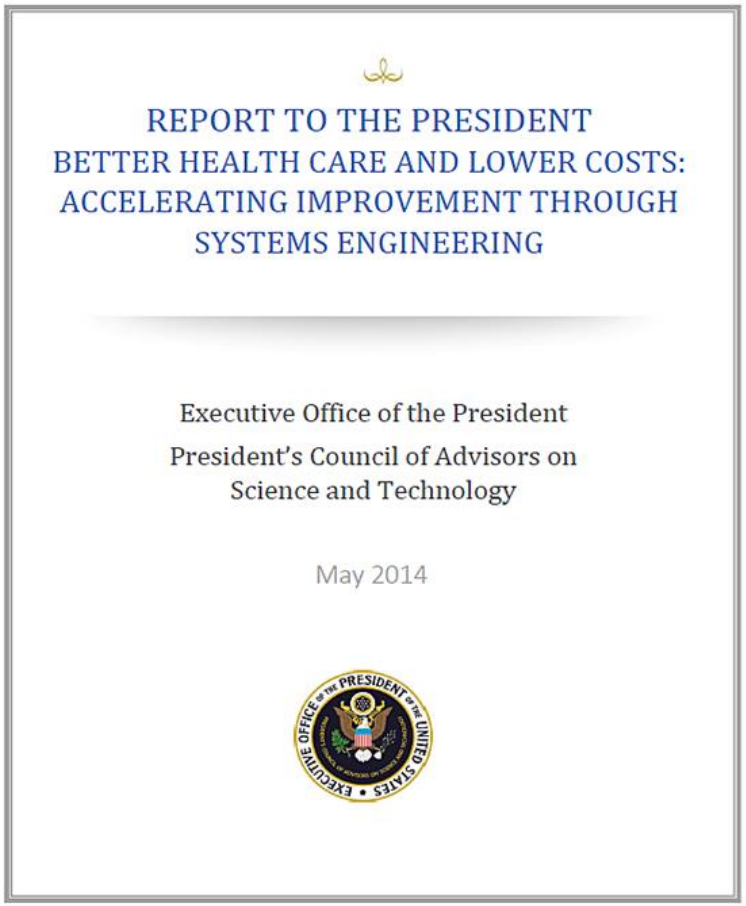
The Presidential Council of Advisors on Science and Technology (PCAST) Report



REPORT TO THE PRESIDENT
BETTER HEALTH CARE AND LOWER COSTS: ACCELERATING IMPROVEMENT THROUGH SYSTEMS ENGINEERING

Executive Office of the President
President's Council of Advisors on Science and Technology

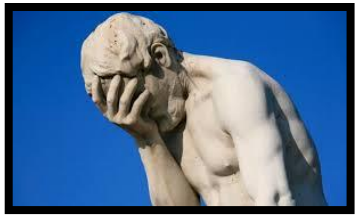
May 2014

Underscores that Systems Engineering (SE) role/skills vitally needed.

Diverse, notable advisory group from industry and academia.

SE is defined broadly– "an **interdisciplinary approach** to analyze, design, manage and measure **complex systems with efforts to improve** its efficiency, productivity, quality, safety and other factors."

PCAST Assessment of the Healthcare System

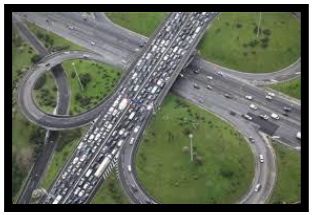


Fee for Service is one of the Biggest Problems

- Really the wrong system metric by itself
- Incentivizes more procedures in less time
- Fee for outcome is optimum but challenging (difficult to transition… and can be gamed itself)

System Lacks Key Enablers

- Accessible and efficient health care data
- Proper methods, metrics, process & tools for complex systems
- People trained in Systems [at least not the right people]



System Contained Embedded Inefficiencies

- Poor data infrastructure
- Lack of Systems approaches [Decision Analysis, Lean, Agile, Systems of Systems, etc.]

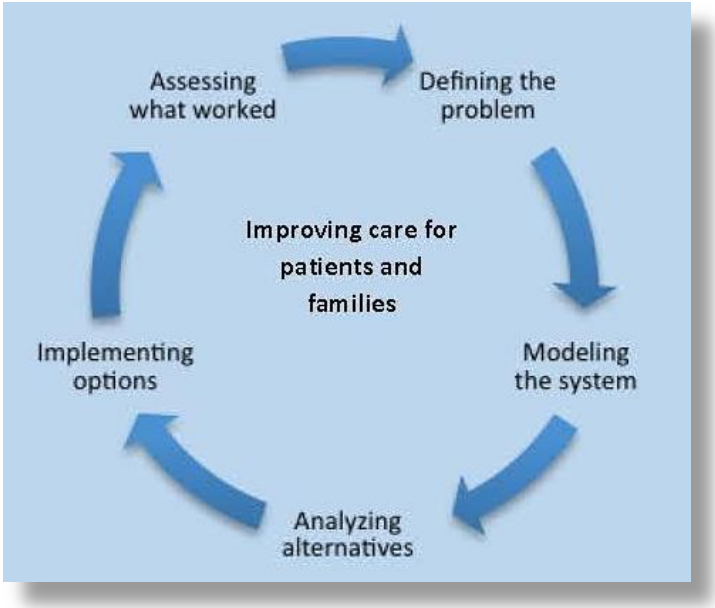
Seven PCAST Recommendations

- Accelerate alignment of payment systems with outcomes
- Accelerate the Nation's health care data infrastructure
- Provide national leadership in Systems Engineering
- Increase technical assistance to local health care workers
- Help engage community in systematic improvements
- Establish awards & challenges related to improvements
- Build new competencies and/or new workforce needed

A Call to Action

International Council on Systems Engineering (INCOSE) Technical Activities

PCAST Report's View of the Systems Approach to Improving Healthcare



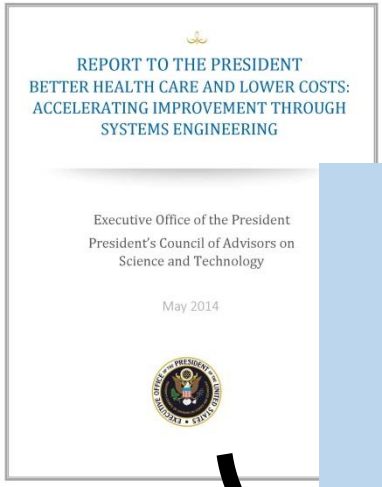
Tools and Methods from Systems Engineers

- Systems engineering models
- Computer simulations (design and analysis)
- Computer simulations (effectiveness)
- Physical simulations/operational models
- Reference models (devices, processes, interfaces)
- Reference architectures
- Process models (development)
- Risk management models
- Compliance management models
- Use cases (care provider, patient, delivery & supply, …)
- Use cases for risk and safety management
- Life cycle models
- Total cost of ownership models

The INCOSE Biomedical-Healthcare MBSE Challenge Team is exploring many of these methods in order to improve the state of the practice for SE applied to healthcare.

INCOSE IW2015 SE for Healthcare Track (24-25 Jan, 2015)

The overall workshop goal was to gather information to direct, and ensure value-add of, INCOSE activities addressing the recommendations of May 2014 PCAST report.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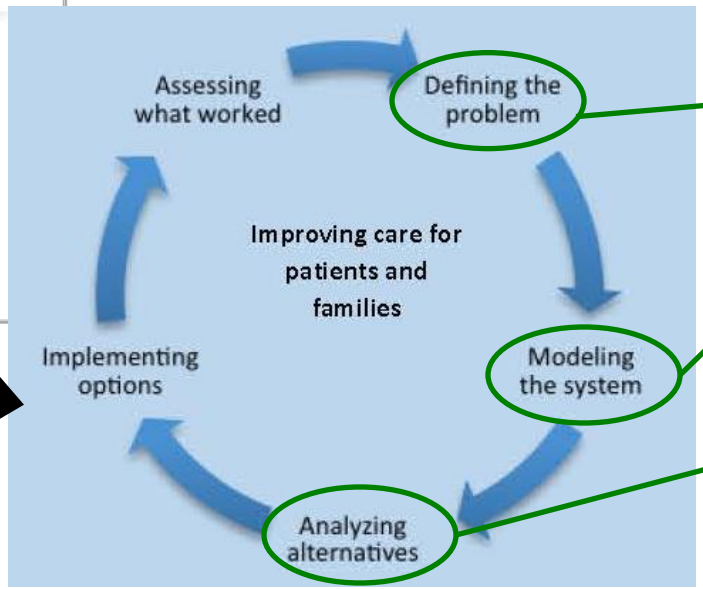
From the PCAST Executive Summary: *"Other industries have used a range of systems-engineering approaches to reduce waste and increase reliability, and health care could benefit from adopting some of these approaches. … Notwithstanding the instances in which these methods and techniques have been applied successfully,* ***they remain underutilized throughout the broader system****."*



- Session 1. Stakeholder Needs – what do healthcare delivery organizations believe are the high payoff applications of the systems approach?
- Session 2. Capabilities – what are the key tools systems engineers can bring to bear to meet stakeholder needs?
- Session 3. Application Context – what approaches should the systems engineering profession pursue to improve healthcare delivery?

The workshop started the dialog to define INCOSE's approach (as an organization and as a collection of individuals) increasing the relevance of systems engineering to healthcare.

Healthcare INCOSE International Council on Systems Engineering Working Group

Workshop Overview

What do stakeholders perceive as the most pressing system and/or system of system level issues?

- Bo Oppenheim, PhD, Prof. of Systems Engineering, Loyola Marymount University
- Michael Kanter, MD, Director of Quality and Clinical Analysis, Kaiser Permanente
- Steve Tarzynski, MD, Chief of Pediatrics at West Los Angeles Medical Center

What aspects of the healthcare system are modeled well and how could a systems engineering approach benefit on-going work?

- John Rice, PhD, past chair of the standards committee for the Society for Simulation in Healthcare
- Joshua Hui, MD, Director of Simulation, UCLA Olive View Emergency Medicine
- Jessica Ray, PhD, Simulation Learning Consultant, Yale New Haven Health System

How does the clinical environment impact systems work?

- Mike Robkin, President, Anakena Solutions/AAMI/UL Committee on Safe Medical Device Interoperability
- Jennifer Jackson, Director of Clinical Engineering & Device Integration, Cedars-Sinai Medical Center
- Chris Unger, Chief Systems Engineer, GE Healthcare

1/3 Presentation, 2/3 Discussion

Workshop Takeaways (1 of 2)

The healthcare "system" is vast

- Multiple "hypersystems" each containing numerous system of systems
- Hard to find a starting point

SE and Engineers have been using engineering language

- Key players (esp. MDs, nurses, CxOs etc.) do not have an engineering background
- Do not respond well to engineering language
- Are often focused on their specialty rather than making systems connections

The legal and regulatory environments strongly drive behaviors

- Some behaviors – like medical device interoperability – are technologically feasible but hindered by liability regulations
- System impacts of legal-regulatory environment not well understood

Workshop Takeaways (2 of 2)

- Healthcare simulation projects/personnel nearly always take a systems approach
  - Many large hospitals have simulation directorates
  - Healthcare simulation professionals have much in common with systems engineers
  - Healthcare simulations look at system characteristics …
  - And tend to provide detailed numerical results on detailed steps in a process
  - There is potential synergy between process simulations and systems engineering models to generalize simulation results to system ramifications

Overarching Observation:

There are many systems thinkers in healthcare – but few systems engineers

Workshop Recommendations

- Systems Engineers (SEs) and INCOSE must learn and speak the language of healthcare
  - ACTION #1: Develop an explanation of systems engineering using terminology and examples that healthcare professionals understand
- SEs and INCOSE must connect to the existing body of healthcare systems-focused work
  - ACTION #2: Partner with established healthcare simulation organizations to show value-added through systems engineering
- INCOSE should sponsor example healthcare systems engineering products
  - ACTION #3: Develop a demonstration healthcare application of Model Based Systems Engineering (MBSE) to show how it adds value

The INCOSE Healthcare Working Group and the INCOSE Biomedical-Healthcare Challenge Team have accepted these recommendations as action items and are planning next steps.

Seeking Your Input on Action #3

Develop a demonstration healthcare application of MBSE to show how systems engineering is used and how it adds value

- The workshop proposed that hospital departments are an ideal opportunity for a reference model - useful to device and service providers as a 'context' for their modeling
- "Goldilocks"…big enough to make a difference, not so large to be unmanageable
- Prioritized some challenges: OR, ER/ED, Pharmacy, Lab, Ambulatory Clinic…

For the Emergency Department example, must define the characteristics of a "good" demo

- **Boundary Conditions:** Patient in the door to patient discharged (deceased, internal transfer, external transfer, ambulatory exit)?
- **Goals:** What are the criteria for a successful model?
- **Context**: How does it fit within a modeling strategy (reference architecture, reference models, specific stochastic or lean hospital models)?

Questions?

- Points of Contact
  - INCOSE Healthcare Working Group
    - Chris Unger (Christopher.Unger@med.ge.com)
    - Bob Malins (rjmalins@eaglesummittech.com)
  - INCOSE Biomedical-Healthcare MBSE Challenge Team
    - Ajay Thukral (ajay.thukral@cientivegroup.com)
    - Jack Stein (jack.stein@me.com)

APPENDIX


March 25th, 2015
Reston VA USA
Model-Based Systems Engineering (MBSE)
in Healthcare IT Modernization, Integration
and Innovation Summit

Systematic Approach to Modeling

Systems Engineering Models

Reference Architectures
Reference Models

SE models employ a graphical language to describe and characterizing the system (physical + information + human) and how it achieve specific goals through interactions with its stakeholders and environment.

Pros
- Defines all roles and their relationship to requirements
- Defines/manages all interfaces
- Defines dependencies (internal & external)
- Can supply standards to allow comparison ("translation") of OR and SA models

Cons
- Results often abstract & hard to communicate or translate into action plans
- Potentially harder to justify or fund

Operation Research Models

Detailed models or process maps to improve the efficiency and effectiveness of the steps in an operational process by making focused decisions about what activities add value to the process and what activities do not.

Pros
- Addresses tangible details of process operations
- Directly involves "floor staff" in the analysis
- Defines specific, implementable changes
- Improvements easy to document
- Documents participants/roles & process details that can be integrated into SE models

Cons
- Very focused; results often specific to 1 activity stream; ties to parallel streams may be difficult to discern
- Results often unique to the organization being analyzed

Systems Analysis Simulations

SA simulations predict how the system (physical + information + humans) will perform under specified conditions, including under stressed conditions.

Pros
- Identifies bottle-necks and rate limiting steps in activity stream
- Identifies how resource limits impact throughput
- Shows the impact to goals of changes and variation in operating conditions
- Defines activity streams & exchanges for SE models
- Can be used to compare options identified by OR and SE modeling

Cons
- Results often abstract & hard to communicate or translate into action plans
- External factors & context often hard to capture in model

The Need for SE Leadership

Systems Engineering is Poised to Help EVERYONE

… or, if not coordinated properly …

Systems Engineering will Become Associated with Healthcare CHAOS

Map the $ Flows in US Healthcare System

http://blogs-images.forbes.com/danmunro/files/2012/01/healthcarecosts.jpg

Hospitals are the biggest slice…start the analysis there