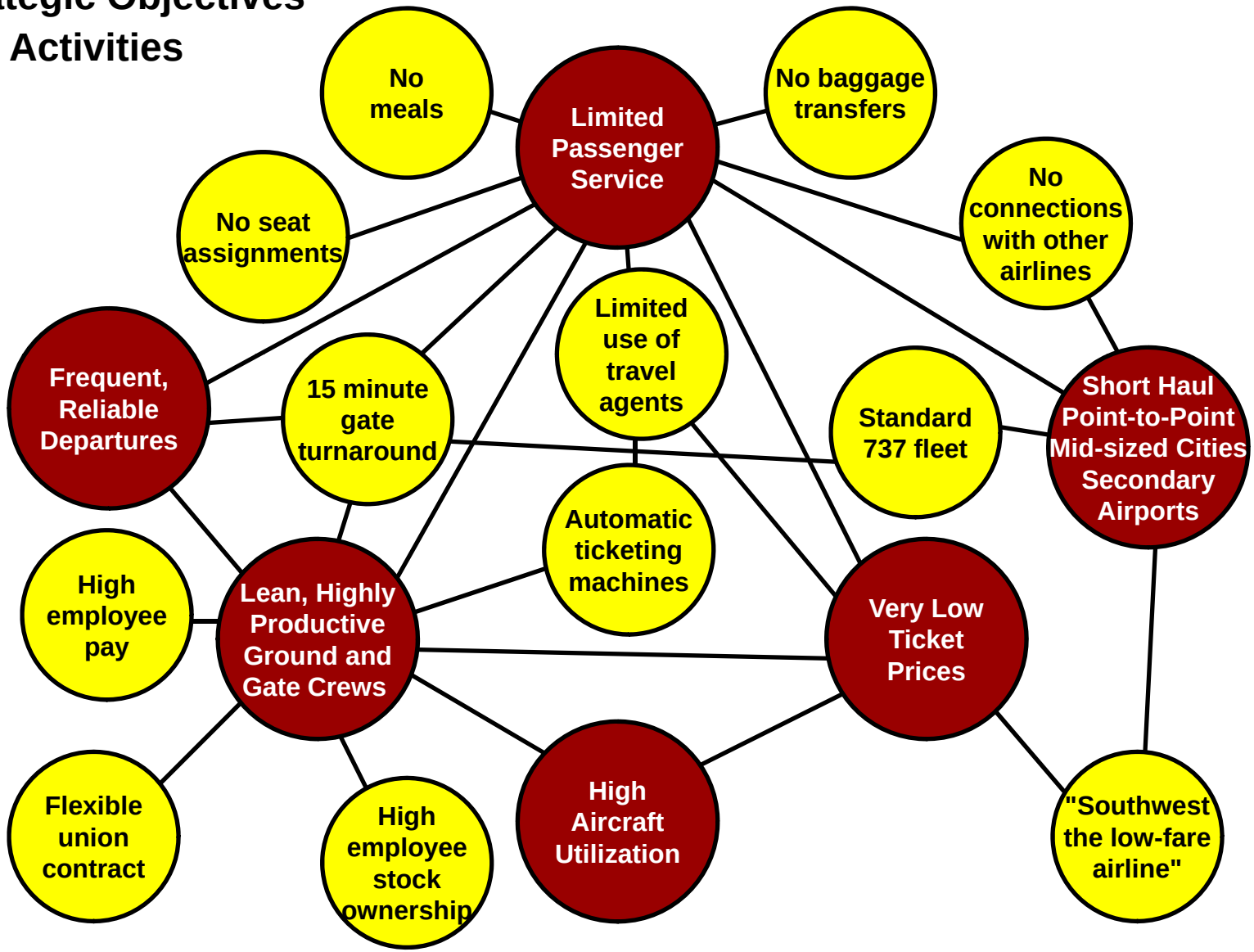


- All differences in cost or price derive from hundreds of activities required to create, produce, sell, and deliver.
- Activities are the basic units of competitive advantage.
- Overall advantage or disadvantage results from all of a company's activities, not only a few.
- Strategic positioning means performing *different activities* from rivals' or performing similar activities in *different ways*.

Southwest Airlines

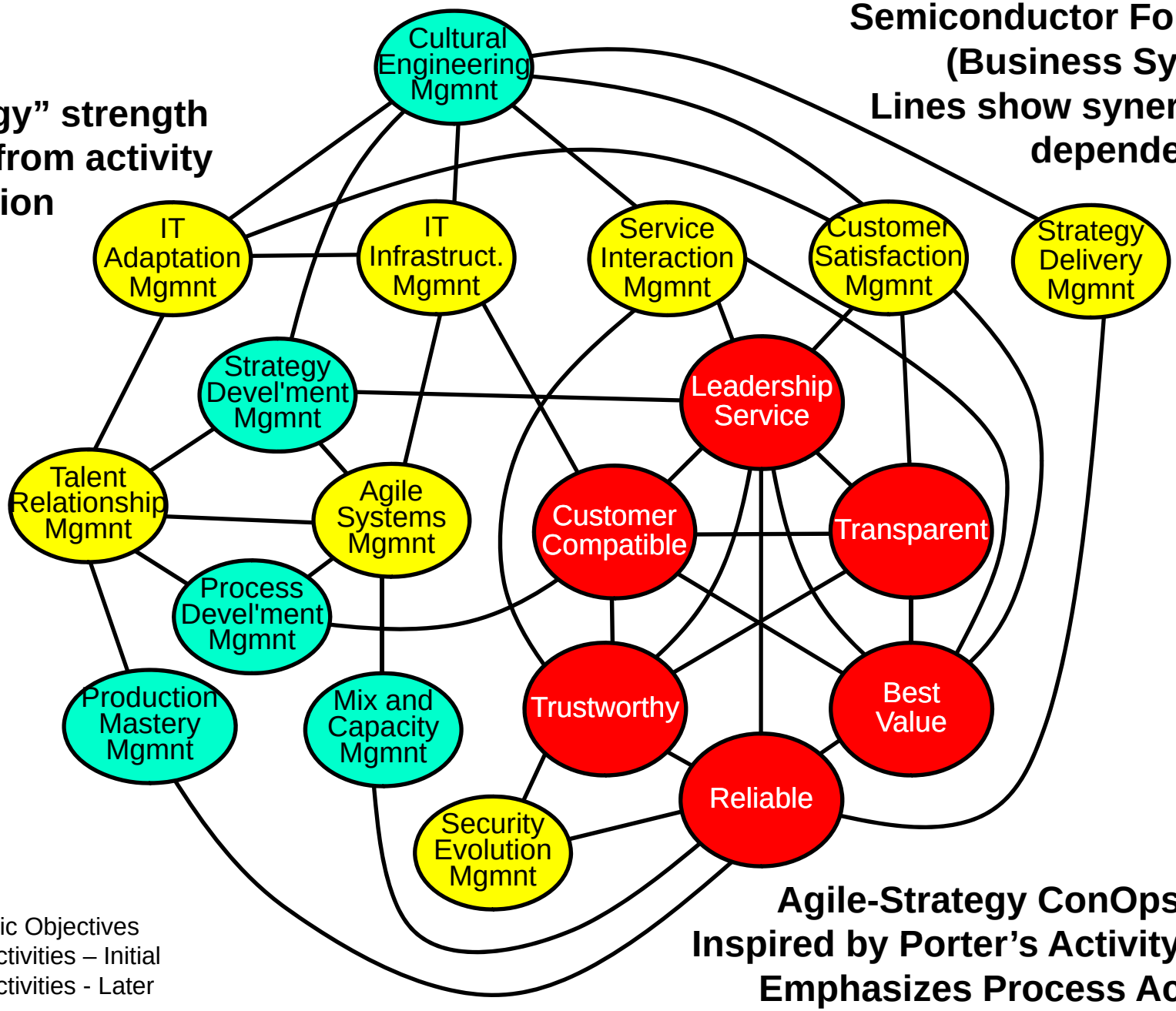
(Concept of Operations – Value Proposition Focus))

- Strategic Objectives
- Key Activities



“Strategy” strength comes from activity interaction

Semiconductor Foundry (Business System) Lines show synergistic dependencies



- Strategic Objectives
- Agile Activities – Initial
- Agile Activities - Later

Agile-Strategy ConOps Web Inspired by Porter’s Activity Web Emphasizes Process Activity and Response Objectives

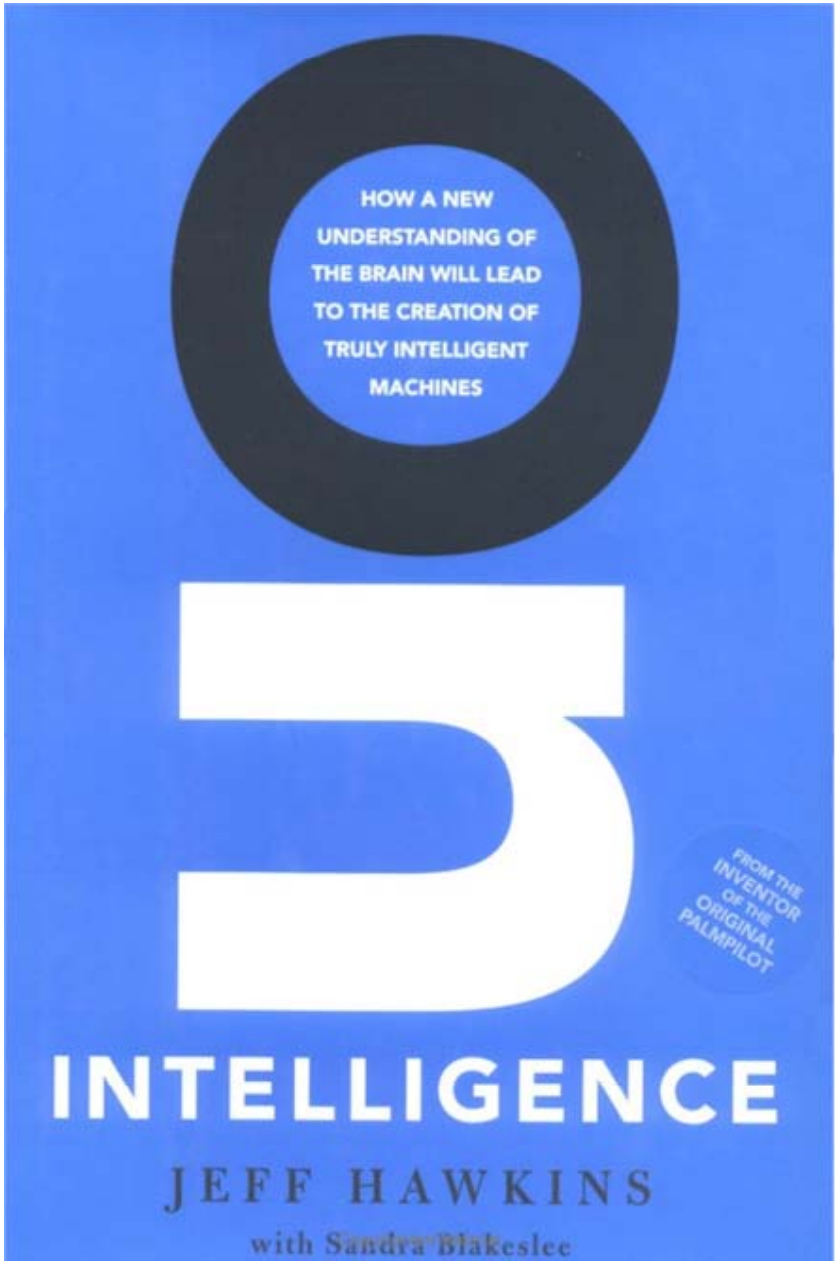
On Design Patterns and Expertise

The work of Nobel Laureate Herbert Simon: central finding was that pattern recognition is critical in most human decision making tasks:

> **"The more relevant patterns at your disposal, the better your decisions will be. ... We need to pay much more explicit attention to teaching pattern recognition.**

P.E. Ross, "Flash of Genius," Forbes, pp. 98-104, Nov. 1998.
www.forbes.com//forbes/1998/1116/6211098a.html

Hawkins is a founder of two leading mobile computing companies—Palm Computing and Handspring—and also of the Redwood Neuroscience Institute in Menlo Park, Calif., which explores memory and cognition.



Systems Analysis: The Brain

A Pattern Memory and Prediction System

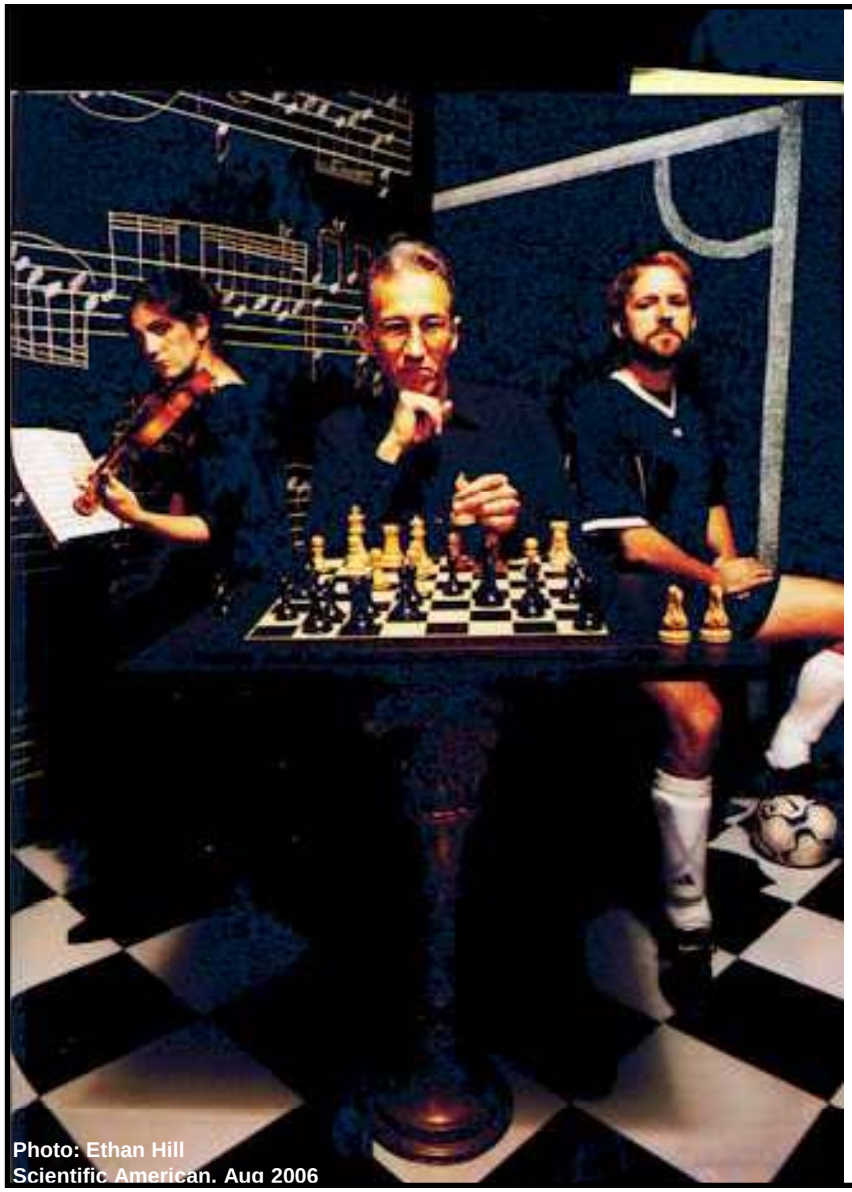
The brain constantly compares new sensory information with stored memories and experiences and combines the information to anticipate the future. In essence, as we wander around, we build a reserve of information from which we construct an internal model of the world. But we constantly update that model.

The continuous interplay of sensory input, memory, prediction and feedback—which occurs instantly through parallel processing in the neocortex—ultimately gives rise to consciousness and intelligence.

Hawkins proffers a "comprehensive theory of how the brain works," of "what intelligence is," and of "how your brain creates it."

This book provides some provocative thoughts on how the brain and the mind may actually function.

Richard Lipkin, Scientific American



The Expert Mind

Studies of the mental processes of chess grandmasters have revealed clues to how people become experts in other fields as well.

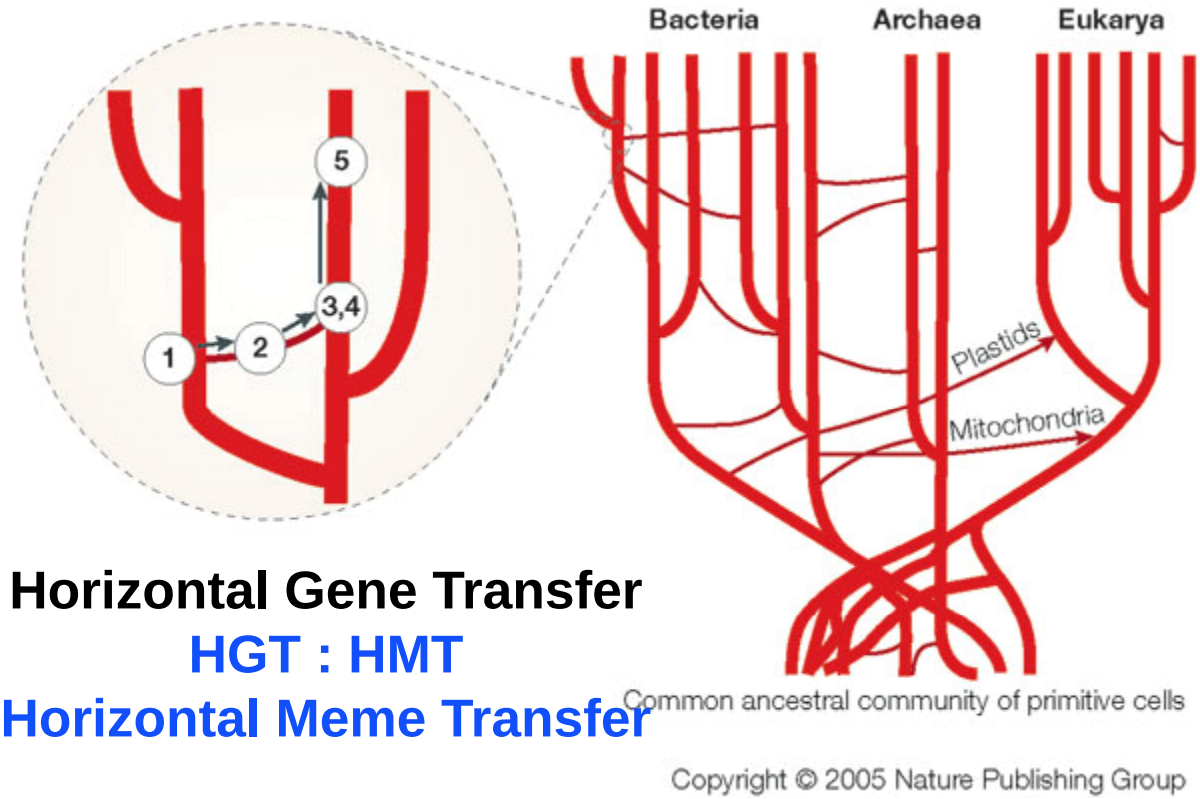
Effortful study **is the key to achieving success in chess, classical music, soccer and many other fields. New research has indicated that** ***motivation*** **is a more important factor than innate ability.**

200,000 patterns,
10,000 hours

Systems Evolution and Innovation

Woese, Carl. 2000. Interpreting the universal phylogenetic tree. PNAS. 97(15):8392-6. www.ncbi.nlm.nih.gov/pmc/articles/PMC26958/pdf/pq008392.pdf

"Vertically generated and horizontally acquired variation could be viewed as the yin and the yang of the evolutionary process.



Horizontal Gene Transfer

HGT : HMT

Horizontal Meme Transfer

A continuum of 5 steps leading to the stable inheritance of a transferred gene in a new host.

Figure from: Smets, Barth F. and Tamar Barkay. 2005. Horizontal gene transfer: perspectives at a crossroads of scientific disciplines. *Nature Reviews Microbiology* 3, 675-678 (September 2005).

Vertically generated variation is necessarily highly restricted in character; it amounts to variations on existing themes.

Horizontal transfer, on the other hand, can call on the diversity of the entire biosphere, molecules and systems that have evolved under all manner of conditions, in a great variety of different cellular environments.

Thus, horizontally derived variation is the major, if not the sole, evolutionary source of true innovation."

The Aircraft ISR Re-Fit Problem

- Mission system installation in military acquisition context
- Customer's need for the latest technology
- Technology advances are creating new mission systems at an increasing rate, driving the demand for QRC.
- Goal is to shorten the completion time without compromising quality
- Mission requirements and "boxes" often change late
- Army wants QRC for intelligence surveillance reconnaissance (ISR) to be robust, scalable, tailorable
- Air Force wants QRC challenges continually met as success is measured by rapidly adapted EW

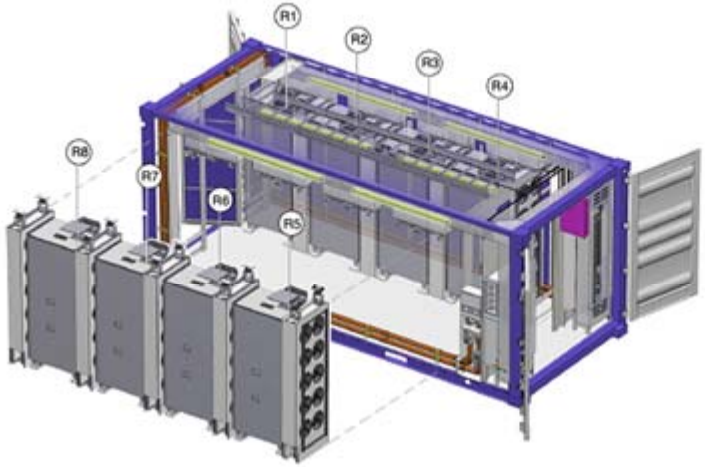
What is needed:

Process Architecture for

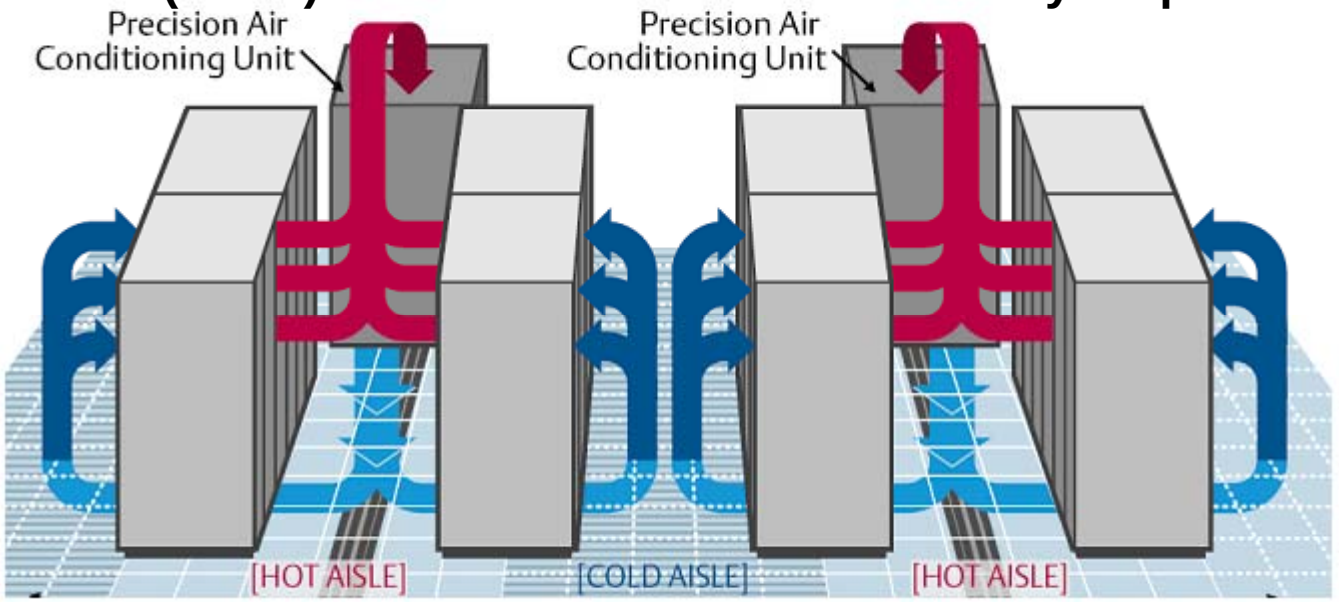
Quick Reaction Capability (QRC)

ISR: Intelligence, Surveillance, Reconnaissance

Using Modular Concept Patterns

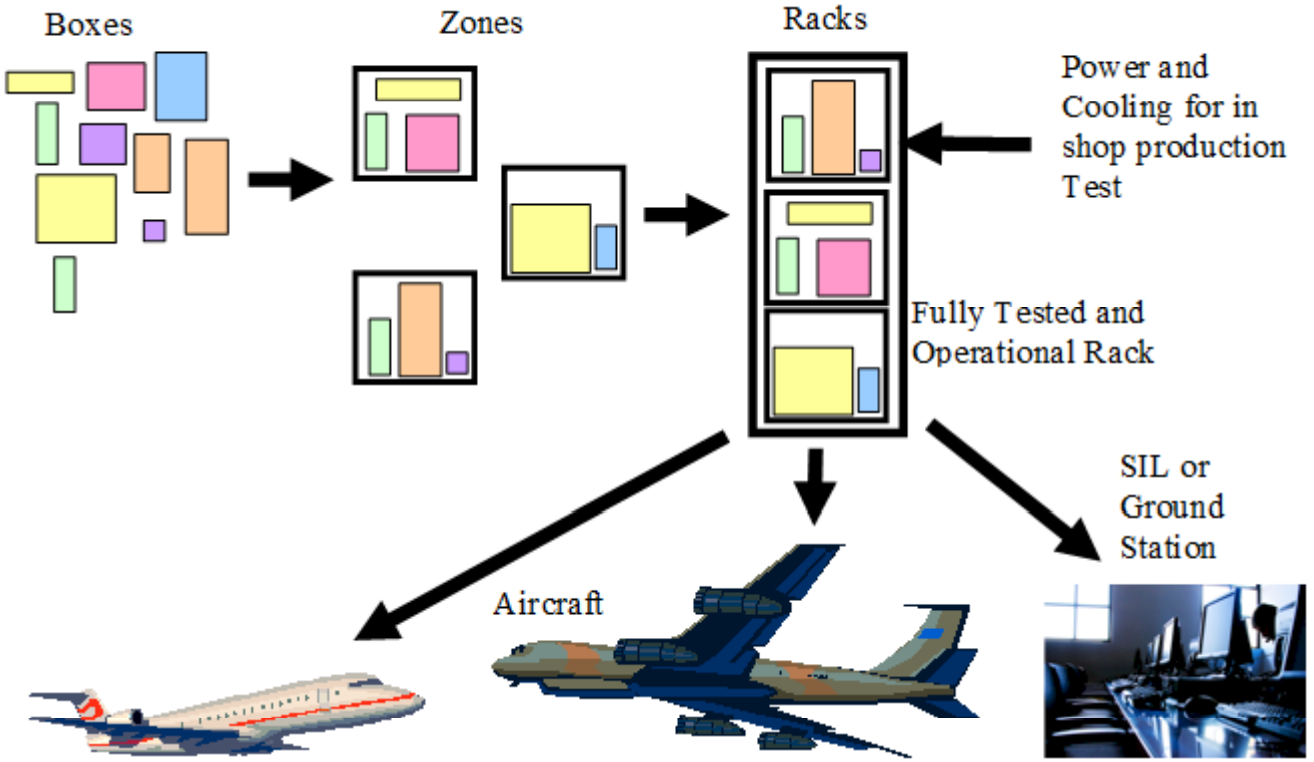


Unit Load Devices (ULDs) **Data Centers** **Navy Ship Modular Racks**



Hot Aisle and Cold Aisle (Liebert Corporation 2006, 7)

Quick-Reaction Aircraft Installation Architecture



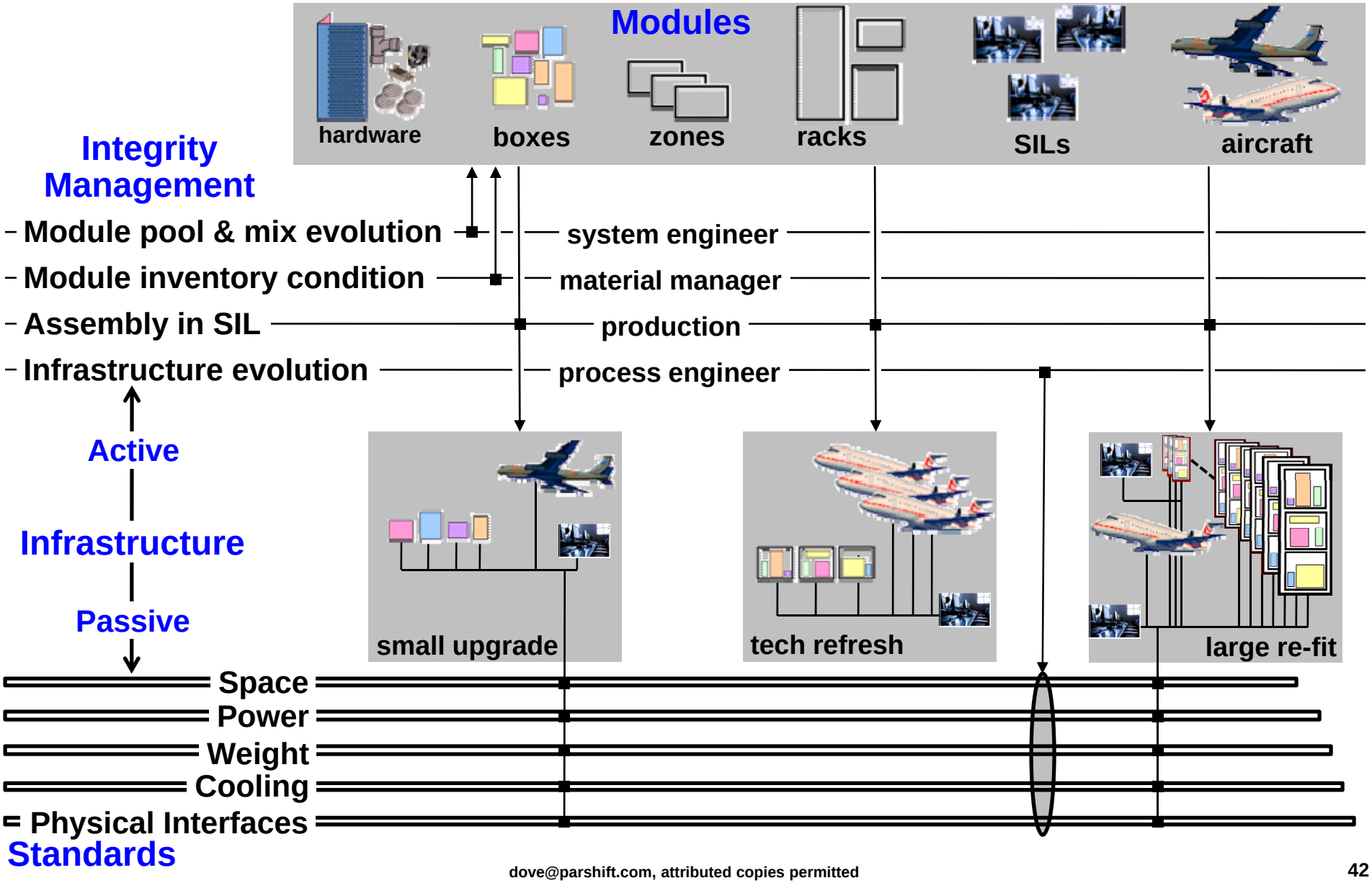
The aircraft installation infrastructure must be modified. A one time event during the original modification.

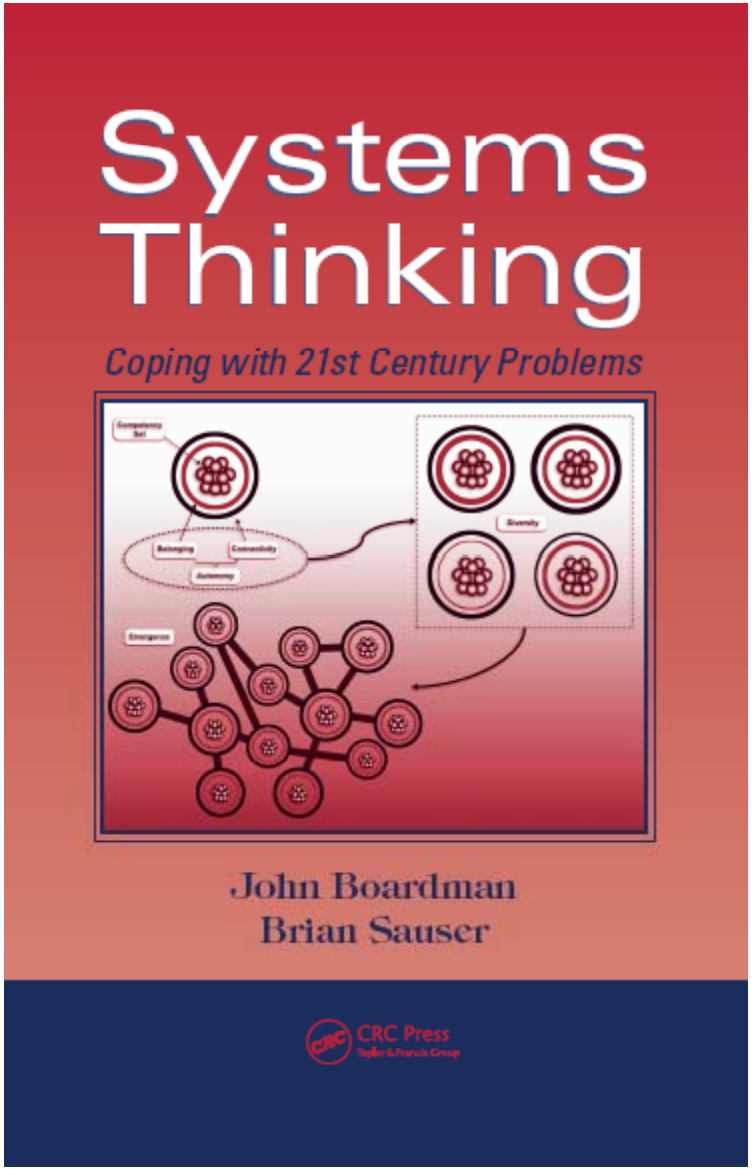
Once done, rack modules can be removed and re-connected on multiple platforms without further modifications.

SIL: Systems Integration Lab

Parameter	Nature of Interoperability Standard
Space	Racks shall be designed in preset widths, depths and heights.
Power	Each rack shall have a maximum kW equipment load rating. Racks with multiple power types (e.g. 115 VAC 400 Hz and 28 VDC) limits should be set on each type.
Weight	Each rack shall have a maximum equipment weight rating.
Cooling	Each rack shall rate the kW cooling capacity at a specified exhaust temperature.
Physical Interfaces	Rack mounting provisions, cooling connections, and electrical connection interfaces shall have standard locations and configurations.

QRC Aircraft Installation Architecture



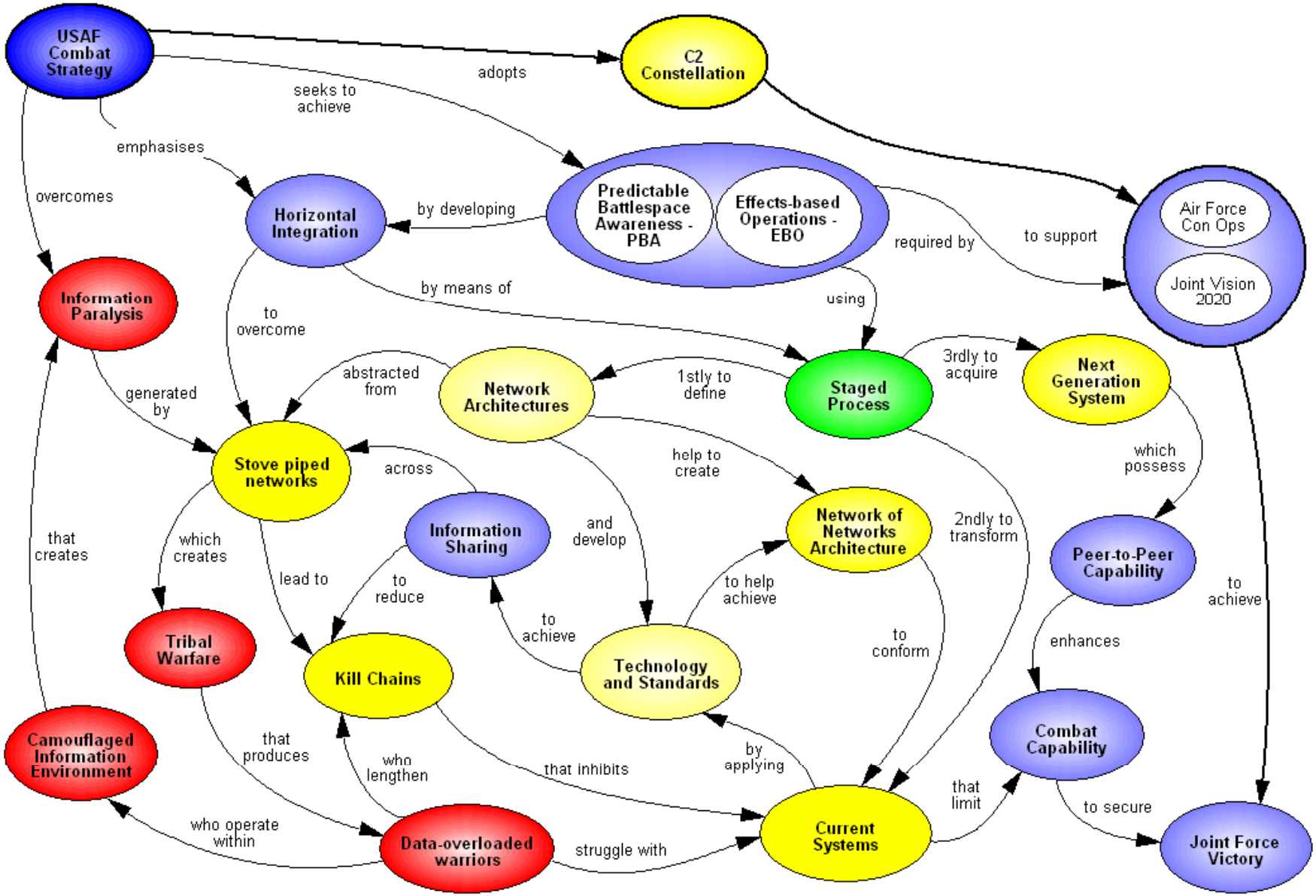

Systems Thinking
Coping with 21st Century Problems
John Boardman
Brian Sauser
CRC Press
Taylor & Francis Group


Manufacturing & Industrial Engineering
Systems Thinking
Coping with 21st Century Problems
By examining the links and interactions between elements of a system, systems thinking is becoming increasingly relevant when dealing with global challenges, from terrorism to energy to healthcare. Addressing these seemingly intractable systems problems in our society, Systems Thinking: Coping with 21st Century Problems focuses on the inherent opportunities and difficulties of a systems approach. Taking an engineering systems view toward systems thinking, the authors place a high value on the thinking process and the things applied to this process.
In the hopes of initiating critical thinking and encouraging a systems response to problems, the book provides pragmatic mechanisms to understand and address co-evolving systems problems and solutions. It uses several contemporary and complex societal issues, such as the Iraq war, the Google phenomenon, and the C2 Constellation, to illustrate the concepts, methods, and tools of a system as well as the meaning of togetherness in a system. The text also interweaves the meanings of complexity, paradox, and system to promote the improvement of difficult situations.
Featuring a holistic, nonlinear way of looking at systems, this book helps readers better organize and structure their thinking of systems in order to solve complex, real-world problems.
Features
• Incorporates systems concepts, patterns of thinking, and examples from a range of domains, including technology development, engineering, business management, the intelligence community, and policy
• Highlights the use of systamigrams, a unique form of system diagramming that aids companies in their thinking of major endeavors
• Discusses system of systems (SoS) in terms of the authors' original research on various defense and space projects
• Includes an extensive number of exercises as well as many case studies and results from collaborative research and development projects with leading corporations
• Offers a free software tool called SystamiTool, useful for creating, editing, and demonstrating systamigrams, on the authors' website
54910
ISBN 1-4200-5491-0
90000
CRC Press
Taylor & Francis Group
an Informa business
www.crcpress.com

SystemiTool

Buy the book, download free tool

A graphical technique for understanding and identifying the significant elements and their inter-relationships captured in multiple and diverse expressions of stakeholder concern and need



Becoming & Being a Systems Engineer

Game developers are today's ultimate complex systems engineers.
No success w/o comprehensive system thinking and deep user harmony.

Tomb Raider: Underworld

SPORE! Construction tools let you create the Spore universe. Choose how creatures evolve. Decide how they develop a civilization. Plot how they take over the universe.

http://video.google.com/videoplay?docid=8372603330420559198

Battling Video-game Cheaters

http://www.mmsend9.com/ls.cfm?r=193409740&sid=8695619&m=935085&u=IEEENY
&s=http://spectrum.ieee.org/consumer-electronics/gaming/steamed-valve-software-battles-videogame-cheaters

Game developers build multi-agent systems with artificial intelligence, and try to outthink game hackers

This is the face we need to see on millions of problem solvers all over the world as we try to tackle the obstacles of the next century

Jane McGonigal, video: www.ted.com/talks/jane_mcgonigal_gaming_can_make_a_better_world.html

Here we see the face of classic gaming emotion…
a sense of urgency, a little fear, intense concentration
deep deep focus on tackling a really difficult problem
optimism, surprise…a gamer on the verge of an epic win.

Average WoW player plays 22 hrs/week
= half time job…

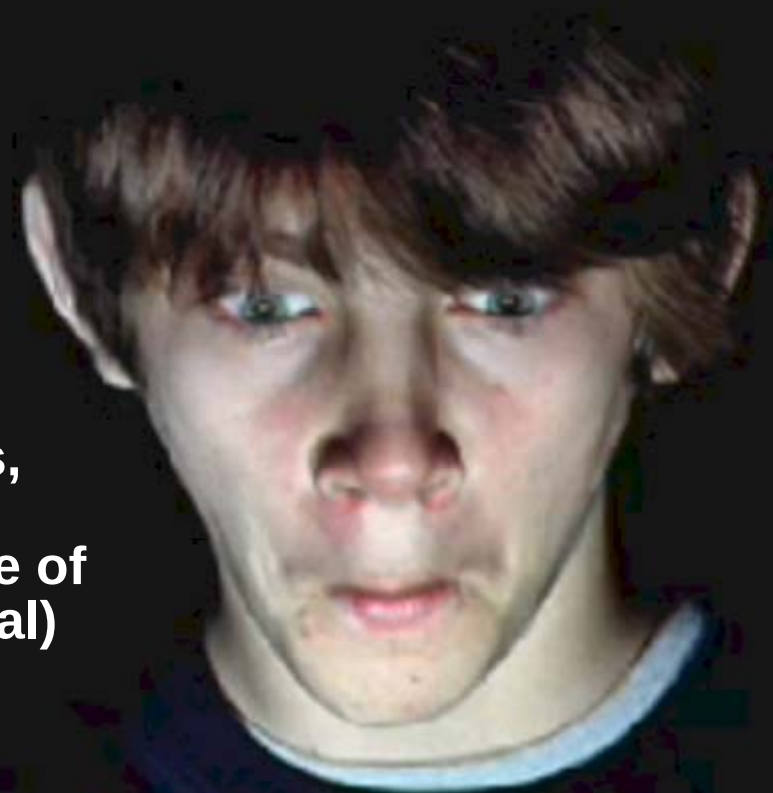
WoW: World of Warcraft

Jane McGonigal, video: www.ted.com/talks/jane_mcgonigal_gaming_can_make_a_better_world.html

Average everywhere in the world.
10,080 hrs = US schooling 5th-12th grade.

10,000 hours gaming by age 21

80,000-article WoW wiki is 2nd biggest in world, 5 million users a month.



Super-Empowered Hopeful Individuals, believing they are individually capable of changing the (virtual) world.

- **Urgent Optimism – extreme self motivation to act immediately tackling an obstacle.**
- **Social Fabric – virtuoso at weaving a tight social fabric. .**
- **Blissful Productivity – happier working hard than relaxing and hanging out.**
- **Epic Meaning – Love awe inspiring missions.**

Jane McGonigal, video: www.ted.com/talks/jane_mcgonigal_gaming_can_make_a_better_world.html

Jane McGonigal

Gaming can make a better world

Reality is broken, says Jane McGonigal, and we need to make it work more like a game. Her work shows us how. Games like World of Warcraft give players the means to save worlds, and incentive to learn the habits of heroes. What if we could harness this gamer power to solve real-world problems? Jane McGonigal says we can, and explains how.

In the best-designed games, our human experience is optimized: We have important work to do, we're surrounded by potential collaborators, and we learn quickly and in a low-risk environment. In her work as a game designer, she creates games that use mobile and digital technologies to turn everyday spaces into playing fields, and everyday people into teammates.

McGonigal directs game R&D at the Institute for the Future, a nonprofit forecasting firm where she developed *Superstruct*, a massively multiplayer game in which players organize society to solve issues that will confront the world in 2019. She masterminded *World Without Oil*, which simulated the beginning of a global oil crisis and inspired players to change their daily energy habits. McGonigal also works with global companies to develop games that build on our collective-intelligence infrastructure -- like *The Lost Ring*, a mystery game for McDonald's that became the world's biggest alternate reality game, played by more than 5 million people. (Not to mention the delightful *Top Secret Dance-Off*, which taps that space in our brains where embarrassment and joy mingle.) She's working on a book called *Reality Is Broken: Why Games Make Us Happy and How They Can Change the World*.

Video and text above at: www.ted.com/talks/jane_mcgonigal_gaming_can_make_a_better_world.html


Systems Engineer #1
Best American Job
Nov 2009 Money Magazine
http://money.cnn.com/magazines/moneymag/bestjobs/2009/snapshots/1.html
"big think" managers on large, complex projects.
They figure out the technical specifications and coordinate the efforts of lower-level engineers working on specific project aspects.
"The transit system I work on really makes a tangible difference to people,"
says Anne O'Neil, chief systems engineer for the New York City Transit Authority.

Chief Scientist Systems Engineering & Integration
Pacific Northwest National Laboratory (DOE)

(Recruitment posting, June 2010)

This position provides senior technical leadership in the integration, testing and evaluation of complex technology systems for homeland security applications.

All systems are expected to include hardware and software components; most will be integrated in novel ways and applied to unique venues and scenarios.

This position will:

- **provide technical leadership,**
- **interact effectively with external clients,**
- **lead the development of systems that meet program objectives,**
- **interact effectively with internal program managers, and**
- **direct and mentor technical teams of scientists and engineers.**

This position will assemble and direct multidisciplinary teams in:

- **physics;**
- **electronics;**
- **computer hardware, software and systems operations;**
- **testing; and**
- **evaluation.**

The major challenges for the position will be design and development of novel technology systems to meet new threats across a spectrum of national risks and vulnerabilities.

Responsibilities & Accountabilities:

* **Provide technical leadership in the integration, testing and evaluation of technologies for national defense and homeland security.**
* **Develop creative solution/mitigation technologies to the nation's security risks.**
* **Ensure that:**
  - **the risks associated with new technologies are identified and mitigated;**
  - **that new technologies meet all regulatory requirements,**
  - **that new technologies are acceptable to stakeholders and the public as relevant and appropriate, and**
  - **that costs of the new technologies are acceptable.**
* **Prepare high-impact papers and reports, to include publications in peer-reviewed literature as appropriate.**
* **Participate in systems engineering professional organizations; represent PNNL as a technical contributor and/or an officer in such organizations.**
* **Communicate effectively (written and oral) with internal PNNL project managers and staff; communicate effectively with clients and external colleagues.**

Requirements:

* This position requires expertise in the integration, testing and evaluation of non-IT hardware systems and the software that supports those systems.
* A subject matter expert in systems engineering as applied to the integration, testing and evaluation of hardware systems for national defense and homeland security, e.g., radiological, explosives, chemical, and biological detection technologies.
* A working knowledge of software that supports the subject hardware systems.
* A track record of relevant publications in the peer-reviewed literature and/or high-impact, sensitive documents for national defense and/or homeland security clients.
* Should be certified in systems engineering by a national/international professional organization (e.g., INCOSE), and should be active in one or more systems engineering professional organizations.
* Should have name recognition among academics in systems engineering and/or federal agencies that sponsor systems engineering research and development.
* Desired level of experience is a Bachelors degree in engineering plus a PhD in systems engineering (exclusive of information technology or computer science).

The Air Force Research Laboratory

La Luz Academy

Inspiring the Future...
Creating the Possibilities...

Mars Missions | DoD STARBASE | PETES PRS | Intro to SE | SPACE | Pinpoint WeatherNet | Teacher Institute | STEM Expeditions

Intro to Systems Engineering Flight
(Eighth Grade)

- Fact Sheet
- Video Clip
- Recruiting Flyer
- Online Forms

In AFRL La Luz Academy's Intro to Systems Engineering Flight, for eighth graders, students learn the basics of Systems Engineering and program small robots called Boe-Bots® to run a series of increasingly challenging obstacle courses, in a series of three non-consecutive instruction days. The curriculum also incorporates teamwork and Air Force Core Values *(Integrity First, Service Before Self, and Excellence in All We Do)*.

Last modified 10 June 2009

File 3

High-Speed Robot Hand

We Don’t Need You Anymore

August 3, 2009 by Travis Deyle,
http://www.hizook.com/blog/2009/08/03/high-speed-robot-hand-demonstrates-dexterity-and-skillful-manipulation

**Dribbles a ping-pong ball,
spins a pen,
throws a ball,
ties knots,
tweezers a rice grain,
tosses/catches
a cellphone!**

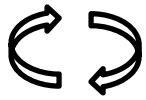
In Summary

Create

- Model your Concept of Operations (Objectives enabled by Sub-Systems)
- Model your Architectural Concept (Modules / Framework)
- Model your Requirements
  - What the customer requires
  - What the problem space requires
  - What the competition requires
  - What you require

Build

- Development
- Verification



Operate

- Deploy / Run
- Support / Improve

Exciting Jobs on the Edge of STEM

Robots

UAS (Unmanned Autonomous Systems)

Space systems

Open systems

Multi-agent systems

Anti-Terror systems

Security systems

Quick Reaction Capability systems

Self-evolving systems

Multi-user game environments

Biological systems

Soft systems (human systems)

Social systems

…many more

STEM: Science – Technology – Engineering – Math

47 US-Based SE-Centric University Programs

22Apr2010: http://www.incose.org/educationcareers/pdf/INCOSE_LISTofUS_Based_SE_Programs.pdf

School	BS	MS	PhD
Air Force Institute of Tech.		x	x
Boston University		x	x
Case Western Reserve Univ.	x		
Colorado School of Mines		x	x
Colorado State University		x	
Colorado Technical Univ.		x	
Cornell University		x	
Embry-Riddle Aeronautical U.		x	
Florida Institute of Tech			
George Mason University	x	x	
George Washington Univ.	x	x	x
Iowa State University		x	
Johns Hopkins University		x	
Loyola Marymount University		x	
MIT		x	
Missouri U. of Science and Tech		x	x
National University		x	
Naval Postgraduate School		x	x
Oakland University	x	x	x
Old Dominion University		x	
Penn State U. at Great Valley		x	
Portland State University		x	
Rochester Institute of Tech.		x	
Southern Methodist Univ.		x	
Southern Polytechnic State U.		x	

School	BS	MS	PhD
Stevens Institute of Tech.		x	x
Texas A &M		x	
Texas Tech University		x	
U. of Alabama, Tucson		x	x
U. of Arizona, Tucson	x	x	x
U. of Arkansas, Little Rock	x	x	
U. of Maryland		x	x
U. of Missouri – Rolla		x	x
U. of North Carolina, Charlotte	x		
U. of PA, Philadelphia	x	x	x
U. of Southern California, LA		x	
U.of Virginia	x	x	x
U. of Houston, Clear Lake		x	
U. of St. Thomas		x	
U. of Texas, Arlington		x	
U. of Texas at El Paso		x	
US Air Force Academy	x		
US Military Acadamy, West Point	x		
US Naval Academy, Anapolis	x		
U. of Maryland, Baltimore		x	
Washington Univ., St. Louis	x		
Walden University		x	