Why Do Systems Engineering in Healthcare?

Identify risks early (not just hazards)

- Concepts and risks explored simultaneously
- Requirements, functions, designs respond directly to risks

Ensure interfaces are understood and implemented correctly

- Operational and Functional interfaces capture your concept …
- … And drive the design of physical interfaces

Build the understanding of the system of systems

- Never lose track of the big picture
- Ensure the details match the big picture

High Barriers to Acceptance

Basic SE Tools
from NAE/IOM Report: Building a Better Delivery System – A New Engineering/Health Care Partnership 2005

Basic SE Tools from SEBoK

TABLE ES-1 Systems Engineering Tools and Research for Health Care Delivery

Tool/Research Area	System Levels of Application			
	Patient	Team	Organization	Environment
SYSTEMS-DESIGN TOOLS				
Concurrent engineering and quality function deployment		X	X	
Human-factors tools				
Tools for failure analysis				
SYSTEMS-ANALYSIS TOOLS				
Modeling and Simulation				
Queuing methods				
Discrete-event simulation				
Enterprise-Management Tools				
Supply-chain management				
Game theory and contracts				
Systems-dynamics models				
Productivity measuring and				
Financial Engineering and Risk				
Stochastic analysis				
Value-at-risk				
Optimization tools for indiv				
Distributed decision making				
Knowledge Discovery in Data				
Data mining				
Predictive modeling				
Neural networks		X	X	X
SYSTEMS-CONTROL TOOLS				
Statistical process control	X	X	X	
Scheduling		X	X	

Systems-Design Tools
Modeling and Simulation
Enterprise-Management Tools
Financial Engineering/Risk Analysis
Knowledge Discovery in Databases
Systems-Control Tools

Example Systems Engineering Tools for Healthcare

1.0 Define the Problem
  1.1 Establish the scope and context of the problem (define boundary conditions)
  1.2 Stakeholder identification and management
  1.3 Lifecycle mapping
  1.4 Value Stream Process Mapping
  1.5 SWOT analysis (Operational Deficiencies and Technological Opportunities)
  1.6 Workflow/Usability/Use Case analysis
  1.7 Observa...
  1.8 Root Cau...

2.0 Investigate...
  2.1 Requirem...
  2.2 SE Evalu...
  2.3 Trade-of...
  2.4 Model-B...
  2.5 Technica...

3.0 Develop th...
  3.1 Concept...
  3.2 Architec...
      control,
  3.3 Define the Implementation
  3.4 Process Redesign Techniques (including Lean Six Sigma)
  3.5 Active Integration
  3.6 Agile / Lean Development Principles (iterative development)

4.0 Launch and Assess the Solution
  4.1 Managing Change in Organizations
  4.2 Stakeholder Management, Change Management Techniques
  4.3 Spiral, Agile, and Lean Startup Delivery Practices (Minimal Viable Product delivery)
  4.4 Business Risk Management
  4.5 Metrics and benchmarking

Define the Problem
Investigate Alternatives
Develop the Solution
Launch and Assess the Solution

- Most hospitals have trouble accepting 'investing in documentation/models'. Need to lower the barrier to entry… especially in terminology and "theory".
- "Defining the problem" and "Launch and Assess" are key areas…that can be tailored to healthcare delivery applications

Barriers to Acceptance: Example

Dr. E. Goldlust, a medical researcher at Kaiser Permanente attempted to create a model of an emergency department (with senior administration support).

It was rejected by medical professionals as too time consuming and complex.

What is a use case?

A use case is a story about how a set of behaviors achieves a goal (or meets a need) of a user of the system (actor)

Simple content

- Persona (User or stakeholder)

- Preconditions:

- Postconditions:

- Steps:

Even simpler content is just a picture and the steps
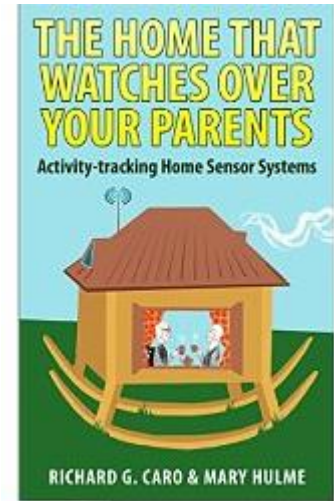
More advanced Content

- Primary Actor:

- Scope:

- Level:

- Stakeholders and Interests:

- Precondition:.

- Minimal guarantee:

- Success guarantee:

- Main success scenario:

- Extensions:

From Writing Effective Use Cases, by Alistair Cockburn, Addison-Wesley Professional; 1st edition (2000)

The VA SERC uses the term "Patient Journey"…well accepted by physicians and executives

Personas: Capturing the "Story" behind the Stakeholders

- The need: Ability to 'monitor' the health of elderly remotely
- Enabled by: new sensors, connectivity, algorithms…
- The Challenge: 'the elderly' and their caretakers are all different
- Reference: "The Home that Watches Over Your Parents"
  - Richard Caro and Mary Hulme, Commonwealth Club, Jan 8, 2015, http://www.commonwealthclub.org/events/2015-01-08/home-watches-over-your-parents
- Defined five "personas"…talk focused on "Go-go" and "No-Go"
  - "Go-Go" is healthy, asymptomatic, and maybe a bit worried about privacy
  - "No-Go" is infirm, and may not 'remember' their concerns
- Book studies 15 different devices
  - Surprisingly, 'visual appeal' turned out to be critical to Go-Go acceptance
  - Actually, care-takers and loved ones had personas also!

Personas help you "Know" your Stakeholders

What might be other examples?

The Microsoft Zune was an MP3 player…but iXxxx + iTunes is a system

- you can get and play any music anywhere on any device…$0.99 per track, cloud storage,

Shazam! Is a way to identify the music you hear…and buy it

The kick activated rear door is a way to store your groceries in your SUV

A use case is a complete story in how a user captures value in their context