CORE OPS

Creating Operating Room Efficiency to Optimize Patient Safety

DELIVERING OPTIMUM PATIENT CARE in today's complex healthcare system can be an enormously daunting task. Since the 1999 Institute of Medicine Report detailing the relationship between morbidity/mortality and medical error, the healthcare industry as a whole has come under increasing pressure to emphasize safety standards and reduce adverse patient outcomes. In response, the medical community is focusing their efforts on the development and application of rigorous scientific protocols to analyze deficiencies in healthcare delivery.

The challenge facing the healthcare industry today, however, is not simply the reduction in human error as has been espoused in other fields. After all, medical professionals are among the most highly trained and skilled individuals within the modern workforce. Rather, the challenge is how to optimize performance among notably high achievers in a field where sentinel events are arguably rare.

The good news is that ventures to improve patient safety and reduce potential hazards in healthcare have been ongoing for more than a decade. Nevertheless, the literature provides little guidance regarding best practices for hazard identification and related intervention recommendations. In an effort to enhance patient safety and increase efficiency in the operating room, the industry recently turned to the field of Human Factors (HF) for assistance.

It is well known in medicine that providing a prescription without diagnosis is malpractice. The same can be said about human factors and healthcare optimization. To offer up solutions without understanding the underlying disease state (i.e. where impediments to performance exist) makes no sense. Likewise, to base one's diagnosis on anecdotes and intuition rather than data is a prescription for the status quo at best and failure at worst. Having a better understanding of the human factors that produce hazards can ultimately help us develop systems to prevent it. Just like medical diagnosis, it is paramount to understand *why* hazardous events occur and *how* other events lined up to create the circumstances surrounding the hazard.

By utilizing qualitative and practical observational methods that focus on real-world experience and pressures - such as accidents, sentinel events, and "near miss" incidents - HF scientists can improve operational policies and technology design to make workplace systems more adaptive and resilient in the face of shifting demands.

Medical Human Factors Lab
Department of Human Factors

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Albert Boquet, PhD

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Kristen Welsh, BA, BS
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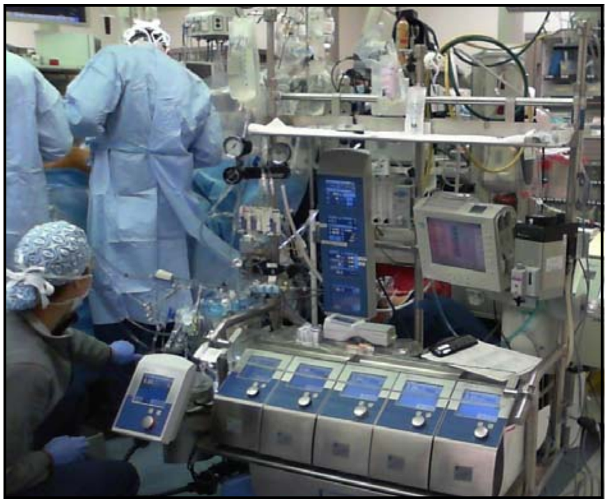
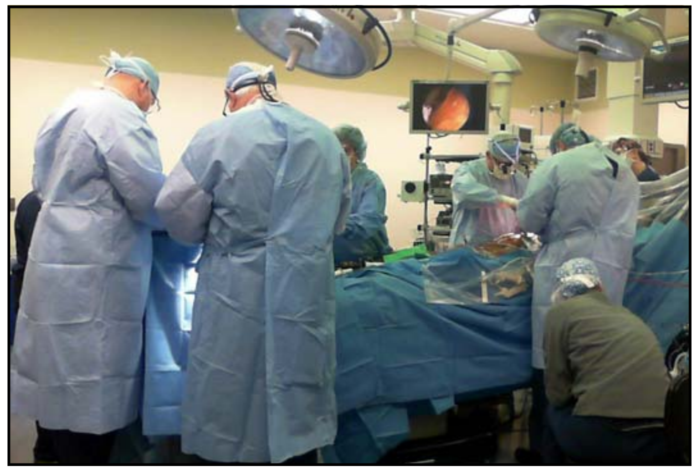
EMBRY-RIDDLE Aeronautical University



One of the most complex and characteristically demanding environments of clinical medicine is the cardiovascular operating room (CVOR). While there is a great deal of literature aimed at understanding hazards in the CVOR, little of this work has been singularly focused on flow disruptions and their correlation to human error. It stands to reason that any approach that will prove successful in this endeavor will address not just hazardous events in the CVOR, but also the preconditions (e.g. flow disruptions) that set the stage for the occurrence of such hazards.



There are few standardized tools for the measurement of flow disruptions and potential hazards in the CVOR and none have been developed for use by untrained professionals. A user-friendly self-assessment tool that allows cardiac teams to understand the nature and frequency of flow disruptions and/or potential hazards in the CVOR is vital to recognizing where performance is impacted and how management and healthcare providers can eliminate sticking points that disrupt the orderly and efficient flow of surgery.

We are currently working to develop an integrative “toolkit” that will equip cardiothoracic surgical teams and other healthcare professionals/ administrators with the necessary metrics to strategically identify and categorize flow disruptions and potential hazards impeding optimum performance in the cardiac operating room. This undertaking is nested within a greater initiative to optimize patient safety through the comprehensive assessment of hazards in the cardiovascular operating room and other complex environments in the hospital setting.

Our multidisciplinary approach includes multiple sites and a diverse team of scientists and clinical practitioners capable of diagnosing the relevant issues using validated human factors tools. Once identified, these hazards can be prevented and/or mitigated using data-driven interventions that are developed using established human factors principles.

One of the difficulties associated with addressing systemic hazards is the objective classification of the data required to identify those areas that may benefit from interventions. In an effort to circumvent inherent limitations associated with *post hoc* subjective data collection, Our research team has adopted two separate human factors frameworks that can be used to collect and analyze flow disruptions and potential hazards in the CVOR and others areas of the hospital in real time:

RIPCHORD

(Realizing Improved Patient Care through Human-centered Operating Room Design)

a framework for identifying and classifying flow disruptions in the operating room

HFACS

(Human Factors Analysis and Classification System)

a framework for identifying and classifying both latent and active causal and contributory factors of human error in complex systems

RIPCHORD is a taxonomy which classifies flow disruptions or events occurring during surgery and other complex events that impede the "flow" or progression of the medical procedure. Whether as seemingly trivial as tripping over a cord on the floor or spilling saline to much more disrupting events, such as not having the needed equipment for a heart valve replacement, these "flow disruptions" introduce unwanted distractions and open the door for inefficiencies and errors to occur.

Not only does the untimely nature of flow disruptions in the CVOR sabotage procedural efficiency, these interruptions potentially set the stage for hazards downstream. Serious hazards are often triggered by multiple preconditions that, in and of themselves, also pose a potential or real risk to the patient. Such latent failures predispose the system to error and may result in adverse events if numerous deficiencies are present within the various levels of a system.

RIPCHORD

Observational Taxonomy

Communication (Verbal and Non-verbal)
- Ineffective Communication
- Lack of Response
- Ambiguous Communication
- Confusion
- Simultaneous Communication
- Non-essential Communication
- Environmental Noise
- Lack of Sharing

Interruptions (Other)
- Phone Calls/Pages/Texts/Web
- Non-essential Personnel
- Spilling/Dropping Items
- Teaching Moments
- Outside Distractions
- Searching Activity
- Equipment/Supplies
- Wires/Tubing

Usability
- Data Entry (non-computer)
- Computer
- Equipment
- Surfaces
- Barriers
- Packaging

Coordination and Planning
- Personnel Rotation/Scheduling
- Personnel Not Available
- Common Information
- Protocol Failure
- Planning and Preparation

Environmental Hazards
- Slipping/Falling
- Sharps
- Crushing
- Fluids
- Contaminated Equipment

Layout
- Connector Positioning
- Equipment Positioning
- Furniture Positioning
- Permanent Structures Positioning
- Inadequate Use of Space
- Impeded Visibility

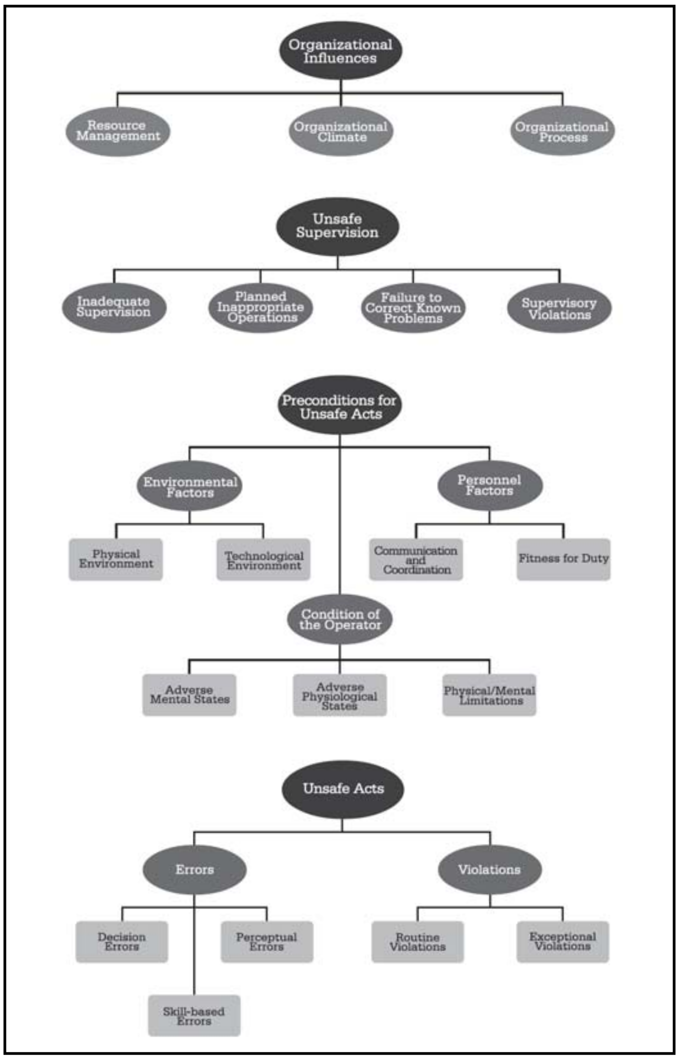
Equipment Issues
- Surgeons Equipment
- Anesthesia Equipment
- Perfusion Equipment
- General Equipment

HFACS is based on James Reasons' (1990) "Swiss Cheese" model of accident causation and provides a theoretical framework for dissecting the potential etiology of errors in complex systems. According to James Reason, accidents and adverse events occur when there are breakdowns in the interactions among components involved in a production process. These failures degrade the integrity of the system, making it more vulnerable to operational hazards, and thereby more susceptible to catastrophic failures.

Reason's approach to accident causation is based on the assumption that there are fundamental elements of all complex productive systems that must work together harmoniously if safe and efficient operations are to occur. This approach takes into consideration the cascading nature of human error, asking accident investigators to contemplate the role organizational factors play in the genesis and management of human error.

HFACS

Observational Taxonomy



Together, the frameworks provide a systematic means of going beyond a "root cause analysis" approach that oftentimes results in the collection of data that is equivocal in nature, making it difficult to establish causal links to the events under investigation. Interventions based on data-driven techniques such as RIPCHORD and HFACS provide for effective and verifiable mitigation of those events that pose the greatest stumbling blocks to optimized procedures.

FOCUS

FLAWLESS OPERATIVE CARDIOVASCULAR UNIFIED SYSTEMS

In 2008, the Society of Cardiovascular Anesthesiologists (SCA) Foundation launched the Flawless Operative Cardiovascular Unified Systems (FOCUS) project. FOCUS is a progressive national research effort to improve patient safety cardiac operating rooms. The goal of the FOCUS initiative is to substantially decrease the incidence and severity of human error in the cardiac operating room through scientific analysis leading to culture change. Central to this theme of cultural change is overall improvements in safety and quality.

The aviation industry has learned to manage crew resources for maximum effectiveness and error prevention through accident investigation, sentinel event review, and behavioral analysis. Likewise, FOCUS intends to achieve the same by conducting ethnographic research rooted in human factors principles to study the current processes, cultures, and systems at play in the CVOR. FOCUS is a complementary and cooperative effort designed to raise the bar for patient safety through human factors engineering. The near-term goal of FOCUS is to identify gaps in patient safety during cardiac surgery; in the long-term, the researchers and workgroups will use this knowledge to facilitate improvements in the quality of care delivered.

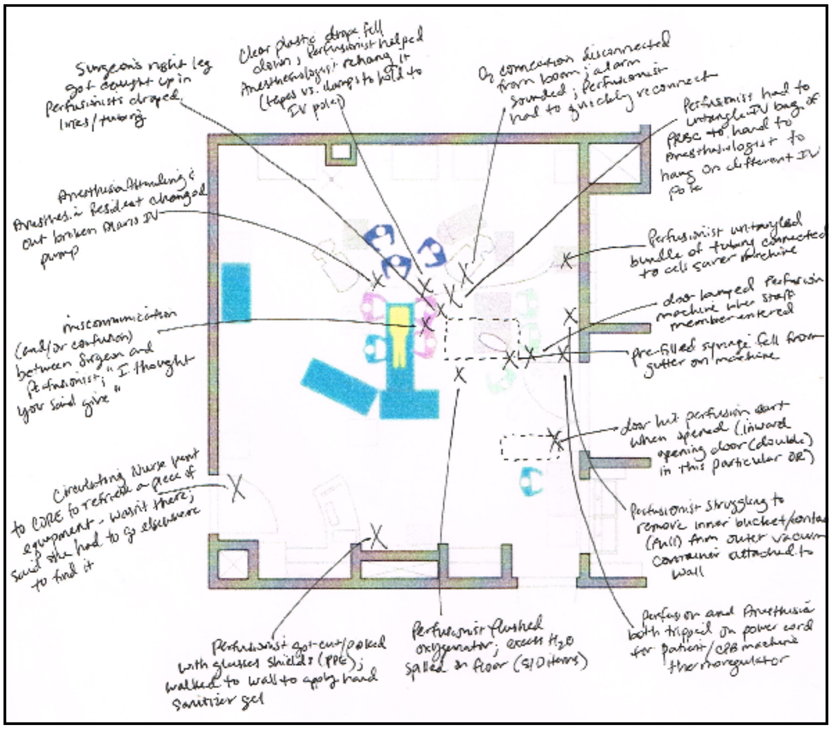
LENS

LOCATING ERRORS THROUGH NETWORKED SURVEILLANCE

Following the launch of the FOCUS initiative, the SCA Foundation contracted a research team from the Johns Hopkins University (JHU) Hospital's Quality and Safety Research Group (QSRG) to develop and test research methods to achieve the goal of creating harm-free cardiac surgery. Out of this collaboration came the LENS, or Locating Errors Through Networked Surveillance, project vision. The LENS study specifically sought to integrate the insight of diverse disciplines, including industrial psychology, organizational sociology, human factors engineering, and cardiovascular clinical care, in order to identify patient safety hazards in cardiac surgery. CORE OPS utilized RIPCHORD and HFACS to reanalyze the observational data collected during the LENS study, allowing FOCUS to formulate a clearly prioritized list of CVOR hazards.

While analysis of the data collected during the LENS study using RIPCHORD and HFACS provided insight into general areas of flow disruption and potential hazards in the CVOR, a greater level of resolution is necessary if improvements are to continue. Rather than use human factors principles to analyze global statements that characterize the overall status of the CVOR, the CORE OPS team is interested in studying flow disruptions and potential hazards threatening optimal performance of the cardiothoracic surgical team and ultimately patient outcomes.

Current research involves embedding individual team members in one of three clinical specialties (perfusion, anesthesia, circulating). During the procedure, the researchers “shadow” staff from each clinical specialty in an effort to focus their investigation on flow disruptions and potential hazards unique to that clinical specialty. Digital data is collected in real time using a customized software application installed on hand-held tablets (Microsoft SurfacePro’s).



The application, known as the Observation Precision Tool to Improve Communication and Safety (OPTICS) was specifically developed to capture demographics, RIPCHORD, and HFACS data. OPTICS enables the researcher to capture the description of the event, the type of disruption, the staff involved, and the duration of the event. Event location can also be saved by marking an architectural rendering of the surgical suite.

The application enables both real time and *post hoc* classification of flow disruptions and potential hazards using drop down menus tailored to each framework.

We currently have relationships established with:

- Society of Cardiovascular Anesthesiologists (SCA)
- Society of Cardiovascular Anesthesiologists Foundation (SCAF)
- Medical University of South Carolina (MUSC)
- Halifax Health Medical Center

FUTURE RESEARCH DIRECTIONS:

- Continued validation of RIPCHORD
- Continued application and refinement of HFACS for the healthcare industry
- Human factors in healthcare architecture
- Shiftwork and fatigue associated with healthcare providers
- Communication within the OR; including, haptics, proxemics, and non-verbal communication
- Expand scope of inquiry into other specialty areas including pediatrics, trauma, emergency room, and labor & delivery

SCOTT SHAPPELL

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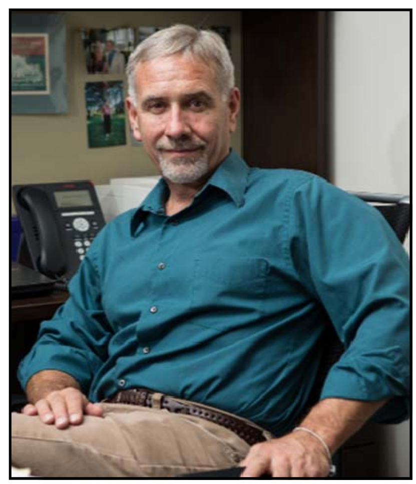
EDUCATION

Ph.D. in Neuroscience, University of Texas
B.S. in Psychology, Wright State University

> ***"Our job as professionals in the field of human factors is to make things safer, efficient, and more compatible with humans. In effect, we work at the cutting edge of human performance as we optimize the interface between humans and design."***

Dr. Shappell is a Professor and Chair of the Department of Human Factors. He arrived at ERAU in 2012 from Clemson University, where he was a professor of Industrial Engineering. Prior to his career in academia, Dr. Shappell was a Human Factors Research Branch Manager at the Civil Aerospace Medical Institute of the FAA. In addition, he was served nearly 20 years (11 on active duty) in the U.S. Navy as an Aerospace Experimental Psychologist. An internationally renowned consultant in human factors and systems safety, Dr. Shappell co-developed the Human Factors Analysis and Classification System (HFACS), a method for investigating and analyzing the role of human error in aviation accidents that has been adopted by aviation organizations worldwide. He was also the coauthor of the RIPCHORD taxonomy for examining flow disruptions in the CVOR.

BERT BOQUET



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EDUCATION

National Institute of Health Postdoctoral Fellow
Ph.D. in Experimental Psychology, University of Southern Mississippi
B.A. in Psychology, Nicholls State University

> ***"The real purpose of the scientific method is to make sure nature hasn't misled you into thinking you know something you actually don't know. - Robert Pirsig"***

Dr. Boquet is an Associate Professor of Human Factors. Prior to joining Embry-Riddle, he was a principal investigator for the Federal Aviation Administration (FAA), where he conducted research on the effects of stress/workload, shift work, and fatigue in both the air traffic and flight deck divisions. He was the lead investigator for the FAA, examining human error in all parts of civil aviation, including maintenance related aviation accidents, aircrew error in general rotorcraft, and helicopter emergency medical systems accidents, as well as general and commercial aviation accidents using Human Factors Analysis and Classification System (HFACS). He is an international consultant and is currently working with the SingHealth organization in Singapore and Bayer Material Sciences in Leverkusen, Germany. Dr. Boquet has also served Embry-Riddle in a variety of administrative roles, including Chair of the Human Factors Department and Assistant Vice President of Research for the Daytona Beach, FL and Prescott, AZ campuses. He is a certified HFACS instructor and also serves as a senior research fellow for Wiegmann, Shappell & Associates, where he trains organizations in the use and implementation of HFACS in safety management systems.

JENNIFER S. CABRERA

B.S. in Biology, College of William & Mary

Following her undergraduate studies, Jennifer accepted a Postbaccalaureate Intramural Research Training Award Fellowship at the National Institutes of Health, where she used classical electrophysiology techniques to investigate the functional properties of high-affinity channel antagonists in the development of novel antimalarial drugs. Her experience with specialized laboratory equipment enabled her smooth transition to working as an Architectural Programmer with LSY Architects & Laboratory Planners. There she enjoyed collaborating with senior architects and engineers on technically-challenging design projects that culminated in the construction of laboratory and clinical facilities in the government and academic sector. She is looking forward to combining human factors principles with her unique background in the biomedical sciences to optimize OR efficiency and make workplace systems more resilient in the face of shifting technological demands.

TARA N. COHEN

B.A. in Psychology, University of Southern California

Tara's interest in human factors is drawn from a background in psychology combined with her passion for aviation and interest in design. Throughout her private pilot training, she became interested in the complexity of systems, how they function, and how to better design them for the user. Because of her background, she has developed an interest in understanding how human behavior plays a role in complex environments, and what can be done to increase efficiency throughout various systems. "I see myself driving advancements that would forever change the medical industry – building my credibility to lead a team of innovators in academia, at a startup or an established business or institution."

OLIVIA D. CROWE

B.S. in Civil Engineering, Embry-Riddle Aeronautical University

Olivia, a native of Sebring, FL, brings a very unique combination of applied skills and real-world technical expertise to the Medical Human Factors team. With a degree in Civil Engineering and eleven years of experience flying rotary-wing aircraft, she offers the discipline a distinctive eye for system evaluation and design. Her previous research efforts have focused on the analysis of human factors in helicopter EMS accidents and general/commercial aviation runway incursions. Her current research with CORE OPS allows Olivia to work in a field that bridges the gap between her love for aviation and medical human factors, affording her the opportunity to optimize human performance by effecting a positive change in overall system design. Ultimately, Olivia would like to expand her research to include work in other specialties, particularly neurosurgery and pediatric cardiovascular surgery.

ERIN E. POHL

B.A. in Psychology, Flagler College

Erin’s initial interest in interior architecture combined with her undergraduate degree in psychology all came together when she took an intro human factors course at Flagler College in St. Augustine, Florida. Once becoming more familiar with the applied nature of human factors in high risk environments, she started to set her sights on the importance of human factors in the healthcare field. More specifically, Erin has her sights on the fascinating field of healthcare architecture. Growing up in Cincinnati, Ohio with her mother being a nurse, she understood the complex nature of the healthcare field very early on and imagines the kind of important impact she could make on the world with her graduate studies.

KRISTEN L. WELSH

B.S. in Mathematics, Pfeiffer University
B.A. in Aerospace Communications, Embry-Riddle Aeronautical University

Kristen's interest in communication stems from her early childhood experience of stuttering and speech therapy. "Communication is the one thing that every human can admit needing a little help in. No one can communicate perfectly. I can't, but I strive to do it better every day," she says. Growing up in North Carolina, her mother would take her to different health departments and hospitals, sharing stories of the emergency room. Kristen was fascinated by the medical field. After witnessing first-hand the frustration of coordination and planning in the medical field, Kristen endeavors to combine her interests of communication and medicine to improve patient care and safety while optimizing the efficiency of medical team communication.

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