



System Safety in Healthcare

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White House Wants System Engineering for Safety and Reliability in Health Care

System safety engineering will be a great tool for designing health care systems for patient safety, but the White House has a wider goal — one that includes not only patient safety, but also reliability, efficiency, productivity, quality and cost reduction. Therefore, systems engineering is poised to become the next proactive tool in health care.

A report, titled “Report To The President, Better Health Care And Lower Costs: Accelerating Improvement Through Systems Engineering,” was prepared by the President’s Council of Advisors on Science and Technology (PCAST) in May 2014 [Ref. 1]. The report highlights systems engineering, widely used in manufacturing and aviation, as an interdisciplinary approach to analyze, design, manage and measure a complex system. It also points out that, in spite of excellent examples, systems methods and tools are not yet used on a widespread basis in U.S. health care.

Understanding Systems Engineering

Systems engineering is the process of identifying a system of interest, choosing appropriate performance measures, selecting the best modeling tool, studying model properties and behavior under a variety of scenarios, and making design and operational decisions for implementation. Systems engineering focuses on coordination, synchronization and integration of complex systems of personnel, information, materials and financial resources.

Sometimes, mathematical modeling and analysis techniques are used to perform simulations to predict system behaviors for potential states of the system. Among other things, systems engineering modeling has been used for, among other things, therapeutic optimization of radiation therapy in cancer treatment, to model kidney alloca-

tion problems, in HIV treatment, in seizure warnings and in vaccine protocols [Ref. 2].

The Plan for Implementing System Engineering

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significant portion of those costs does not lead to better health or better care.” Patient safety is just as critical. According to the National Patient Safety Foundation, more than 1,000 patients die each day from preventable hospital mistakes [Ref. 3]. The report acknowledges that other industries have used a range of approaches, known collectively as systems engineering, to improve productivity, efficiency, reliability and quality. This is accomplished by using tools such as alerts, redundancies, checklists and systems that adjust for human factors. U.S. commercial airlines, for example,

have reduced fatalities from hundreds in the 1960s to approaching zero now, with the risk of death from flying now at 1 in 45 million flights.

The report uses the term “systems engineering” to include the full suite of tools and methods that can analyze a system, its elements and connections between elements; assist with the design of policies and processes; and help manage operations to provide better quality and outcomes at lower cost.

The report’s plan is to implement systems tools and methods to ensure that care is reliably safe, to eliminate inefficient processes that do not improve care quality or people’s health, and to ensure that health care is centered on patients and their families. The Council proposes increasing engagement with communities in improving health care delivery and the propagation of systems en-

gineering know-how at all levels. It recommends that the U.S. build a health care workforce that is equipped with essential systems engineering competencies that will enable system re-design.

Barriers to Implementation

The predominant “fee-for-service” payment system for compensating doctors — rather than a payment model based on the value of service — is the primary barrier to using systems methods and tools, according to the report. As a prerequisite to progress, the report suggests that the nation must accelerate the transition to payment models that pay for value rather than volume. Recognizing that it is hard to improve on what cannot be measured, the report also calls for accelerated development of the U.S. health data infrastructure.

There are other barriers that limit the spread and dissemination of systems methods and tools, such as insufficient data infrastructure and limited technical capabilities. These barriers are especially acute for practices with only one or a few physicians (small practices) or for community-wide efforts. To address these barriers, the report proposes the following approaches where the Administration could make a difference:

- Accelerate alignment of payment systems with desired outcomes
- Increase access to relevant health data and analytics
- Provide technical assistance in systems engineering approaches
- Involve communities in improving health care delivery
- Share lessons learned from successful improvement efforts
- Train health professionals in new skills and approaches

How Can Systems Engineering Be Applied?

The Council’s suggested method of applying systems engineering is an iterative loop consisting of several steps:

- Defining the problem
- Modeling the system
- Analyzing alternatives

- Implementing options
- Assessing what worked
- Repeating the process until the system is robust

What More Should be Done?

The Council has a good overall plan and mentions some tools such as reliability analysis, statistical analysis, waste reduction, Six Sigma and the Toyota Production System. It should include more tools such as system modeling, system architecture, reliability allocation, system boundaries, optimization and simulation.

Since the number of fatalities from hospital mistakes is more than 1,000 per day (about 400,000 a year, according to the National Patient Safety Foundation), patient safety has to be the No. 1 priority. We need to use system safety engineering tools that are usually not covered in a systems engineering suite of tools but are, in fact, the systems tools. Such tools are:

- Preliminary hazard analysis to predict all life cycle harm scenarios before the system is designed
- System hazard analysis to mitigate harm scenarios from miscommunications among interfaces and interactions among various functional entities
- Sneak circuit analysis to counter unexpected faults, taking into account events not happening at the right time or happening at the wrong time
- Event tree analysis to analyze the consequences of different paths
- HAZOP (Hazard Operability) analysis used in the chemical and oil industries

Most of these tools and more are covered in MIL-STD-882E, which is available at no cost on the Internet [Ref. 4].

When hospitals apply the systems engineering approach to medicine, there is a need to develop a new set of parameters to measure success. Since most of the problems with failure of a system or sub-system can result in harm to a patient, it is difficult to allocate weight to these parameters. Hence, there is a need to develop a measurement matrix before assessing the impact. ●

References

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