THE NATIONAL ACADEMIES

MEETING SUMMARY

IDEAS TO INNOVATION

Stimulating Collaborations in the Application of Resilience Engineering to Healthcare

June 13-14, 2013
Government-University-Industry Research Roundtable (GUIRR)
University-Industry Demonstration Partnership (UIDP)

Resilience engineering is an emerging field of study that focuses on the fundamental systemic characteristics that enable safe and efficient performance in expected and unexpected conditions. As work environments become increasingly complex, maintaining efficiency and a high level of performance can be challenging, especially in the healthcare environment. The application of resilience engineering to healthcare is an emerging field. This workshop, co-hosted by the MedStar Health Research Institute and GUIRR's University-Industry Demonstration Partnership (UIDP), explored how resilience engineering can be applied in the healthcare environment.

Experts in resilience engineering from around the world shared the field's underlying principles with a group of safety and healthcare leaders. The goal of the workshop was to bring together representatives from academia, industry, and government to explore ways in which collaborations can accelerate the pathway from research (ideas) to product development (innovation) and specifically how resilience engineering can be applied in complex safety-critical systems such as healthcare.

This workshop was the first in UIDP's Ideas to Innovation series, which is designed to share knowledge, spark innovative ideas, and inspire new collaborations and partnerships. The workshop began with presentations on the fundamentals of resilience engineering, followed by case presentations with expert panelists to further participants' understanding of the concepts.

To open the workshop on June 13, **Rollin J. "Terry" Fairbanks**, director of MedStar Health's National Center for Human Factors in Healthcare, and **Neil J. Weissman**, president of the MedStar Health Research Institute, presented a welcome and introduction. Dr. Fairbanks said that the healthcare industry has had isolated examples of success in increasing patient safety but no overall, sustained improvement so far. The industry needs to explore innovative safety approaches from sources outside of healthcare, including other industries and fields such as resilience engineering, he said. Because tools do not yet exist to apply resilience engineering to healthcare, the workshop's goal was to stimulate innovative thought and collaborations that might lead to the discovery of such tools.

Next, Dr. Weissman explained that Medstar Health was supporting the workshop as a way to pursue the organization's mission to be a trusted leader in caring for people and advancing health through education, research, and innovation.

In the first session of the workshop, **Erik Hollnagel**, senior consultant at the Centre for Quality, Region of Southern Denmark, and **David Woods**, director of the Center for Complexity in Natural, Social, and Engineering Systems at Ohio State University, presented a primer on resilience engineering. Both are key scholars who shaped the foundation of the field of resilience engineering. Dr. Hollnagel offered an overview of the principles of resilience engineering in his presentation, "Resilience Healthcare: The Basic Issue." He explained that there are two fundamental interpretations of safety: safety-I and safety-II. Safety-I is defined by the absence of things that can lead to a negative outcome, such as accidents, incidents, and near misses. Under this interpretation, safety can be improved by identifying and addressing the factors that contribute to adverse outcomes. In contrast, safety-II is defined by the ability to succeed in both expected and unexpected situations; with this interpretation, safety can be improved by understanding and strengthening the everyday performance of systems to allow success under varying conditions. In safety-I, we learn from what went wrong after an adverse event; in safety-II, we learn from what went right in any event with a positive outcome.

According to Dr. Hollnagel, a resilient system is characterized by four qualities: (1) the ability to **respond** to both expected and unexpected conditions in an effective and flexible manner; (2) the ability to **monitor** conditions and performance that could develop into challenges or opportunities; (3) the ability to **learn** from both failures and successes; and (4) the ability to **anticipate** future issues in both the near and long term. These capabilities are interrelated, and the output of one often serves as the input to another. An organization cannot be truly proactive without the ability to anticipate, which depends on its abilities to respond, monitor, and learn.

Dr. Woods continued the primer on resilience engineering with a presentation titled "On Being Resilient in the Age of Complexity." He proposed that problems arise from the complexity and brittleness of systems rather than from the erratic behavior of the people who operate them. Complexity in a system results from extensive and often hidden interdependencies, and systems are increasingly brittle due to short-term pressure on them to work faster, better, and cheaper.

Dr. Woods described the situation at NASA leading up to the 2003 Columbia accident as a prime example of complex systems becoming increasingly brittle under pressure to be faster, better, and cheaper. NASA was pressing to reduce the cost of launches while also trying to tighten schedules for missions.

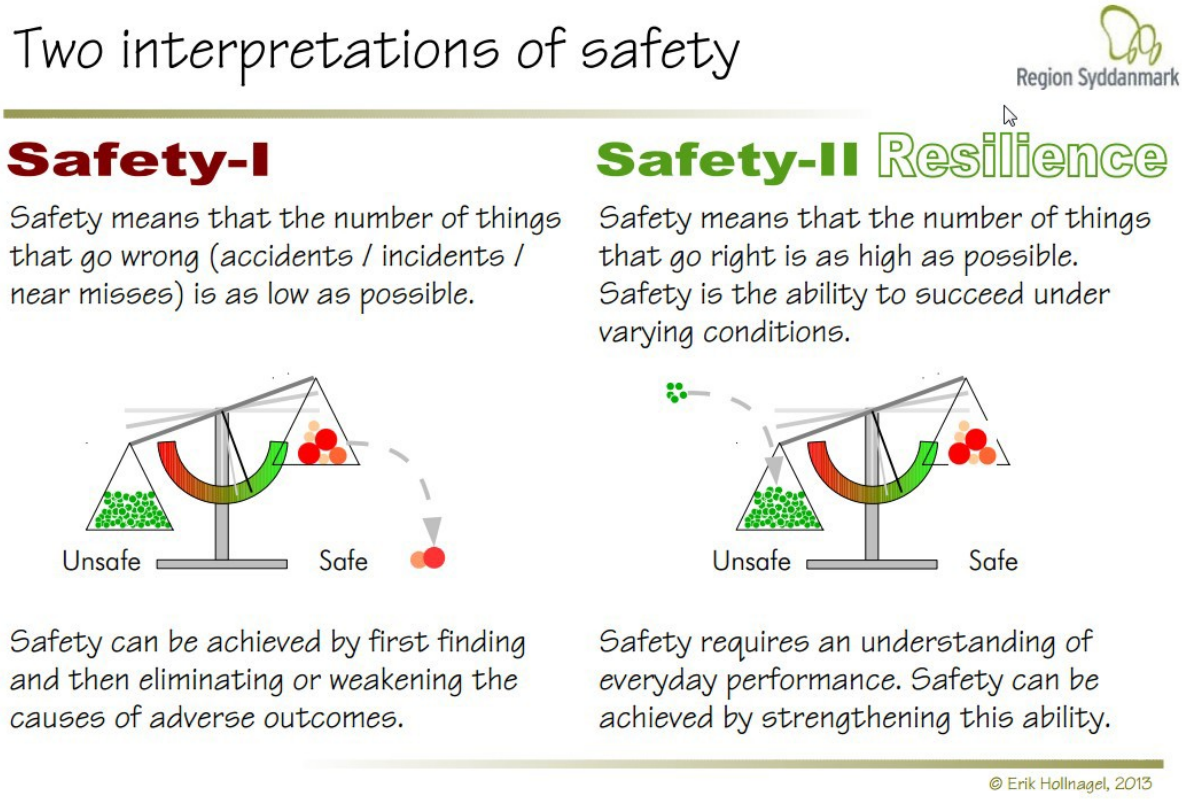

Figure 1 Two interpretations of safety
Source: Presentation by Erik Hollnagel, June 13, 2013

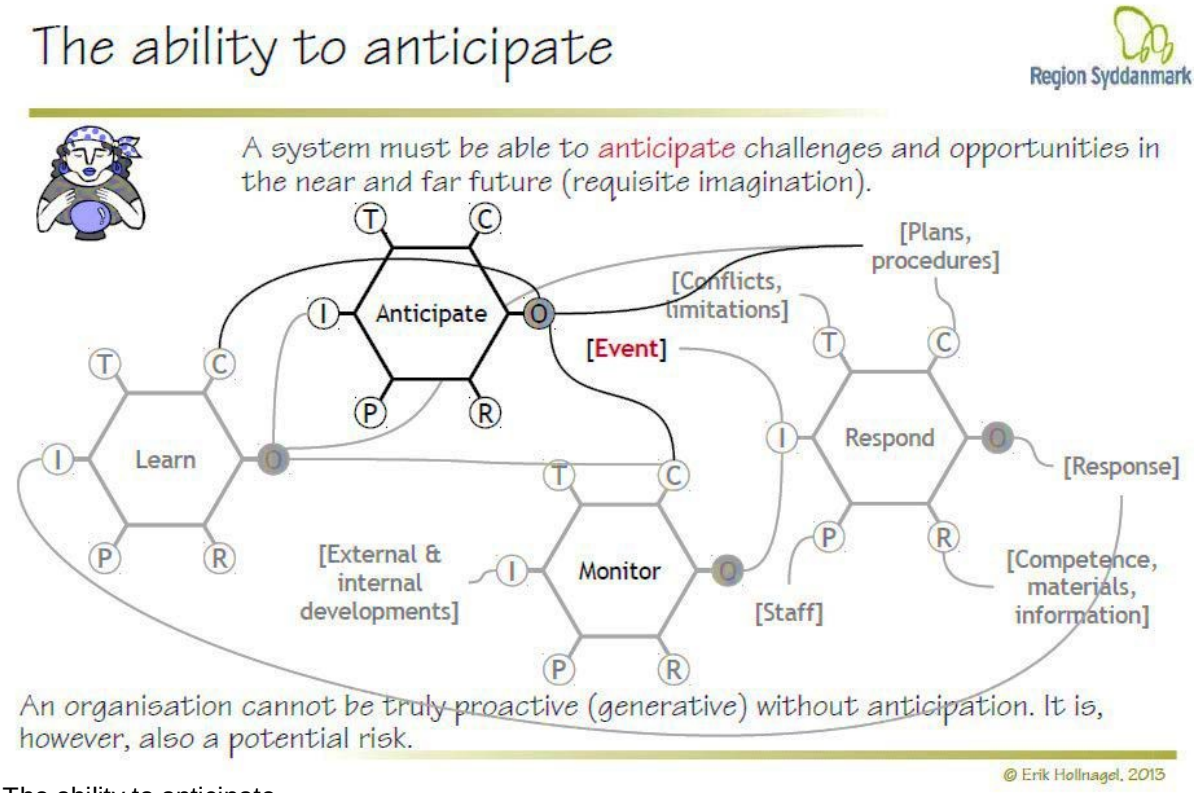

Figure 2 The ability to anticipate
Source: Presentation by Erik Hollnagel, June 13, 2013

At the same time, they were cultivating new partners and relationships and experiencing an erosion of skills in their personnel. There was also heightened public interest in the shuttle program. These factors combined to create an environment that was both increasingly complex and increasingly brittle, and which eventually led to failure.

Resilience can be engineered into systems, Dr. Woods proposed; there are measures, models, and findings that can help us understand how complex adaptive systems work. Practitioners must recognize that surprise and unexpected conditions are normal, not exceptional. In this context, expertise is defined by the ability to anticipate surprises and challenges. Further, system boundaries are always challenged; resilience is the ability to adapt when events challenge system boundaries.

Dr. Woods described three patterns in which people and systems fail to adapt: decompensation, working at cross-purposes, and getting stuck in stale behaviors. *Decompensation* refers to situations in which the capacity to adapt is exhausted as challenges grow and cascade. *Working at cross-purposes* occurs when systems become fragmented into silos that each work to adapt to local pressures, but whose separate efforts undermine the ability to achieve overall system goals. *Getting stuck* is the tendency to perpetuate outdated behaviors that are no longer effective, and this occurs due to complexities in learning how to adapt when events challenge plans and boundaries. Resilient systems reduce the risk for these patterns of breakdown by continually adjusting response capabilities and by anticipating changing demands and the potential for surprise.

Richard Cook, professor of healthcare system safety at the Royal Institute of Technology in Stockholm, Sweden, built on the resilience engineering concept in his presentation "How Did We Get Here?" Dr. Cook noted that attention to safety is currently a byproduct of accidents; the attention an accident receives is related to its size, its recency, and its "distance," i.e., relative importance to an individual. In contrast, resilience engineering focuses on the story of the accident that never happened.

Dr. Cook proposed that there are two stories to an event. The first story—the one we usually tell—focuses on the contributing factors and offers a rationalization of how the accident came to be. The second story, often more complex and difficult to discover, is about the factors that usually *forestall* such events. These factors include the adaptive sociotechnical structures—the interactions between technology, people, and organizations—that routinely produce safe and reliable performances in the presence of hazards and opportunities for failure.

There is a deep paradox in this, suggested Dr. Cook. Overt accidents are rare because of resilience, but the scarcity of accidents can convince system designers,

regulators, managers and operators that the hazards are absent rather than just successfully managed. The absence of accidents makes it easy to regard the contributors to resilience as mere inefficiencies and to remove them. Thus, resilient systems may drift or be driven toward brittleness. Pre-accident hints that a system is becoming more brittle are often discounted or rationalized because of the benefits, e.g., speed in conducting tasks, that brittleness provides. The resulting tension between the desire for resilience and the gains derived from brittleness is the basis for resilience engineering.

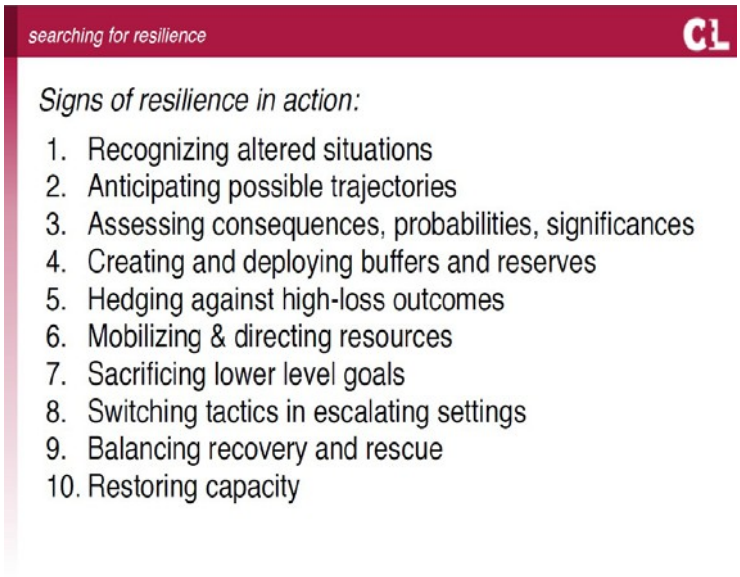

Figure 3 Signs of resilience in action
Source: Presentation by Richard Cook, June 13, 2013

Next **Tom McDaniel**, global manager for Human Performance and Zero Harm at Siemens Energy, provided a perspective on resilience engineering from the energy industry. At Siemens the safety focus is no longer on simply investigating failures and correcting the factors that caused them. Rather, the strategy includes intervening prior to failure and investigating successes, consistent with the resilience engineering philosophy and the safety-II perspective. Safety problems are often not safety problems at all, but system problems, Mr. McDaniel said. In a typical incident investigation, he follows an 80/20 rule, where 80 percent of the investigation is focused on the organization or system, and only 20 percent of the investigation is focused on the individual involved and specific sequence of events. According to Mr. McDaniel, "Industry needs new thinking and concepts to reach a new level of safety maturity, and these are all coming from the resilience engineering group. Traditional approaches to safety—including compliance, behavior-based safety, and management systems approach—are all valued and necessary, but not sufficient. Resilience engineering is giving us new direction to achieve Zero Harm."

Garth Hunte, trauma director of the department of emergency medicine at St. Paul's Hospital, Providence Health Care and Associate Professor, Department of Emergency Medicine at the University of British Columbia, Vancouver, BC, offered the presentation "What is Resilience Engineering and Why is it Important?" According to Dr. Hunte, the key to resilience engineering is in understanding everyday practices and the difference between "work as done" and "work as planned." Dr. Hunte suggested that systems have three options: adapt, transform, or fail. Emphasizing the words of Dr. Woods, he stated that success results from resilient systems that recognize and adapt to variation, change, and surprise. Conversely, failure represents breakdowns in the adaptations that are directed at coping with complexity. Safety resides between us, in the interactions among practitioners, he concluded.

The next phase of the workshop consisted of several case presentations with expert panel discussion to offer a resilience engineering perspective. In all cases, there was a focus on understanding work as done vs. work as planned.

Seth Krevat, assistant vice president for safety at MedStar Health, presented the first case, involving a medication error that resulted in a chemotherapy patient receiving both the wrong drug and the wrong dose. Expert panelist **Ann Bisantz**, professor and chair of industrial and systems engineering at the University at Buffalo, identified several examples of brittleness within pharmacy processes that contributed to this error. Expert panelist **Jeffrey Braithwaite**, director of the Centre for Clinical Governance Research at the University of New South Wales, pointed out that the case was investigated and presented from a safety-I and first-story perspective. He suggested that additional investigation should focus on understanding how work is actually done in the pharmacy, since everyday behaviors frequently lead to no errors, indicating resilience. With a better understanding of the second story, the resilience of the system can be assessed, and ways to strengthen the system can be identified.

Next **Barbara Pelletreau**, senior vice president for patient safety at Dignity Health, presented the second case, in which a surgical sponge was mistakenly left inside a patient. Expert panelist **Shawna Perry**, director of patient safety systems engineering for Virginia Commonwealth University Health Systems, observed that this case was addressed from a safety-I perspective: A linear process was used to evaluate a specific problem, and the second story was not investigated. Healthcare providers often use coded language and other tricks or workarounds to circumvent the system. Expert panelist **Elizabeth Lay**, director of human performance at Calpine Corporation, pointed out the importance of identifying signs of brittleness in systems and situations, such as deference to authority, oversimplification, nonadoption of safe practices, and a pressure to continue work as usual.

Joan Ching, administrative director of hospital quality and safety and **Cathie Furman,** senior vice president, Quality and Compliance at Virginia Mason Medical Center presented the final case, an examination of the trade-offs between reducing patient falls and managing a hospital's overall resource constraints. A patient identified as being at an extremely high risk of falls may need one-to-one observation by a staff member. However, this means that the constant observer is no longer available to perform his or her previous duties, creating a resource shortage elsewhere in the system. Expert panelist **Christopher Nemeth**, principal scientist and group leader of Cognitive Systems Engineering at Applied Research Associates, Inc., stressed the need for human factors expertise to understand healthcare at the system level. Developing genuinely resilient systems also requires understanding work as it is performed rather than as it is imagined. Expert panelist **Dr. Garth Hunte** pointed out that limited resources are a constant issue in healthcare, which is additional evidence of the need for resilient healthcare systems.

After the case presentations, **Sidney Dekker**, professor in the School of Humanities at Australia's Griffith University, joined the conference via Skype and discussed the importance of resilient individuals and organizations in his presentation on the "second victims" of medical errors. The second victim is defined as a healthcare provider who has been involved in an incident which potentially harms a patient and for which the provider feels responsible. Error in healthcare is often painted as a moral failure, Dr. Dekker contended, and adequate support is not provided for the second victims of errors.

Dr. Dekker asserted that to build a resilient organization, care must be provided to the caregiver, particularly when the caregiver is a second victim. After an incident the second victim should be provided with immediate support, the equivalent of psychological first aid. Next, the second victim should be empowered. This can be accomplished by debriefing and allowing the person to explain his or her actions, constraints, and larger goals as the situation unfolded. The second victim may also be empowered by playing a role in the investigation and by meeting with the first victim, if appropriate. Finally, the support to the second victim should be ongoing; e.g., the well-being of the second victim should be monitored on anniversaries of the event.

The next session of the workshop was directed at sparking collaborations through a series of "World Café" roundtable discussions, moderated by **Paul Plsek** of Paul E. Plsek & Associates and the MedStar Institute for Innovation. World Café is built on the assumption that, collectively, people already have within them the wisdom and creativity to confront even the most difficult challenges. The first World Café session at the workshop explored the potential for advancing healthcare safety via collaborative application of resilience science, using three roundtable questions.

(1) *What, to you, were the most interesting concepts or insights today about resilience science, and why?* Many participants highlighted the novelty of the resilience engineering approach to safety, with a particular interest in the shift in focus from what went wrong (safety-I) to what went right (safety-II), and in the important distinction between work as done vs. work as planned. There was an interest in the concept of the second story and the need to get beyond the first story to fully understand a system. The groups explored ways to move resilience engineering from concepts to application in healthcare—e.g., by educating both administrators and front-line providers.

(2) *What might be some of the best opportunities (issues, problems, settings) to apply resilience science concepts in healthcare, and why?* Work as done vs. work as planned and workarounds were discussed, and participants proposed numerous specific opportunities to apply resilience engineering to healthcare. Potential areas of application included resource allocation, especially in systems with limited resources and limited slack; medication administration; perinatal issues; home-based care; design of physical environments; and team briefs and hand-offs.

(3) *What do you see as some of the challenges (both conceptually and practically) that would have to be overcome in order to successfully apply resilience science to healthcare, and what do you think can be done to overcome these?* Many participants identified the necessary paradigm shift from current approaches to safety as a major challenge; they suggested focus needs to shift from safety-I to safety-II, from reactive operations to proactive strategies, and from linear thinking to complex thinking. Other challenges include helping these novel concepts infiltrate the front lines of the healthcare industry and finding ways to effect a culture change. Tools and established methods for applying resilience engineering to healthcare are needed as well, some participants pointed out, as are ways to measure the success of resilience engineering efforts. Identifying local champions across ranks and specialties will be important in overcoming these challenges, some participants noted, as will developing the necessary methods, metrics, and training.

The second day of the workshop (June 14, 2013) began with a presentation by **Robert Wears**, professor of emergency medicine at the University of Florida and a visiting professor at Imperial College London. Dr. Wears expanded on the fundamental differences between safety-I and safety-II; while safety-I focuses on examining the components of a system after an accident, safety-II focuses on studying why normal work is safe so much of the time. Safety-I often identifies erratic acts by people as the cause of accidents, so it attempts to achieve safety by constraining people's actions through standardization, guidelines, procedures, rules, interlocks, checklists, and barriers. Safety-II instead observes that accidents are prevented by people

adapting to conditions. It attempts to achieve safety through enabling people—for example, by making hazards, constraints, and goal conflicts more visible and enhancing people's repertoire of responses to varying conditions. Safety-I assumes that systems are well designed, well understood, and basically safe; safety-II assumes that systems are poorly understood and basically unsafe. Safety-I assumes that safety is an attribute of a system, while safety-II assumes that safety is an activity within a system. Safety-I assumes that reliability is directly related to predictability, but safety-II assumes that since variation is necessary and unavoidable, reliability is directly related to responsiveness and adaptability. Safety-I is defined by its opposite (failure), and safety-II is defined by its goal (success).

Dr. Wears then discussed why safety-I persists: not *despite* the fact it is wrong, but precisely *because* it is wrong, wrong in ways that benefit organizations and organizational leaders. In his estimation, safety-I offers: seemingly simple explanations to what are likely much more complex problems; an illusion of control, with the idea that additional constraints can solve problems; and solutions that have little impact on managers and organizations. For example, retraining front-line providers is often employed as a solution rather than the more difficult and expensive reorganization or refitting.

The next session assembled an expert panel—Mr. McDaniel and Drs. Hunte and Perry—to discuss the question "How does resilience theory fit with other known safety models, and what unique perspectives can it bring to healthcare?" The panelists suggested that the safety-II approach must complement the current safety-I approach. They recognized reasons to continue using safety-I, including regulatory requirements and the idea that, if done well, safety-I is the right approach for certain problems. However, the panelists also recommended that something new be done because, in their opinions, there has not been enough progress in healthcare safety, and organizations feel pressure to improve. Some panelists advocated for *adding* the safety-II approach to the existing safety-I approach; in their estimation, integration of the two approaches can maximize the benefits of each.

Sorrel King, president and co-founder of the Josie King Foundation, provided a call to action. The Josie King Foundation is a nationally prominent organization that was started after eighteen-month-old Josie King died from medical errors. The foundation's mission is to prevent patients from dying or being harmed by medical errors. Mrs. King spoke passionately about the need to inspire healthcare providers, to touch their hearts through stories, and to remember that the primary focus should always be care of the patient. Medical errors are the fourth leading cause of death in the United States, she said, and 75 percent of all sentinel events are attributed to a breakdown in communication. Not every change needs to be costly, she said, and change needs to start with individual attitudes. Mrs. King challenged the healthcare providers present to use not only resilience engineering but also their own stories to influence other providers to improve patient safety.

The final session of the workshop was an open space session, a meeting approach which starts with the creation of the agenda by the participants themselves, and proceeds with small group discussions on the topics identified. The initial open space topics, which evolved throughout the workshop, were:

- What are some real-world examples of applying resilience engineering to healthcare?
- What needs to be researched in resilience, and who might fund it?
- How do we set up accident evaluations to begin moving people from safety-I to safety-II?
- How do we notice brittleness and design for resilience… in real life?
- How do we bridge the goals of optimization (e.g., lower costs) and still maintain resilience?
- How do we spread practical application of resilience to many organizations with varying degrees of sophistication?
- Is there a government role in Meaningful Use Stage 3[1] for resilience engineering?
- Can safety-I and safety-II coexist in a lean organization?
- How do we set up a safety organization?

All workshop attendees participated in the first discussion, "What are some real-world examples of applying resilience engineering to healthcare?" Dr. Hollnagel described two of his recent projects. The first involved an incident in which a psychiatric patient was admitted to the hospital and subsequently stabbed three healthcare providers with a knife that he had somehow smuggled in. The hospital's immediate reaction was to require a strip search of all psychiatric patients upon admission. Dr. Hollnagel, however, used a safety-II approach to investigate how psychiatric admissions were actually performed, to better understand "work as done," which led to the identification of system improvements. In the second project, he was tasked with improving the process of doing hospital rounds. Again, he used the safety-II approach to understand how work was done and to help the team identify ways to strengthen the system. Following this discussion, each participant was able to participate in two additional discussions of his or her choice, which offered further opportunities for participants from many disciplines to collaborate.

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[1] Meaningful Use is using certified electronic health record technology to improve quality, safety, efficiency, and reduce health disparities; engage patients and family; improve care coordination, and population and public health; and maintain privacy and security of patient health information. Meaningful Use has the following 3 stages: Stage 1 data capture and sharing; Stage 2 advance clinical processes; Stage 3 improved outcomes. Source: HealthIT.gov

The variety and scale of technical, social, and economic change in healthcare is enormous. Resilience is considered critical to success, yet health practitioners may lack understanding of how resilience is generated and preserved, leaving them ill equipped to provide clear guidance on the design of future healthcare systems.

Translating the principles of resilience into practical application in healthcare remains a great challenge. This workshop stimulated collaborations and efforts that may lead to tools and methods for applying resilience engineering concepts to healthcare.

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About the University-Industry Demonstration Partnership (UIDP)

The purpose of the University-Industry Demonstration Partnership (UIDP) is to enhance the value of collaborative partnerships between university and industry in the United States. UIDP is an organization of universities and companies who seek to build a stronger relationship between these parties. UIDP provides a unique forum for university and industry representatives to meet and discuss operational and strategic issues such as contracting, intellectual property, and compliance matters. These conversations might otherwise never take place, and they serve to help university representatives better understand the culture and constraints of their industry counterparts, and vice versa.

About the Government-University-Industry Research Roundtable (GUIRR)

GUIRR's formal mission is to convene senior-most representatives from government, universities, and industry to define and explore critical issues related to the national and global science and technology agenda that are of shared interest; to frame the next critical question stemming from current debate and analysis; and to incubate activities of on-going value to the stakeholders. The forum is designed to facilitate candid dialogue among participants, to foster self-implementing activities, and, where appropriate, to carry awareness of consequences to the wider public.

For more information about GUIRR visit our web site at
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