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Activities to Promote Resilience During Health Information System Transitions

Helen J. A. Fuller[1], Tim Arnold[1,2], Michael O'Neil[1], and Darren P. Wilson[1]

[1]Human Factors Engineering, Clinical Informatics and Data Management Office, Office of Health Informatics, Veterans Health Administration, Department of Veterans Affairs, Washington, DC, USA
[2]University of Michigan, College of Pharmacy, Ann Arbor, MI, USA

ABSTRACT

Health information systems are ubiquitous in modern medicine. They are sometimes involved in problems with the delivery of care, and this seems to be especially prevalent when transitioning to a new system. Resilience is the ability of systems to respond to unexpected demands or circumstances to allow resumption or continuation of normal operations. We propose that some methods and techniques commonly used in human factors and usability work may promote system resilience, which may be especially important during times of transition. Examples include contextual inquiry, task analysis, risk assessment, and trade-off studies. These activities help people understand and communicate context of use and gain a more comprehensive understanding of the difference between work-as-done (WAD) and work-as-imagined (WAI), as well as navigate risks and benefits when making decisions regarding system changes.

Keywords: Human factors, Resilience, Safety, Patient safety, Human systems integration, Systems engineering

INTRODUCTION

In the process of delivering healthcare, there are times when a patient may be inadvertently harmed. The current patient safety movement grew as there was increased public awareness of the scale of patient harm, with a goal of preventing unintentional harm to patients (e.g., Kohn et al., 1999; Stoelting, 2000). This movement tended to organize in a way that prioritized adoption of a barrier model of safety to prevent things from going wrong, sometimes termed Safety-I or Protective Safety, which focuses on reducing systems failures (Hollnagel, 2018). However, preventing patient harm also requires that the right care be delivered at the right time (Wildavsky, 1988).

Drawbacks of adopting a strictly protective safety approach (Safety I) have been documented and are extensible to healthcare (Morel et al., 2008; Cook & Ekstedt, 2016; Cook, 2019). Concerns include complexity and brittleness, pointing to the importance of also considering the topic through a lens of Safety-II or Productive Safety, which emphasizes understanding how things go right and supporting activities or structures that contribute to system success (Hollnagel, 2018). More recently, Leveson (2020) has proposed a systems approach to safety termed Safety-III, which generally defines safety as freedom from unacceptable losses.

Human factors engineering (HFE) strives to understand human interactions with systems to promote better design. This includes considerations of tools, training, processes, and policies used during work. A key goal of HFE is to increase the usability—generally defined as effectiveness, efficiency, and user satisfaction—of systems (ISO, 2018). Improving safety is also a common focus (e.g., Lee et al., 2017; Chapanis, 1996), and when HFE operates in the realm of healthcare, the capacity of a system to adapt to changing conditions to maintain acceptable levels of function without compromising patient safety becomes crucial.

RESILIENCE

Resilience is a concept that dates back many years and has roots in multiple disciplines, including ecology, psychology, and engineering (e.g., Holling, 1973; Doorn, 2020). Here, we consider resilience as the ability of systems to respond to unexpected demands or circumstances to allow resumption or continuation of normal operations (Woods, 2015). Resilience engineering looks for ways to enhance the ability of systems to succeed under varying conditions.

Hollnagel (2015) proposes that four abilities are necessary for resilient performance: the ability to respond, the ability to monitor, the ability to learn, and the ability to anticipate. Nemeth and colleagues (2011) shared examples of resilience in healthcare operations and described how information systems can contribute to brittleness or resilience. For example, automation surprises in information technology (IT) systems may lead to an inappropriate response by the caregiver that could lead to patient harm. On the other hand, well-designed IT systems may support clinicians' cognitive work under changing conditions.

While resilience is often discussed in terms of system performance and success, it may also have important implications for safety. More traditional views of system safety described an organizationally managed system, in which safe work practices are defined centrally and it is the job of the safety professional to track adherence to such practices and correct any deviations (Provan et al., 2020). In contrast, newer views of safety such as Safety-II align more with a decentralized, individually-managed safety approach. Such a system recognizes that variation is inevitable and that safety is best managed by facilitating safe variation. The role of safety professionals is to build knowledge regarding changing risk that can facilitate action before people are harmed and to create guided adaptability by developing capacity for anticipation, readiness to respond, synchronization, and proactive learning (Provan et al., 2020).

HEALTH INFORMATION SYSTEM TRANSITIONS

Health information systems are ubiquitous in modern medicine. They are sometimes involved in problems with the delivery of care, and this seems to be especially prevalent during times of transition to a new system.

Transitioning to a new electronic health record (EHR), in particular, is difficult, because the EHR is used in so many aspects of patient care and because healthcare systems often evolve alongside an EHR. Health information systems and practices may grow and develop in concert with healthcare workflows, IT infrastructure, business practices, and the physical workspace. Multiple authors have described the challenges of such transitions (e.g., Hanauer, 2016; Huang et al., 2020).

There are some key activities and practices that can facilitate the change to a new health information system. First, it is essential to understand how people are currently doing their work. Often, this activity will take the form of process mapping. Next, it is important to develop a good understanding of the new system, including how it is designed to work, how it is actually working, and how people are using it. Any gaps can then be addressed through mitigations such as system changes, workflow adjustment, and resource allocation or reallocation in the change management process.

HFE AND RESILIENCE IN HEALTHCARE

HFE as a Framework to Support Safety

Provan and colleagues (2020) suggested key activities for safety professionals that promote guided adaptability, which in turn supports resilient systems. These activities include exploring everyday work, supporting local practices and guiding changes, reducing conflict between goals and negotiating for resource distribution as needed, aiding trade-off decisions, and facilitating information flows and learning. Many of these activities align closely with methods and techniques that human factors engineers currently use, suggesting that HFE work may support system resilience. Examples of this alignment are shown in Table 1.

There is overlap between many of these activities, and several of them are complementary. In addition, some are more appropriate at particular times in a project lifecycle. For example, contextual inquiry has the greatest effect on the project outcome if conducted early, so that findings may be documented and applied during subsequent decisions and trade-off discussions.

Applications of HFE During Health Information System Transitions

During the implementation of a new health information system at a large healthcare organization, we have engaged in human factors work to support usability and safety of healthcare delivery. Particular challenges during the implementation pointed to needs that could be addressed through the safety activities described above. We will describe three examples of how human factors activities were employed to enhance safety and resilience in the system.

A significant source of frustration during the implementation has been attempts to map existing workflows to the requirements of the new system.

Table 1. Safety activities to promote guided adaptability outlined by Provan and colleagues (2020) and the corresponding HFE activities that may support them.

Safety Activity (Provan et al., 2020)	Supporting HFE Activities
Explore everyday work	Task analysis, contextual inquiry, semi-structured interviews, pluralistic usability walkthroughs, ethnographic studies, focus groups
Support local practices and guide adaptations	Usability evaluations, heuristic evaluations, document review using methods such as natural language processing and heuristic evaluation, teaching and supporting human centered design methods, risk assessment
Reduce goal conflict and negotiate redistribution of resources	Cognitive task analysis, user interviews, risk assessment
Facilitate information flows and coordinate action	Visual modeling, human centered design methods
Generate future operational scenarios	Heuristic evaluation, usability evaluations (A/B comparisons)
Facilitate sacrifice judgments	Risk assessment, usability evaluations (A/B comparisons), trade-off studies

There are also important distinctions between business process modeling and mapping cognitive workflows, which requires information about how representative users perform critical tasks and can be used to assess the usability of a system (e.g., Kushniruk & Patel, 2004). To explore everyday work and facilitate communication between departments and groups for better decision-making, we have used a number of human factors techniques to understand and illustrate Work as Done (WAD) versus Work as Imagined (WAI). One request during the implementation was to develop language to discourage users from entering a lab value when they were supposed to click on the value uploaded from a device. After user interviews and pluralistic usability walkthroughs with interface mock-ups, we learned that the value was almost never present for the users to select because it took 15–20 minutes for the device to connect and transmit the value to the interface. By sharing these findings, including graphical depictions of the WAD and WAI workflows, we were able to help management understand the workers' actions and determine that a technology or policy solution was warranted.

In some cases, we have found areas where the needs of the users are not being met by the current system design, in which case we seek ways to support local practices and guide adaptations. One such project was configuration of a lab interface to support information flow for the end user. Semi-structured interviews and contextual analysis of related lab software and user-developed documentation helped us explore the users' needs. A risk assessment identified potential failure modes and outcomes. We then proposed a design following usability guidelines and refined it based on user input and operational limitations.

Misalignment between user needs and system capabilities sometimes have suggested the need for significant workflow changes, in which case we might be called upon to generate future operational scenarios and analyze associated risks. For a medication administration task, we have mapped the current approved workflow (WAI) as well as two alternate workflows. We will soon conduct usability testing of these workflows using simulation. The output of the risk assessment and usability analysis should support trade-off analyses and help the organization improve the workflow for this task.

DISCUSSION

Conducting human factors work in a healthcare organization, where safety is always a top consideration, lends a unique perspective on the value of the discipline. We can see how different human factors methods may help to build organizational capacities for safety in the forms of anticipation, readiness to respond, synchronization, and proactive learning (Provan, 2020), which should help the system to succeed under varying conditions.

While different views of safety are sometimes presented as distinct, it seems likely that most organizations today are finding some balance between methods and concepts from Safety-I, Safety-II, Safety-III, and beyond. Human factors work can occur at the intersection of the aims of these various approaches and be able to assist in optimizing this balance. Trade studies to select among alternatives or resolve conflicting requirements are a classic component of human factors work (e.g., Chapanis, 1996). Often, we are considering the trade-offs between different dimensions of usability such as success rates versus speed, but an extension of trade studies might help us identify the most useful combination of considering what can go wrong (Safety-I), what we need for things to go right (Safety-II), and what levels of risk we will accept (Safety-III).

As always, there are limitations with the ideas discussed here. This remains largely conceptual, and there is not yet a strong empiric foundation to these arguments. It is also difficult to communicate the idea of decentralizing safety efforts to support resilience, possibly because centralized safety methods may be more familiar and seemingly concrete. In fact, it is difficult to measure if these ideas will work, what unintended consequences they might bring, and what opportunities may be lost by going in this direction rather than any of the myriad others open to us. Of course, we also cannot know the unintended consequences and lost opportunities associated with staying where we are.

Future work to explore how best to deploy human factors methods to support safety may need to first focus on education about these ideas and creating a community that will understand their importance. Introducing well-defined human factors methods such as heuristic evaluation and task analysis and encouraging exploration of this space may contribute to the growth of this community, as people often learn best by doing and by teaching others. Building knowledge through training and experience increases readiness and should contribute to more resilient systems. From this base, we can consider how best to cocreate with the community infrastructure to maintain a systems safety mindset, possibly by embedding usability tools and expertise within work systems.

CONCLUSION

A solid portfolio of human factors methods thoughtfully employed in analysis, design, development, test, and evaluation may support increased resilience of a system. These methods support and complement each other and should be executed as appropriate at different points within the lifecycle of a project to maximize human and system performance and resilience.

Perhaps one of the most important findings that can come from utilizing human factors methods is sufficient understanding of a system for us to thoughtfully consider what we should be involved in and what should be left to develop on its own. The language of resilience engineering may help us to recognize and describe systems that are already displaying resilience so we can better see how to support their functions, avoid interfering with their success, and apply those lessons learned in the future.

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