BMJ Quality & Safety Online First, published on 21 June 2013 as 10.1136/bmjqs-2012-001450

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The science of human factors: separating fact from fiction

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▸ Additional material is published online only. To view please visit the journal online (http://dx.doi.org/10.1136/bmjqs-2012-001450).

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*This article is in recognition of Dr Ben-Tzion Karsh and includes a tribute in the acknowledgements.

Received 15 August 2012
Revised 11 January 2013
Accepted 14 February 2013

Linked

▸ http://dx.doi.org/10.1136/bmjqs-2012-002036

To cite: Russ AL, Fairbanks RJ, Karsh B-T, *et al*. *Quality and Safety in Health Care* Published Online First: [*please include* Day Month Year] doi:10.1136/bmjqs-2012-001450

ABSTRACT

Background Interest in human factors has increased across healthcare communities and institutions as the value of human centred design in healthcare becomes increasingly clear. However, as human factors is becoming more prominent, there is growing evidence of confusion about human factors science, both anecdotally and in scientific literature. Some of the misconceptions about human factors may inadvertently create missed opportunities for healthcare improvement.

Methods The objective of this article is to describe the scientific discipline of human factors and provide common ground for partnerships between healthcare and human factors communities.

Results The primary goal of human factors science is to promote efficiency, safety and effectiveness by improving the design of technologies, processes and work systems. As described in this article, human factors also provides insight on when training is likely (or unlikely) to be effective for improving patient safety. Finally, we outline human factors specialty areas that may be particularly relevant for improving healthcare delivery and provide examples to demonstrate their value.

Conclusions The human factors concepts presented in this article may foster interdisciplinary collaborations to yield new, sustainable solutions for healthcare quality and patient safety.

INTRODUCTION

> "Human error in medicine, and the adverse events that may follow, are problems of psychology and engineering, not of medicine.[1]"

Medicine is devoted to human health and healing, but the science behind why errors occur, and how to reduce the likelihood of preventable harm to individuals, are well described in human factors literature. Human factors—a science at the intersection of psychology and engineering—is dedicated to designing all aspects of a work system to support human performance and safety. Human factors, also known as ergonomics, uses scientific methods to improve system performance and prevent accidental harm.[2] The goals of human factors in healthcare are twofold: (1) support the cognitive and physical work of healthcare professionals[3] and (2) promote high quality, safe care for patients.[4]

Human factors knowledge has been suggested as a promising mechanism with which to improve healthcare delivery,[5–7] yet this body of knowledge remains largely untapped. The reasons for this are not fully known. Gurses *et al*[8] posit that safety efforts have been sluggish due to the inadequate integration of human factors principles and methods into healthcare. Their article provides valuable recommendations to accelerate the uptake of human factors. In addition, we believe that common misconceptions about human factors may slow the integration of human factors into healthcare and hinder healthcare improvement. The term 'human factors' itself can be misleading and may result in fundamental misunderstandings. It appears that several misconceptions about human factors science are beginning to take root in peer-reviewed medical literature.[9–16] For example, some papers refer to 'human factors', yet point to the 'failures' of people as the underlying cause of adverse events or broken healthcare delivery processes,[17–19] a stance that is contrary to human factors science and counterproductive for advancing patient safety.[20 21]

Other literature describe the application of human factors for specific applications or select healthcare audiences.[22 23] The goal of this paper is to provide a general introduction to human factors, directed at a broad audience, by presenting five fundamental human factors concepts.

SEPARATING FACT FROM FICTION

Fact #1: *Human factors is about designing systems that are resilient to unanticipated events*.

Fiction: *Human factors is about eliminating human error*.

In early childhood, most of us learnt that 'everyone makes mistakes'. Errors are inevitable, and attempting to eliminate human imperfections in healthcare or any other industry is a futile goal.[24] Therefore, human factors experts gather data about *human characteristics and human interactions with the work environment* to design systems and tools that support physical and cognitive abilities of humans and are resilient to unanticipated events.[4] This includes gathering data on:

- *Human physical characteristics*, for example, anthropometric measurements on the patient population to redesign hospital beds and reduce the risk of patient entrapment[25]
- *Human cognitive characteristics*, for example, a cognitive task analysis with intensive care unit staff to inform the design of decision support for ventilator settings and reduce the risk of errors[26] and
- *Human interactions with the overall work system*, for example, how procedural policies, work hour restrictions and patient load can be coordinated to mitigate errors during transfers of care.[3] The study of the overall work system is formally known as macroergonomics.[27] Cognitive engineering is another well-known framework for studying and designing complex systems.[28 29]

Human factors is a term that could easily be misunderstood to refer to the failures of people. This position, sometimes expressed in terms of 'the human factor' or 'caused by human factors', is in opposition to human factors science, which attempts to design systems that support human performance and are resilient to unanticipated events.[2] A human factors approach can also foster a culture of safety, promote a learning environment, and encourage the development of a culture where unintentional errors are reported without fear of retaliation and findings are used to improve various system components to yield sustainable change.[30]

Fact #2: *Human factors addresses problems by modifying the design of the system to better aid people*.

Fiction: *Human factors addresses problems by teaching people to modify their behaviour*.

Work systems often create challenges for people. Human factors aims to identify what aspects of work are challenging or made the 'wrong action' seem reasonable in context, and modify these aspects of system design to aid people in the workplace and promote safety.[3] This most frequently involves changing technologies, processes, tools and other inanimate work system components.

While it is critical that healthcare professionals and staff have the education and training necessarily to perform their role, training itself is generally a weak safety intervention.[2] Table 1 outlines when training is likely to be effective or ineffective for improving patient safety, and can serve as a guide to patient safety professionals. In general, human factors approaches strive to avoid using training to compensate for poor system design; rather the focus is on redesigning systems, tools and techniques to yield sustainable improvements in safety.[38] Emphasis is placed on first evaluating organisational components, prior to implementing any training programmes, to ensure that the system design supports safety.[39] However,

Table 1 Overview of when training may or may not be appropriate as a human factors approach to improve patient safety

Training is likely an *appropriate* human factors approach to patient safety if…	**Training is likely an *inappropriate* human factors approach to patient safety if…**
A. The goal is for individuals to become *familiar* with *new* technologies, tools or devices to learn about the available options and functions (eg, training a physician when s/he is *first* introduced to an electronic health record; training when first learning how to use laparoscopic tools). Training should include knowledge about strengths and limitations of specific technologies.[31]	A. The goal is for individuals to stop using technologies, tools or devices 'in the wrong way'. (This is described as the 'bad apple' fallacy.[35 36])
B. It allows individuals to *develop and test* new techniques or *practice* evidence-based techniques in a safe, low risk environment (eg, simulation of operating room to practice a team communication technique that has been demonstrated to improve situational awareness.[32])	B. It is an attempt to change innate human characteristics or imperfections (eg, staff meeting to 'be more vigilant' unlikely to lead to sustainable safety improvements.[2])
C. It provides a mechanism for individuals to *gain experience* with specialised techniques that involve sensorimotor skills (eg, performing surgeries and catheter insertions with supervision or in a simulated environment).	C. It is intended to address a type of error that is occurring across multiple people. (This indicates the system design does not match human characteristics[37] and that system changes, not training, are needed.)
D. It is used to instantiate knowledge in realistic scenarios,[33 34] such as to *practice or test* procedures for emergency situations (eg, rapid response).	D. Individuals have been previously trained about the safety issue(s) and the problem persists. (Additional training is unlikely to be effective. The phenomenon above indicates there is an issue with other system components.[20])
E. Other system components are considered *first*, redesigned, and addressed using human factors expertise and principles and no other system changes can possibly be made.	E. Training is the only safety intervention or the primary intervention used, especially when other system components have *not* been carefully considered and modified first.

human factors can also provide valuable input on training, particularly in the context of improving team processes and interactions. In these instances, sophisticated training programmes are often developed, and tend to include goals such as increasing awareness about human characteristics (eg, the potential impact of and strategies for avoiding fatigue, stressors, and cognitive overload); practicing sensorimotor skills or new techniques through experiential simulations; and providing trainees with a broad range of experience in a simulated environment to enhance the system's resilience to unanticipated events.[32 40 41]

Understandably, 'human factors' can sometimes be mistakenly *equated* with 'training' or 'non-technical skills' and confused with strategies that are intended to change human behaviour. For example, a recent slide set by The Joint Commission lists 'human factors' as one of the root causes of sentinel event data, and portrays it as a set of issues typically associated with human resource management such as '… in-service education, competency assessment, staff supervision, resident supervision, medical staff credentialing/privileging…', and other descriptors that are not aligned with human factors science.[42] When a review of a patient safety event leads to a determination that the cause is 'human error', it is not uncommon for healthcare organisations to try and modify the behaviour of the individual or group through counsel or retraining, an approach which has been referred to as the 'bad apple' fallacy.[35 36] Rather than correcting human behavior, human factors approaches focus on improving system design.[3 43] With this approach, deeper investigation into 'human error' often uncovers opportunities to improve technology design, organisational structures or procedures.[24]

Fact #3: *Human factors work ranges from the individual to the organisational level.*

Fiction: *Human factors is focused only on individuals.*

Individual-level human factors research in healthcare has included the redesign of electronic health records, computerised provider order entry systems, bar code medication administration systems, workstations and laparoscopic tools to support healthcare professionals.[4 44] However, human factors work is not limited to the individual level, but ranges from individual to organisational levels, and thus can bring other potential contributions to healthcare. Human factors approaches can examine how the performance and safety of individuals and teams are impacted by organisational design, policies and procedures. For example, this may include:

- Developing techniques to facilitate closed-loop communication and situation awareness across teams.[2 32]
- Understanding how organisational decisions for equipment purchases impact the performance of clinicians that use the equipment. For example, a hospital may purchase infusion pumps based on the needs of anaesthesiologists in the operating room, and then distribute them for use throughout the hospital. The pumps were designed to be at eye level for a sitting user, but in the emergency department, they are mounted on bedrails at the user's waist level. The change in viewing position leads to 'erroneous' key pressing, and a 100-fold overdose of a vasoactive medication.[45]
- Evaluating how organisational or national level policies can filter down to affect clinician workload and patient safety. For example, to accelerate patient care timelines, a national VA directive mandates that specialists address electronic consult requests from primary care providers within 7 days. To meet the mandated timeline and avoid penalisation, specialists often deny consults that lack key information, restarting the clock on the performance tracking system. To proceed with the consult, the requesting provider must re-enter all of the information again. Thus, the policy, in combination with other aspects of the system design, increases clinician workload, and can potentially impact patient safety by delaying patient diagnosis and treatment (eg, colonoscopy/colon cancer).[46]

Efforts focused on designing systems to support individuals in their work environment are important and necessary. However, much work is also needed to ensure that broader organisational components are effectively designed and coordinated to achieve the desired outcomes.

Fact #4: *Human factors is a scientific discipline that requires years of training; most human factors professionals hold relevant graduate degrees.*

Fiction: *Human factors consists of a limited set of principles that can be learnt during brief training.*

Many core human factors methods involve qualitative techniques, such as interviews and observations, which appear to be simple and easy. Similarly, the best, most elegant human factors solutions to problems often seem simple in hindsight: *after* a problem has been reframed in a novel and constructive way. This apparent simplicity belies the expertise required to understand a work domain, its goals and constraints. Human factors expertise cannot be rapidly acquired by means of a brief workshop or seminar, and attempting to apply human factors techniques without proper training and experience is likely to be ineffective[35] or lead to incomplete or misleading analyses and interventions. In some cases, human factors concepts and methods have been misrepresented in the literature. For example, a recent article conducted a closed-ended survey of healthcare professionals, along with a retrospective chart review, in an effort to identify systems factors that contribute to errors in emergency departments.[47] Although the article claims to be in accordance with human factors principles, the methodologies overlook many key system factors that would typically be included in a human factors analysis, such as how the design of technologies and contextual interactions in the system contribute to adverse events.[48] The article discussion implies that more nurses are needed to intercept errors. This conclusion places the burden on people to prevent harm, rather than redesigning system components to promote safer care.

Through the week-long course, Systems Engineering Initiative for Patient Safety, offered by faculty at the University of Wisconsin-Madison, over 300 physicians, nurses, pharmacists and vendor staff have received training on human factors principles for patient safety and health information technology.[49] This type of intensive training enables health professionals and human factors experts to work together in an advanced and substantive manner. Healthcare professionals can help human factors experts understand what is (and is not) clinically meaningful, while human factors experts can bring new theories and methods to the work of improvement. Ideally, partnerships are formed during the early stages of project development to promote success. Improving the safety and effectiveness of care by means of human factors methods will require the development of substantive, long-term partnerships between human factors and healthcare communities.

Fact #5: *Human factors professionals are bound together by the common goal of improving design for human use, but represent different specialty areas and methodological skills sets*.

Fiction: *Human factors scientists and engineers all have the same expertise*.

Similar to the field of medicine, human factors professionals receive general human factors training, but often specialise in a particular human factors domain. Human factors draws upon knowledge of engineering and psychology; thus, fundamental human factors training is most commonly offered by industrial and systems engineering or psychology departments. The majority of individuals with human factors expertise receive training at the graduate level, although some exceptions include a few undergraduate programmes and postdoctoral fellowship training programmes. A human factors specialisation is most commonly acquired through a variety of coursework and pursuit

Table 2 Some of the human factors focus areas that are applicable to healthcare

Specialisation	Description	Example for healthcare
Ageing	Human factors applications to meet the needs, capabilities, and limitations of the elderly and other special populations	Applying human factors principles to reduce inpatient falls[50]
Augmented cognition	"Development and application of real-time physiological and neurophysiological sensing technologies that can ascertain a human's cognitive state while interacting with computing-based systems"	Designing tools that can transmit feedback to the surgeon to improve laparoscopic grasp control[44]
Cognitive engineering and decision making	"Research on human cognition and decision making and the application of this knowledge to the design of systems and training programmes"	Identifying cues and strategies experienced nurses use to recognise infants at risk for sepsis and necrotising enterocolitis to guide the design of training and decision support[51 52]
Communication	Human-to-human communication, especially when mediated by technology	Comparing the information accuracy of manual versus electronic patient status boards in emergency departments[53]
Human performance modelling	"Development and application of predictive, reliable and executable quantitative models of human performance"	Model-based simulations to investigate how and why age and localised muscle fatigue affect postural control and fall risks[54]
Industrial ergonomics	"Application of ergonomics data and principles for improving safety, productivity and quality of work in industry"	The design of a workstation for radiologists using appropriate ergonomic and biomechanics data
Macroergonomics	"Organisational design and management issues in human factors and ergonomics as well as work system design and human–organisation interface technology"	Evaluating system components at various organisational levels (eg, drug route; nurse to patient ratios; medication administration policies) and modifying them in a coordinated manner to aid safe medication administration during shift change[27]
Perception and performance	"Perception and its relation to human performance"	Designing and evaluating visual, audio and combined displays for anasthesiologists[55]
Product design	"Developing consumer products that are useful, usable, safe and desirable"	Redesigning epinephrine autoinjectors for patients in an effort to reduce injection errors during anaphylaxis[56]
Safety	"Development and application of human factors technology as it relates to safety"	Integrating human factors principles into the design of a kit for central line insertion to reduce cognitive burden for healthcare workers, promote best practices and prevent infections[57]
Training	"Training system design and evaluation, innovative technologies for training, and instructional design and implementation"	Developing evidence-based practices for debriefing medical teams, as a mechanism for training and the development of a learning environment[58]
Usability	Measurement of the quality of a user's experience when interacting with a product or system[59]	Comparative, usability evaluation with clinicians to assess two different designs for computerised clinical reminders[46]

Unless otherwise noted, descriptions, including those in quotations, are derived from the Human Factors and Ergonomics Society Technical Groups.[60]

of a master's thesis or doctoral dissertation. Each university tends to emphasise particular areas of the discipline, based on the strengths of the human factors faculty at that institution. This results in human factors professionals who possess different specialised knowledge and methodological skill sets.

Table 2 outlines some of the specialised focus areas within human factors that may be useful in collaborations aimed at healthcare safety and improvement. While some larger healthcare organisations may find it feasible and beneficial to develop a human factors office or department, we recognise that this is not practical for many hospitals. Gurses *et al* provide several recommendations to build human factors capacity in healthcare.[8] In addition, healthcare stakeholders may find it helpful to target human factors specialty areas that are most aligned with their organisational goals when recruiting for a position or developing collaborations.

For instance: hospitals that want to improve overall quality of patient care may seek expertise in macroergonomics; hospitals with a dearth of safety expertise could consider human factors professionals with expertise in safety; and commercial vendors of devices and technologies may benefit from expertise in product design and/or usability. The specialisations in table 2 are not as distinct and differentiated as those found in the practice of medicine, and there are cases where one individual may have expertise in two or three areas. While all human factors scientists strive to improve work systems for human performance and safety, human factors professionals acquire different skill sets that they can bring to healthcare improvement.

SUMMARY

Human factors is an established body of science that is positioned to assist with the challenge of improving healthcare delivery and safety for patients. Human factors and healthcare professionals can work together to identify problems and solutions that may not be apparent by traditional means. While human factors does not promise instant solutions for healthcare improvement, it can provide a wealth of scientific resources for sustainable progress.[61–63] Here, we have attempted to clarify the goals of human factors and pave the way for interdisciplinary collaborations that may yield new, sustainable solutions for healthcare quality and patient safety.

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Acknowledgements **In Memoriam*: We wish to dedicate this article to Ben-Tzion 'Bentzi' Karsh, PhD (1971–2012), a human factors engineer who was internationally known for his macroergonomics work on healthcare and patient safety. Dr Karsh contributed to the conception and drafting of the initial manuscript for this article. He was a mentor, colleague and friend who will be greatly missed.

Contributors All authors contributed to the conception of the paper. AR coordinated the writing, led revisions, and drafted tables 1 and 2. Each author drafted a section of the original manuscript and provided critiques of the intellectual content to produce the final version of the paper.

Funding This work was supported in part by the VA HSR&D Center of Excellence on Implementing Evidence-Based Practice, Center grant #HFP 04-148, VA HSR&D PPO# 09-298 and AHRQ grant R18 HS017902. Dr Fairbanks is supported by a NIH Career Development Award from the National Institute of Biomedical Imaging and Bioengineering (K08-EB009090). Dr Saleem is supported by a VA HSR&D Research Career Development Award (CDA 09-024-1).

Competing interests None.

Disclaimer The views expressed in this article are those of the authors and do not necessarily reflect the position or policy of the Department of Veterans Affairs or the USA government.

Provenance and peer review Not commissioned; internally peer reviewed.

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Human Factors Education for Healthcare Audiences: Ideas for the Way Forward

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Within the last decade, there has been a growing emphasis on applying human factors principles in the healthcare domain, and although human factors is a well-established scientific discipline, it is still a relatively new concept for the healthcare community. Educating healthcare audiences on the goals, history, and contributions of the human factors discipline may dispel misconceptions; preserve the integrity of this scientific discipline; inform healthcare stakeholders about the value of human factors research; and increase the uptake of human factors principles in the healthcare domain. Panel members will share their views on human factors education for healthcare audiences, including their past experiences, personal successes, and insights on the challenges that remain. Panelists will also engage the audience in an open discussion to generate novel ideas on how to advance the healthcare community's understanding of the human factors discipline.

INTRODUCTION

The human factors discipline is receiving increased attention in the healthcare community, and many medical training programs are in the process of designing patient safety curricula, representing a unique opportunity for the HFES community. This timely panel session will foster discussion on human factors education in healthcare and how the human factors discipline can effectively engage healthcare audiences and stakeholders. This panel includes a diverse set of professionals representing both traditional human factors and clinical backgrounds; panelists also represent healthcare institutions as well as academic, government, and consulting groups. In this session, panelists will engage the audience in an open discussion and seek to generate novel ideas for human factors education in healthcare, such as the potential role of HFES in healthcare education.

PANELIST STATEMENTS

Healthcare and Human Factors: Intersections versus Collaborations

Militello, Applied Decision Science. Laura Militello has applied Naturalistic Decision Making models and methods across a range of domains including healthcare over the past 20 years. She has conducted workshops on cognitive task analysis, and cognitive systems engineering for both students and professionals.

Statement. Healthcare and human factors have intersected in interesting ways for several decades. For example, nurse researcher Patricia Benner generated a model of expertise (Benner, 1984) that has influenced human factors studies of expertise and decision making for over 25 years. Device manufacturers and software developers have hired human factors consultants to explore issues of usability and user interface design ((Baeck & Militello, Spring 2003); (Lopez, Militello, Arbuckle, & Wolf, 2011). More recently, the healthcare community has turned to human factors to explore strategies for improving patient safety (Gosbee, 2002; Lin, Vicente, & Doyle, 2001). Many of these "intersections" turn out to be a just-in-time exchange of knowledge in the context of a specific problem.

Although positive outcomes have resulted on both sides of these interactions, deeper and continuous collaboration is needed between the healthcare and human factors communities to address the complex challenges ahead as increasing levels of automation and decision support are introduced throughout the healthcare system. Workshops designed by human factors professionals for a healthcare audience should go beyond these simple intersections. Presenting a specific procedure, technique, or toolbox without a larger perspective and context may encourage organizations to send an individual who will return from the workshop and serve as the resident human factors expert. Effective workshops should focus on communicating a larger perspective, providing theory and context behind the methods, thereby setting the stage for continued collaboration between healthcare and human factors professionals. Promising directions include:

- Presence of full-time human factors professionals in the healthcare setting, such as within the Veteran's Health Administration.
- Workshops that include human factors principles instantiated in real-world examples.
- Workshops with exercises that illustrate the need to acquire practice and experience before applying human factors methods and principles for real-world problems.

As human factors professionals, we have to move beyond "how to" in our workshops, and include a broader perspective to foster continued collaboration.

Curtailing the Propagation of Human Factors Misinformation

Saleem, Roudebush VA Medical Center. Dr. Saleem has spent the majority of his career with the Veterans Health Administration (VHA) and has seen the number of human factors professionals based in the VHA steadily grow over the last 8 years.

Statement. The demand and interest for human factors knowledge within the VHA has grown at a faster rate than the number of VHA human factors professionals and available human factors resources. Because of this imbalance, improperly trained individuals sometimes attempt to apply newfound human factors knowledge to redesign healthcare processes and tools without fully understanding human factors and its associated methods.

The literature demonstrates the propagation of misinformation about the science of human factors itself. For example, a recent article in the *Archives of Surgery* describes a "human factors curriculum" for surgical students (Cahan et al., 2010). Remarkably, the human factors curriculum reported in the article had little resemblance to the science of human factors. Rather, the authors were referring to humanistic qualities like empathy, caring, and work/life balance.(J. J. Saleem, Patterson, Russ, & Wears, 2011) This type of misuse of the term "human factors" threatens the integrity of our field. Likewise, a national VHA survey illustrates the lack of understanding of human factors: Chiefs of Staff at 34 of 111 (31%) VHA Medical Centers reported conducting some type of formal human factors or usability evaluation on computerized clinical reminders and templates during their development (Yano et al., May 2007), yet the number of human factors professionals with the ability to conduct such a formal evaluation within the VHA during the time of the survey was only about half a dozen.

Human factors professionals acquire their skills after years of training and practice; these skills are not easily imparted outside of a formal program of study. Human factors principles, such as usability design heuristics and guidelines of use of color and fonts for visual design, can successfully be passed onto others through short training sessions. However, a majority of human factors methods, such as cognitive task analysis, formal usability testing, summative and formative evaluation techniques, and many ergonomic assessment tools cannot be learned with a short presentation and outside of a formal program of study. Therefore, human factors education in healthcare should address skills that can be effectively imparted through short training programs, while skills that require formal training should be reserved for the human factors professional. For example, one study revealed that while simple ergonomic principles can be easily taught to non-experts in the redesign of their own jobs, ergonomic tools, such as the National Institute of Occupational Safety and Health (NIOSH) lifting equation, cannot be effectively taught to front-line workers (J.J. Saleem, Kleiner, & Nussbaum, 2003). Without this type of distinction, we run the risk that healthcare audiences may apply human factors with insufficient training, resulting in poor design outcomes. In cases where there is a lack of human factors professionals on staff, an organization should consider external resources such as hiring human factors consultants and/or sending employees to formal human factors training programs.

A Little Knowledge is a Dangerous Thing

Wears, University of Florida. Dr. Wears is an active physician who has taken human factors seriously for 17 years. He is currently hoping to be received into the elect by completing his PhD in Industrial Safety at École des Mines de Paris.

Statement. It is generally accepted that the field of human factors and ergonomics could contribute substantively to improving quality, safety and efficiency in healthcare. But the development of true collaboration between these two disciplines has been slow, and we should not be surprised that there are occasional misconceptions and even misdirections. This section of the panel outlines opportunities and challenges from the point of view of healthcare domain professionals.

Opportunities for very simple improvements abound. Healthcare devices and workplaces are full of design problems that have long been identified and remedied in other settings, and when failures inevitably occur, health professionals tend to personalize them, interpreting the failures as the operator's fault because they are unable to see the design and usability issues (Norman, 1988). Thus, even raising consciousness regarding human-device issues frequently engages practitioners and makes them want to learn more.

However, there are several difficult challenges to this educational process. First, healthcare professionals are smart, highly motivated, and achievement oriented, and one of the hardest things to do is to teach smart people how to learn (Argyris, 1991). Roger Kneebone (himself a practitioner who invested in formal training at the PhD level) has called this the "magpie syndrome," noting that often health professionals grasp a few ideas quickly, assume they have comprehended the entirety of the field, and rush off to do their own thing without ever developing a deep understanding or recognizing their need for guidance (Kneebone, 2006). We have seen medical publications treat human factors as if it were "humane factors", solely concerned with the affective aspects of work (Cahan et al., 2010), or attempt to assess issues such as cognitive demand in ways that are irrelevant and show no awareness of the body of work in such areas (Chisholm, Weaver, Whenmouth, & Giles, 2011). So, a little knowledge can be a dangerous thing.

In addition, although healthcare, and medicine in particular, has its intellectual origins in the interpretive tradition, the voices that are privileged in healthcare discourses about science are largely positivist. Because human factors as a field often draws on interpretivist views of science (Lipshitz, 2010), many healthcare professionals may view it as unscientific and treat it dismissively. However, there is reason for optimism. Several healthcare professionals have recently completed PhDs in human factors or related fields (not as a career change, *i.e.*, leaving medicine, but as a career enhancement). At least two others are in PhD programs and several are working on a Masters Degree. In addition, a number of human factors professionals now hold full time, 'hard money' positions in healthcare organizations, where they can help the educational effort in both formal and informal ways. Thus, the way forward should be guided by three principles:

1. Continue to do general education to increase the appreciation of what human factors can bring to the table.
2. Expand venues for health professionals who seriously want to become competent in human factors, for example through training programs for students in full-time employment.
3. Gently but firmly critique and guide those magpies who have picked up the shiny object (human factors) and flown off with it, so they can be led from a little knowledge to a greater understanding.

Where do we Start: It may not be where you think.

Fairbanks, National Center for Human Factors Engineering in Healthcare. Dr. Fairbanks is a practicing physician and safety science researcher with a masters degree in human factors engineering, who finds it fascinating to use today's heath IT systems.

Statement. An outsider's analysis of the interface design of medical devices and health information technology (IT) systems is likely to lead to the conclusion that there is a need to educate manufacturers about the value of human factors engineering. But is this where we need to focus our efforts? Human factors as a concept is often misunderstood by both front-line healthcare providers and organizational leaders, including quality and safety leaders and risk management leaders. For example, many believe it is synonymous with 'teamwork and communication,' or that 'human factors' should be named as a root cause after an adverse event because the nurse or physician "committed a medical error." In fact, some commercially available adverse event and near miss reporting systems include the category "human factors" as a selection under the "root cause" or "contributing cause" field, which perpetuates a misunderstanding that "the human factor" (as sometimes used in healthcare) means focusing on what individual to blame, completely missing the contribution that true human factors perspectives can have to a safety engineering approach.

Currently, few programs for healthcare providers focus solely on human factors engineering. Two notable exceptions are the Systems Engineering Initiative for Patient Safety (SEIPS) Short Course on Human Factors at the University of Wisconsin Madison's Center for Quality and Productivity Improvement, and Red Forrest Consulting's Human Factors and Medical Device Workshops. Many patient safety fellowship or certification programs also include workshops or lectures lead by human factors professionals.

It is inappropriate to expect that a healthcare leader, such as hospital manager or quality and safety specialist, will be able to apply specific human factors engineering methods of evaluation and design after taking a brief workshop or short course. However, the value of these courses is in developing sensitivity to the impact of poor (or good) human factors engineering design. This knowledge might lead a senior hospital leader to ask for usability analysis data from a prospective medical device vendor, or to seek a local usability consultant to conduct a comparison evaluation of two health IT systems under consideration for purchase.

There are several potential avenues to exert influence through education. Medical Schools, Residency training programs, and specialty organizations are currently in the process of designing a patient safety curriculum for their learner groups. This presents a unique opportunity for the HFES community to develop a 'human factors engineering module for patient safety curriculums', which these groups could adapt and integrate into their curriculums.

Two other important groups include the medical device industry and the health informatics industry. Graduate and undergraduate programs in biomedical engineering and biomedical informatics often lack human factors training. Organizations, such as the Association for the Advancement of Medical Instrumentation **(**AAMI) and Red Forrest Consulting, have become more active in educating the medical device industry, and recent regulatory changes in the Food and Drug Administration (FDA) are increasing the visibility of existing human factors engineering programs among device manufactures. There seems to be somewhat less awareness in the health informatics industry, though there is movement in the right direction. For example, a new theme in the call for papers for the 2011 meeting of the American Medical Informatics Association (AMIA) is called "Interactive Systems" and specifically asks for "contributions that highlight human-computer interaction (HCI) research, compelling designs, or innovative interactive technologies, including those that improve our understanding of the social and human elements of health technologies."

However, from the outside looking in at health IT vendors, it often appears that the true value of human factors is missed. For example, take a recent recruiting notice from a large national health informatics vendor appearing on a Linked-In human factors group, which that states that as a member of the user interface design team "you will make it elegant, flashy, and fun. Take rough concepts and turn them into works of art. Contribute to visual standards that will have a company-wide influence on future software design."

Studies of these systems in the actual work environment often show that they lack functionality to support the work of the end user, often have antiquated interface designs that violate even the most basic user interface principles, miss opportunities to protect the user from error, and in many cases, actually facilitate use error (Fairbanks, 2008). However, incorporating human factors design is an expensive undertaking, and though many (if not most) device companies and health IT vendors are aware of the potential, and even have significant internal human factors expertise, the reality is that their customers (e.g., healthcare providers, hospitals, and other healthcare organizations) do not demand it. In fact, customers seem to be instead demanding increased customizability, which only results in increased complexity of the interface design (Johnson, 2006). Hospital biomedical engineering departments often diagnose device events as "user error," return the device to service, and close the case. Much of this could be avoided with an analysis of the work environment (such as what cognitive systems engineering can offer) to inform design, and an iterative process to inform the design of the user interface. But without a demand for better human factors design, why would manufacturers put the resources into such an expensive undertaking?

Though still small, there is a growing demand for human factors engineering expertise in healthcare. This is a great opportunity for our professional community to drive the education of healthcare stakeholders and decision makers about the value of human factors engineering. As more and more healthcare stakeholders recognize the value of human factors engineering, there will be increased opportunities for human factors professionals to become involved in the healthcare domain. To further this goal, human factors experts could consider contacting their local hospital's senior leadership and offer to consult, give a seminar or talk to key groups (such as adverse event review teams), or join healthcare teams as a guest reviewer.

Even though at face level it may appear our efforts would be best spent educating the medical device and health IT industry, it is more likely that they have the knowledge but often choose not to exercise it. Instead, the human factors engineering community would be best served by focusing our educational efforts on the customers of these industries, the healthcare providers and leaders. If we can create an incentive to manufacturers for good human factors design, the rest will fall into place.

Lessons from 8 Years of Training Healthcare Professionals

Karsh, University of Wisconsin. Over the last 8 years, Dr. Karsh has trained approximately 300 physicians, nurses, pharmacists, and vendor staff on human factors engineering for patient safety and health information technology design through the University of Wisconsin SEIPS summer short course. He has also delivered introductory lectures on human factors engineering for healthcare at national medical and pharmacy meetings and many grand rounds.

Statement: Keys to effectively educating healthcare audiences about human factors appear to be, first and foremost, having in-depth knowledge and first-hand experiences of the workings of healthcare delivery and challenges faced by clinicians, caregivers, and patients; second, teaching human factors principles through healthcare examples from the real world, and challenging misconceptions directly through audience participation experiences. Challenges encountered include misperceptions that human factors is common sense or is simply aesthetically appealing software, and beliefs that there is no evidence basis for human factors design principles. Successful education strategies will be shared as well as methods to overcome these challenges.

ACKNOWLEDGEMENTS

This work was supported in part by the VA Health Services Research and Development (HSR&D) Center of Excellence on Implementing Evidence-Based Practice (CIEBP), Center grant #HFP 04-148. Dr. Saleem was supported by a VA Career Development Award. Dr. Fairbanks was supported by a NIH Career Development Award (NIBIB-1K08EB009090). The views expressed in this paper are those of the authors and do not necessarily represent the views of the Department of Veterans Affairs.

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