The Future of Healthcare through a Systems Approach

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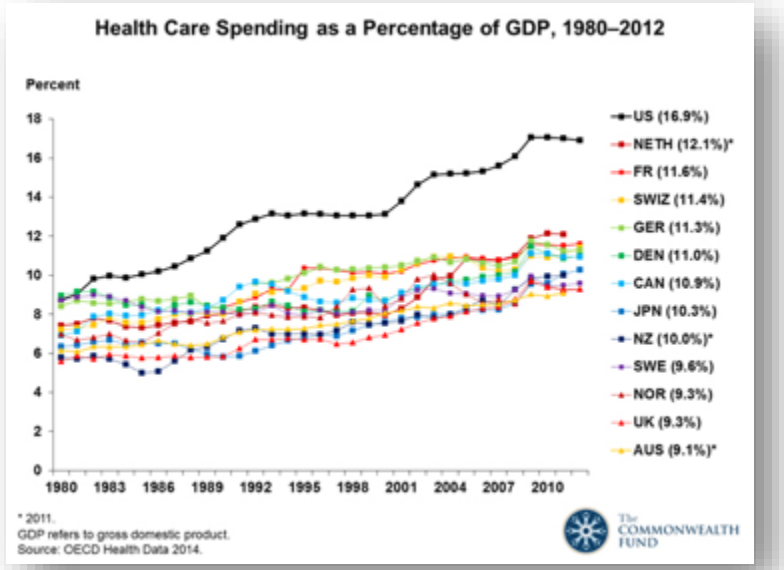
The Problem

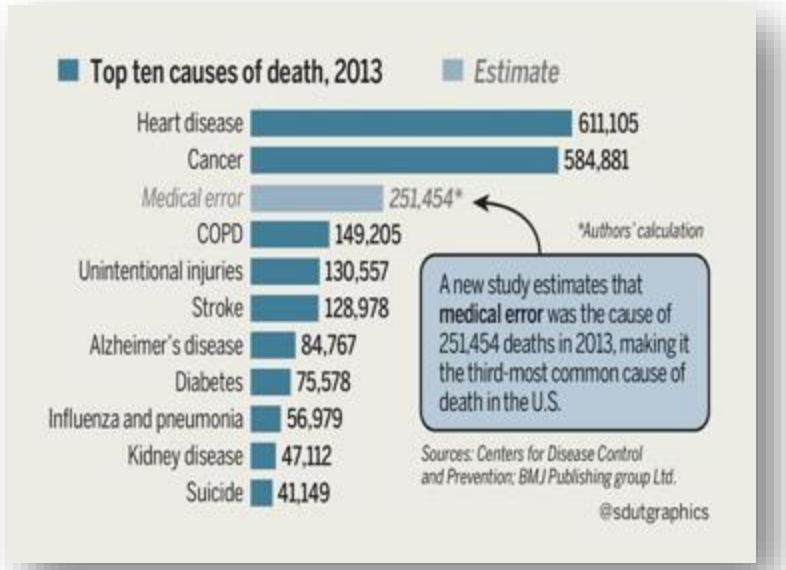
Lack of reliable safety, access, affordability, and outcomes → diminished value

- ❑ Worldwide, hundreds of thousands of patients die from preventable harms
- ❑ Significant healthcare costs are wasted
- ❑ Hospital-based clinicians spend significant time documenting, hunting for supplies, and other nonproductive work

Healthcare costs constrain investments in other social programs (e.g. education, etc.)



https://www.commonwealthfund.org/chart/2014/health-care-spending-percentage-gdp



http://www.sandiegouniontribune.com/news/health/sdut-medical-errors-3rd-leading-cause-death-2016may03-story.html

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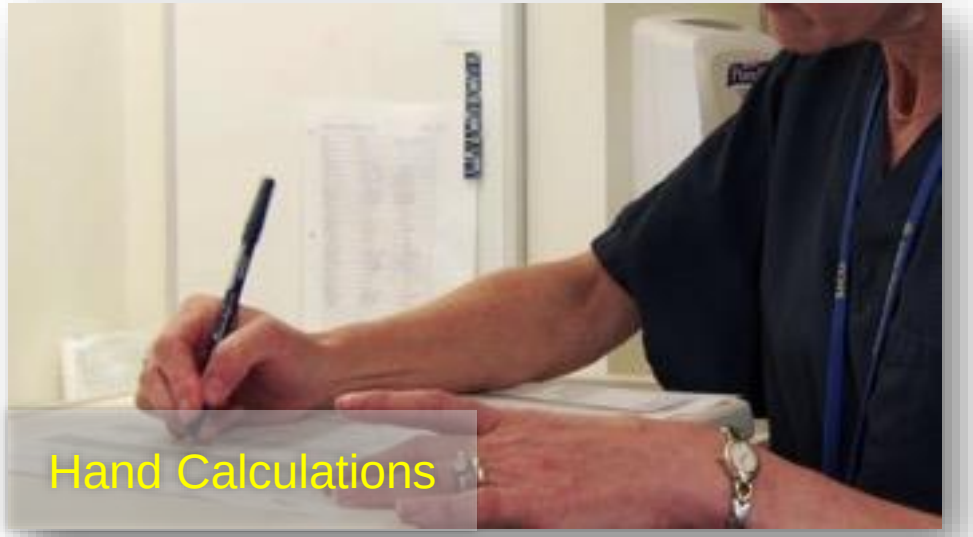
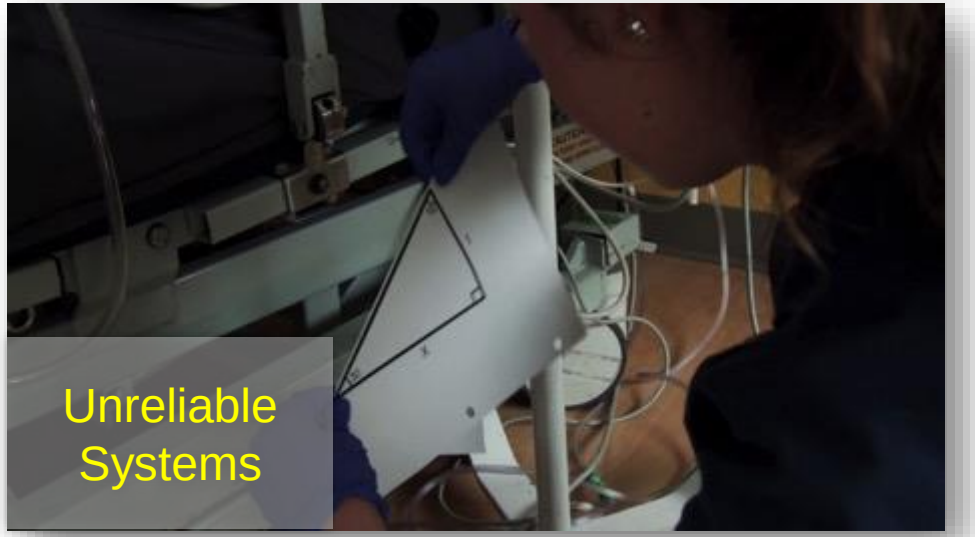
Symptoms of the problem

Current-state: in-patient





System Evolution

Aviation

Legacy

Today

Healthcare

Legacy

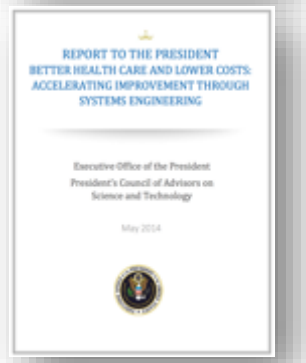
Today

See notes page for citations

Recognition of the problem

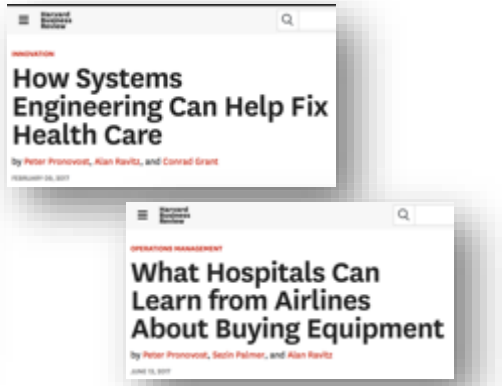
Engineering approaches to resolve the problem

NAE/IOM, 2005



PCAST, 2014

RAE, 2017



JHM, APL, 2017

- **Rapid advances** have **outgrown the capacity** of any one individual or even a group of individuals to comprehensively absorb and apply new knowledge to the benefit of patient care
- **Cottage-industry** origins counter to today where healthcare is a **complex partially interconnected myriad of services** that relies heavily on technology, influenced by markets, and is implemented in any one of a number of different provisioning models subject to statutory laws, policies, licensing, and regulation
- **Persistent underinvestment** by the healthcare delivery sector in information/communication technology

Systems must be designed from the start to ensure seamless integration between culture, workflows, and technology

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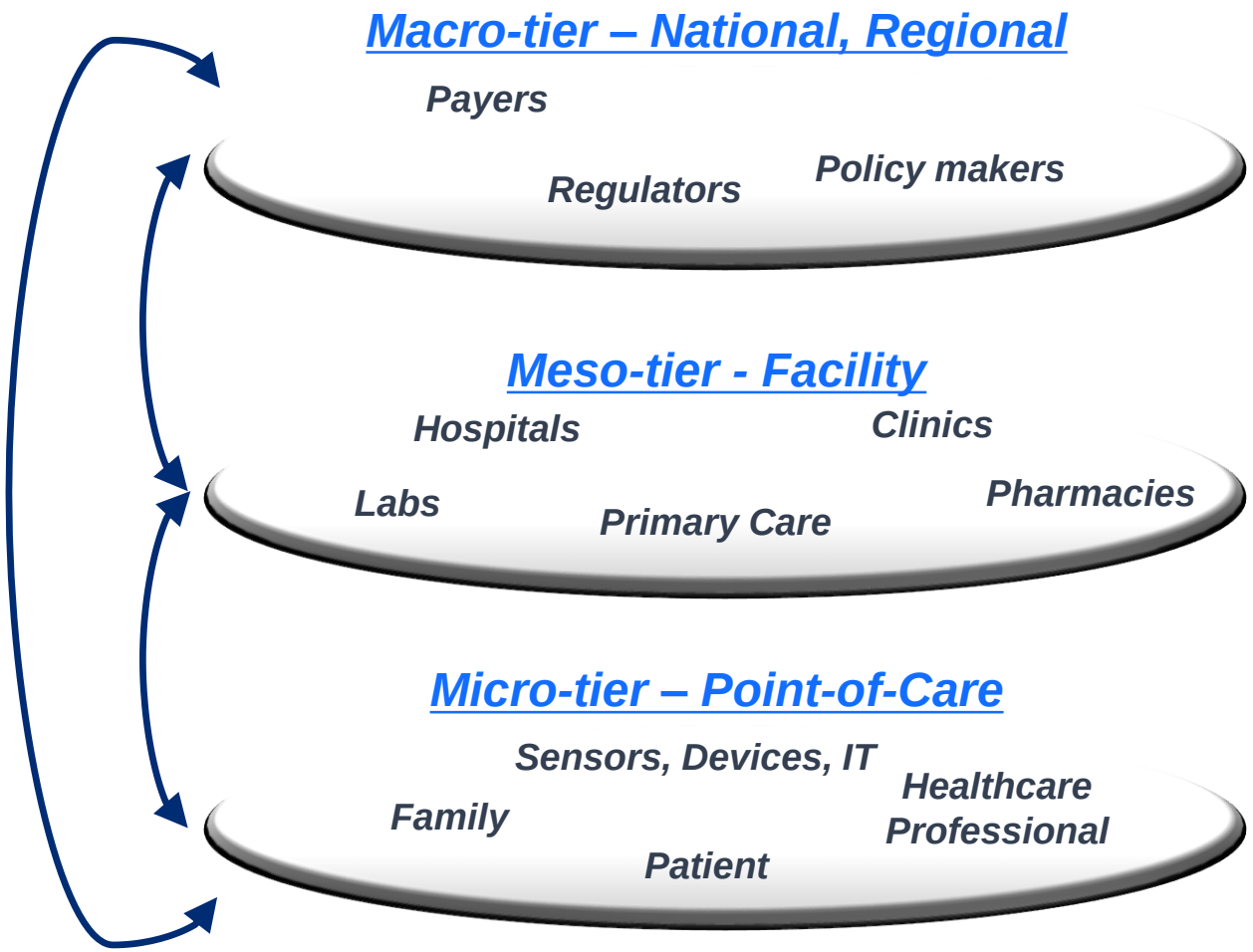
Healthcare

System of Systems



SoS Characteristic	Healthcare
Operational Independence	Operational dependencies exist between healthcare entities in terms of continuity of patient care, exchange of data, insurance claim processing, payment, and regulations, etc. It is difficult to consider this degree of interdependence operational independence.
Managerial Independence	Each healthcare entity has its own management structure where each is managed for its own purpose rather than for the purpose of the overall SoS. Arguably, this lack of cross-dependency adversely impacts the ability of the healthcare SoS to achieve desirable safety, outcomes, and value.
Geographic Separation	A matter of context: At the macro-level, there is little impact to the overall healthcare SoS that, e.g., regulators are not co-located with other entities. At a more granular level, i.e. at the point of care, various devices, personnel, etc. may be co-located with a room or may be distributed within a unit, office, building, or in the case of information technology, even in the Cloud.
Emergent Behavior	Hospitals, emergency medical services etc. are examples of the ability of diverse subsystems coming together to achieve an end result that any single subsystem could not achieve alone.
Evolutionary Development	Technical advancements clearly impact healthcare but so do developments in policy (e.g. US Affordable Care Act [11]; Turkey's Health Transformation Program [12]), regulation, and care provisioning models and all evolve independently and on their respective timelines through independent funding mechanisms.

Maier's five characteristics of Systems of Systems applied to healthcare.

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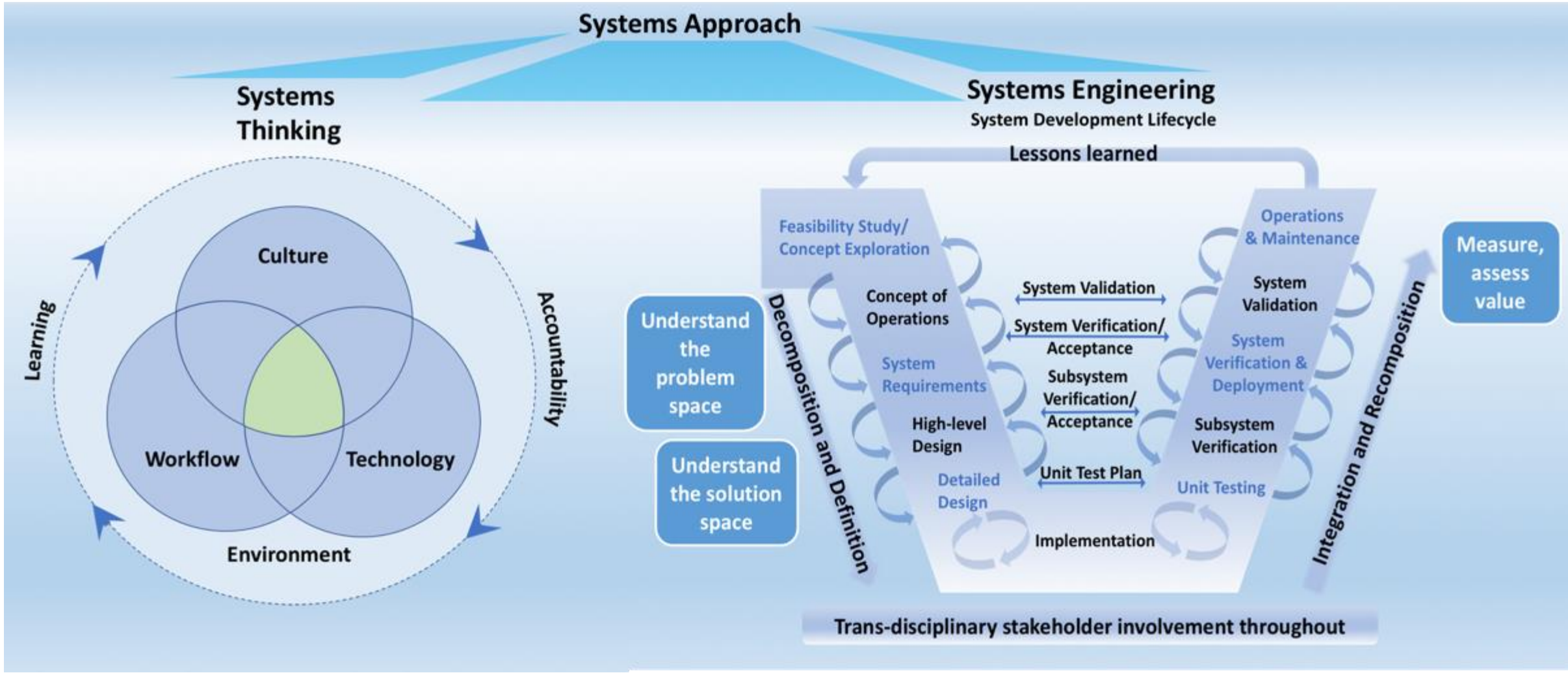
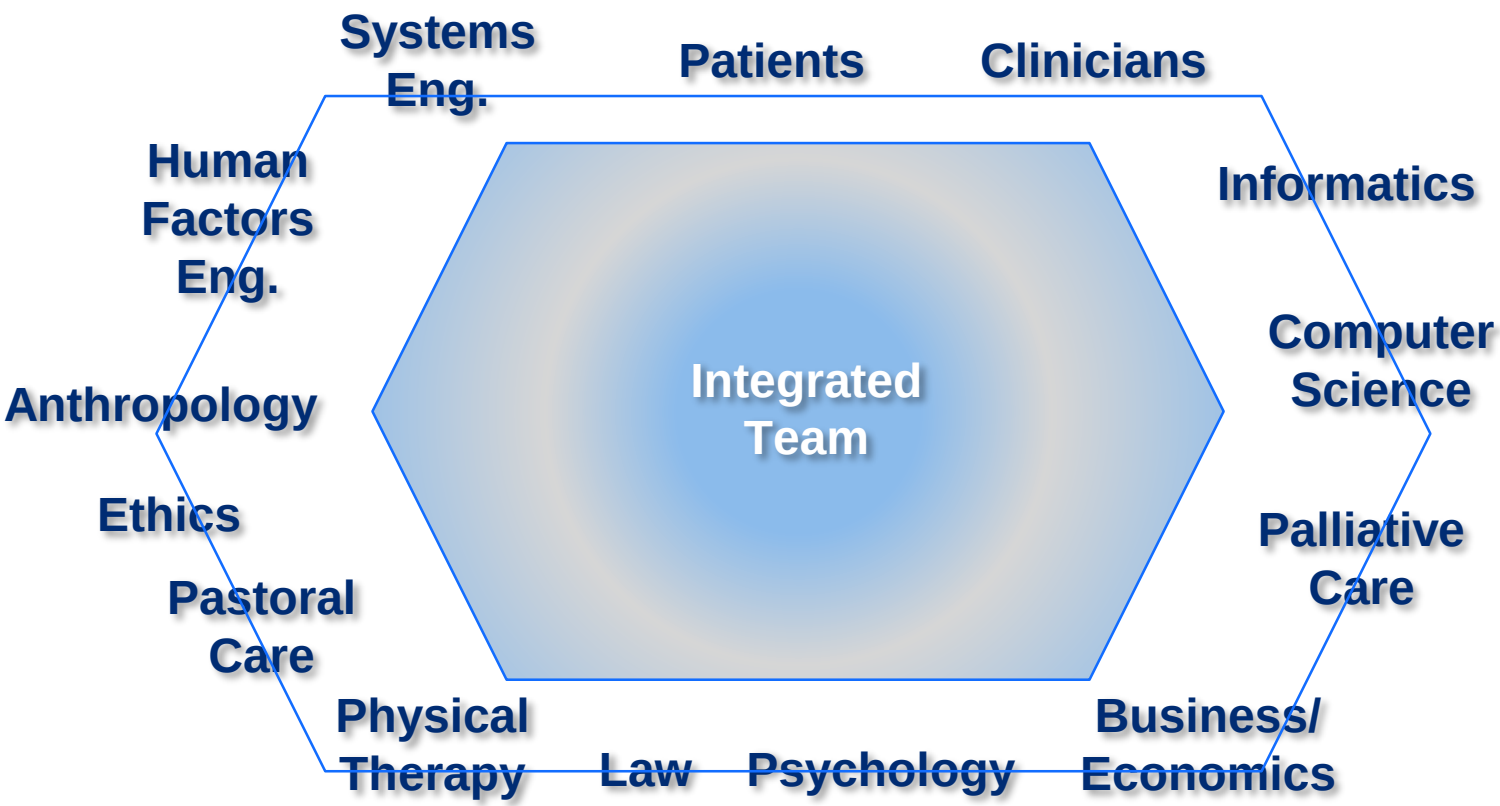
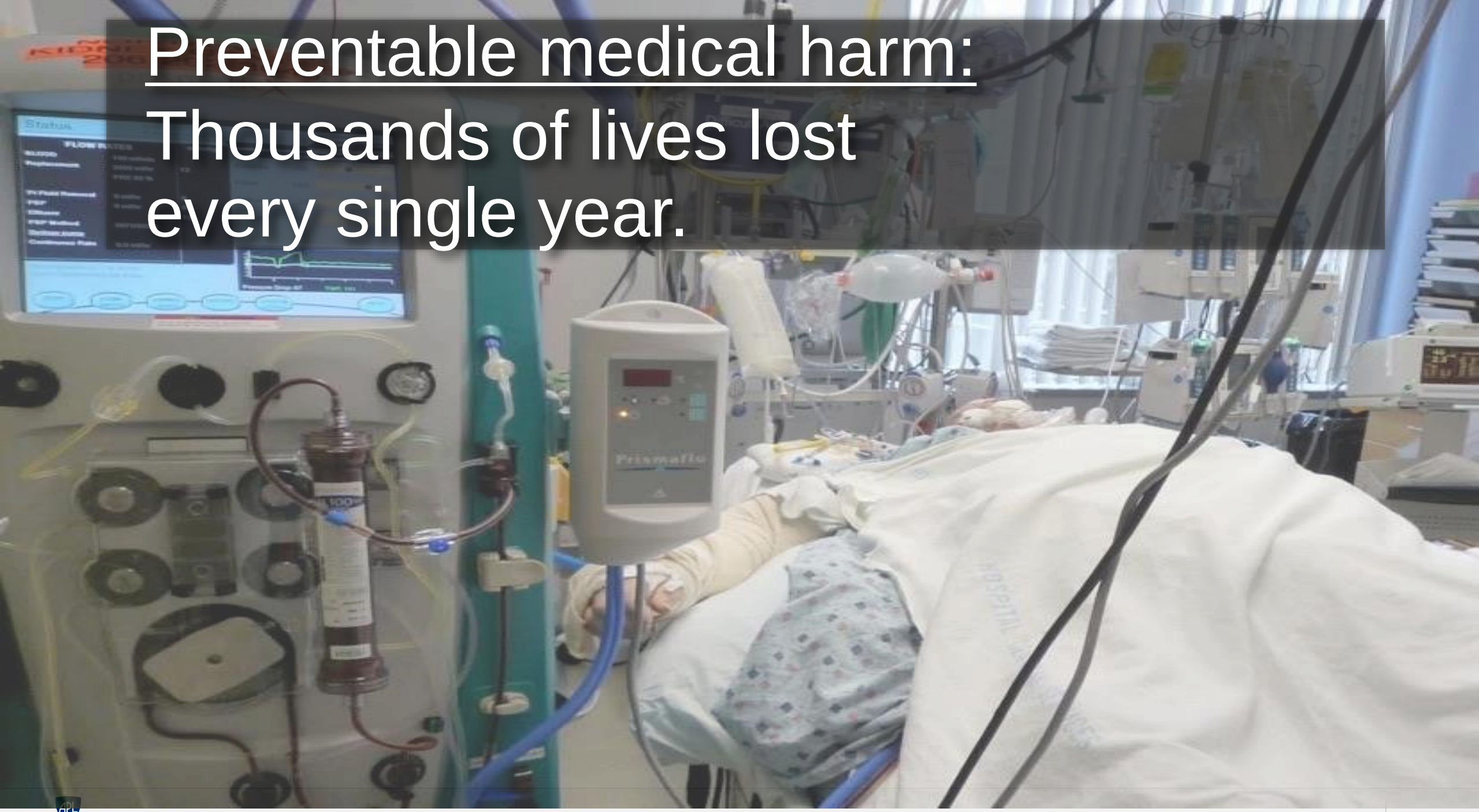
Systems Approach = Systems Thinking + Systems Engineering



Culture, Lexicon, and Transdisciplinary Teams

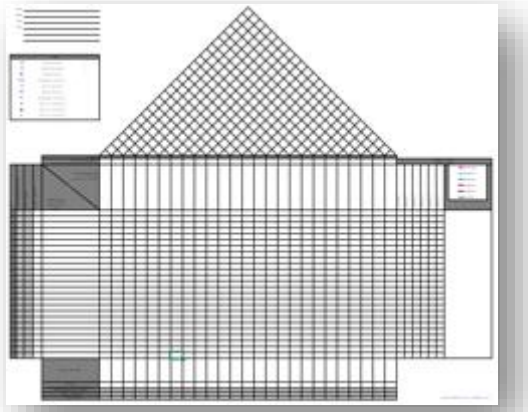


- Challenges
  - Diverse educational background
  - Different value propositions
  - Varying terminology
  - Engineers who think they understand healthcare
  - Clinicians who think they knew systems engineering
- Approaches
  - Shadow healthcare professionals
  - Be less rigid in language used
  - Identify individuals who can “bridge the divide” between healthcare and engineering
  - Stay focused on addressing project objective(s)
  - Engineers know they have done their job when healthcare professionals actively speak as if the solution is theirs

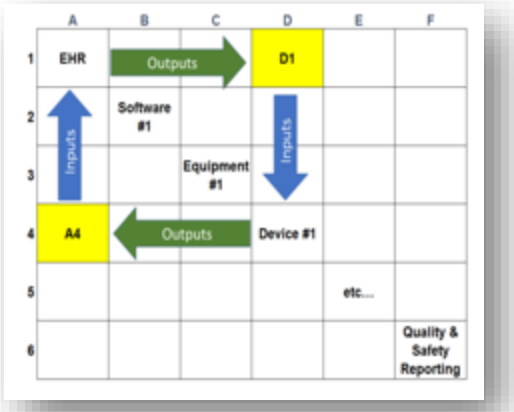


Tools of Systems Engineering Applied to Healthcare

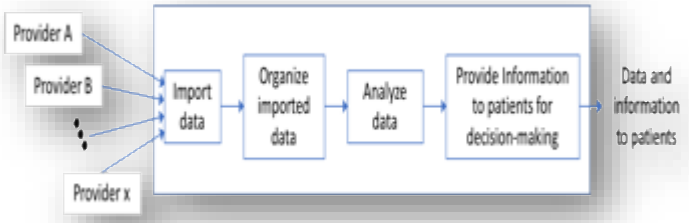
- Numerous approaches – never one size fits all and often more than one approach needed
  - Systems Thinking tools (Design Thinking, Soft Systems Methodology, etc.) and Systems Engineering tools (e.g. QFD, N-squared, etc.)
- Judge how much non-engineers need to know about technical aspects of systems engineering – make the effort "approachable"
- Remaining agnostic to specific solution can be a challenge for many non-systems engineers



QFD



N-squared



Context Diagram

Test & Evaluation

Tools keep focus on holistic, rather than reductionist perspectives

Summary

- Culture of healthcare innovation stems from medicine's hypothesis-driven approach to discovery
  - Approach serves the field well when it comes to understanding the first-principles associated determinants of health and illness
  - Approach has not, however, translated well into the conception, design, development, and fielding of processes, workflow, or technology development that leverage understanding of those health determinants
  - Time for a different approach that can spur the transformation in health needed to yield improved safety, affordability, access, and value
- Critical to define (a) the problem to be solved or opportunity to capitalize upon and (b) the stakeholders involved
  - Human nature tends to leap toward solutions without fully understanding the objective
- Technology is not a panacea
  - Systems Engineers must be disciplined: do not prioritize technology over people

Create a new generation of engineers and healthcare professionals that understand enough of the culture, terminology, and disciplines of both systems engineering and healthcare to lead the way in bringing about revolutionary change

Healthcare Systems Engineering

Master of Science / JHU Whiting School of Engineering – Engineering for Professionals

- Spring 2019
- On-line, part-time study
- Modeled on and derived from WSE EP curriculum in Systems Engineering

https://ep.jhu.edu/

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