SECURITY AND SAFETY SYNERGY—ADVANCING SECURITY WITH HUMAN FACTORS KNOWLEDGE

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Abstract: Security and safety share fundamentally important features as operational activities with the goal to protect people, property, and the smooth economical functioning of organizations and society. In safety-critical industries, safety is seen as the positive outcome of management of problems and trade-offs that are rooted in systems' complexity, goal interaction, and resource limitations. This perspective has led safety research to shift focus and go beyond individual acts and move to systematic aspects of human, technological, and organizational performance. It involves dealing with problems connected to regulations and standardized procedures, technology and automation, and efforts to understand the impact of communication, group dynamics, leadership, and culture on safety. In spite of distinct differences in the nature of threats (intentional/unintentional), there are many areas (use of standardized procedures, human factors training, and modeling for increased understanding of adverse events) where knowledge and experiences from safety operations can fruitfully spill over to security. To establish cooperation between these two fields, for example on regulatory and procedural development, training and simulation, as well as operational evaluation, would be to produce synergies not yet known today.

Keywords: Human Factors; externalities; organizational drift; Crew Resource Management; safety culture

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Security and safety are concepts that share important features; they both involve the risk of occurrence of events with consequences that may range from trivial to disastrous. Yet as concepts they are also different, with security relating to intentional acts by individuals and safety relating to events caused by unintended consequences of a combination of a host of factors. In safety-critical industries, such as aviation and maritime transport, chemical and nuclear industry, and health care, safety is seen as the positive outcome of management of problems and trade-offs that are rooted in systems' complexity, goal interaction, and resource limitations. This perspective has led safety research to shift focus and go beyond individual acts (such as "human error") and move to systematic aspects of human, technological, and organizational performance [1]. It involves dealing with problems connected to regulations and standardized procedures, technology and automation, and efforts to understand the impact of communication, group dynamics, leadership, and culture on safety. The advancement of security issues in a complex modern society should be able to benefit from the knowledge gained through safety industry operations in the field of Human Factors. This knowledge has the potential to make security more safe (for those who design and implement security measures as well as for those who are subjected to them) and effective (in terms of time and resources spent on security measures).

Organizations do not exist just to be secure or safe. They exist to produce or provide goods or services. Customers care about the goods or service—that is why they engage with the organization in the first place (Even where security actually is the goal of an organization it is provided as a complement to another product or activity—protection of property, transportation, etc.). This means that an understanding of the fundamental conditions for security and safety begins with an understanding of the balance between production and protection. Humans normally strive for an acceptable (rather than ideal) level of performance in relation to their goals and resources [2] and to not process all available data is a part of this resource-saving strategy [3]. Consequently, action is guided by an intuitive and implicit trade-off between cost and efficiency [4] or between thoroughness and efficiency [5]. However, this introduces the risk of overlooking possible consequences of these trade-offs, particularly long-term consequences [6]. From investigations of aviation accidents the systematic trade-offs in favor of efficiency/production versus safety/protection have been labeled as "drift" toward accidents [7]. The model of drift has been an important tool for increased understanding of accidents in the otherwise impressively safe global transportation system of aviation. Drift should also be a useful concept for understanding of failure of security systems. In the 24 months leading up to 9/11, there were 30 cases of passengers breaking through cockpit-doors [8]. This type of event may at the time have been recognized as an acceptable risk.

1 THE PRESENT SITUATION FOR SECURITY

Today, the situation is quite different. The pressure to respond quickly and decisively to perceived security threats can produce immense consequences—from severe disruption to significant financial loss. A recent example of this is the consequences of the events in the United Kingdom in September, 2006:

> "In the wake of the plot to smuggle liquids on board aircraft, mix them and use them as explosives the increased security measures during the following nine days meant that British Airway had to cancel about thousand flights resulting in estimated losses of 50 million pounds [9]."

In aviation, security is generally seen as an operational activity parallel and independent to safety. However, it is not unusual that security even by crews is seen as an intrusion (when performed by security staff) or as unwanted and unnecessary (when performed by crews themselves). There are even examples of how security and safety may conflict. The most prominent example, of course, is the locked cockpit door. The extra barrier can delay or interfere with cross-crew coordination, which has been identified previously as contributory to accidents [10]. A locked door can be especially problematic in case of escalating situations (disruptive passengers, or technical problems) where the threshold for coordinating may now have become higher. In a report by Nilsson and Roberg [11], crew members were unanimously negative in their view of the locked door. A manifestation of this problem occurred on an Air Canada Jazz flight in 2006. As a captain returned from using the washroom in the cabin he could not get back into the cockpit. It was not possible to open the door:

> "For roughly 10 minutes, passengers described seeing the pilot bang on the door and communicating with the cockpit through an internal telephone, but being unable to open the cabin door. Eventually, the crew forced the door open by taking the door off its hinges completely, and the pilot safely landed the plane [12]."

The article also stated that "being locked out of the cockpit is a 'nonreportable' incident, there is no way of confirming their frequency as the airlines are under no obligation to report them". Beyond the entertaining qualities of this story, it raises questions regarding the parallel pursuit and of security and safety and their interaction.

2 EVOLUTION OF SAFETY, REVOLUTION OF SECURITY

Aviation safety has evolved, slowly but surely, over many decades. Technological, organizational, and regulatory developments, as well as greater insights into human and team performance, have all contributed to the steady "fly-fix-fly" improvement of aviation safety. Aircraft accidents have become a part of contemporary mythology—crowning heroes, identifying culprits and providing horror stories. All of this experienced and recounted by passengers to the rest of us; potential passengers who could have or may come to be caught up in similar events. There is not any abundance of similar stories and certainly not any similar mythology when it comes to aviation security. Although there certainly are hero stories (as that of the passengers of flight United 93), clear identification of culprits (as in cases of hijackings and bombings), and horrors to be shared also in this area the occurrence of such events have simply not been as frequent as safety-related accidents. Of course frequency alone explains little, but the abundance of safety-related accidents has produced numerous articles, books, documentaries, and movies that have helped to increase public awareness on safety issues. Such stories have also been successfully used in the training of airline crews in human limitations, communication, cooperation, and leadership for increased safety (Crew Resource Management (CRM) training). Security demands, in contrast to the gradual development of safety measures, have exploded dramatically over the past few years. This sudden tightening and acceleration could compromise the claim that security provides an essential service to society. See, as an example, this comment on the response after 9/11:

> "Confiscating nail files and tweezers from passengers seems like a good idea all around: The airlines don't mind because it doesn't cost them anything, and the government doesn't

> mind because it looks like it's doing something. The passengers haven't been invited to comment, although most seasoned travelers simply roll their eyes [13]."

Security measures can appear quite haphazard, arbitrary—capricious even—to passengers or crews or other people subjected to them. Computers that have to be taken out of bags at some airports but not at others. Elderly ladies must give up their knitting ware before entering an aircraft while other passengers do not need to give up elegant and equally sharp pens. "Incendiary material" may not be brought onto an aircraft but alcohol (to drink or to smell better) is accepted and even sold onboard. Every piece of such failing logic will gradually or quickly erode the willingness of those who are supposed to be felt protected, to see themselves as participants guaranteeing their own security. Although the pictures from 9/11 will be remembered and should seem to provide more than enough of modern mythology the patience of passengers and willingness to accept current security measures is probably not endless. This is one perspective on the current status of security:

> It's been four years since the terrorist attacks of Sept 11, 2001, and backups at airport security checkpoint lines are growing, the army of federal airport screeners is still getting low performance marks and uncertainty dogs the contents of airline cargo holds. While the federal government has been spending about $4 billion a year on aviation security since hijackers transformed four jetliners into devastating weapons, critics say there aren't enough results to show for all that taxpayer money [14].

2.1 Production Pressures in Providing Security

As potential goodwill in regard to security might abate, there is a risk that mounting production pressures dictate the operational conditions for security operations. The effects of such production pressures have been seen in a vast number of aviation safety incidents and accidents and they are likely to have an influence also on security. A study of airport screening rather unsurprisingly found that "the longer passengers had to wait, the longer they were to be unsatisfied" and concluded that "There is little question that the effectiveness and efficiency of security screening is a key feature affecting passenger satisfaction" [15]. To reduce this problem computer-assisted passenger prescreening systems have been introduced and these "confirms passengers' identities, performs criminal and credit checks, and retrieves additional information, such as residence, home-ownership, income, and patterns of travel and purchases, used to construct a predicted threat rating" [16]. With the currently fierce competition in the aviation industry—between airlines (increased by the arrival of low-cost carriers), between airlines and business jets, and from high-speed trains (in many parts of Europe)—many security measures will be under pressure to adapt to the demands of "effectiveness and efficiency" from a short-term business perspective rather than to what passengers perceive as illogic and irrelevant threats stemming from vague and remote risks of criminal acts and terrorism.

A new segment of the aviation industry is partly based on the consequences of current security measures. An important reason for the emergence and anticipated success of a new type of small business jet aircraft (Very Light Jets, VLJs) is that the time demanded by security measures for scheduled flight at major airports is unacceptable for upper and middle management [17]. By operating or renting their own aircraft, flying direct and using small airports some of the time spent on security can be avoided or reduced for companies. The same reason has fueled a "remarkable upturn in business aviation" in Europe in recent years [17]. The experience from aviation safety is that this and other types of pressures on operations affect all organizational levels and induce risks of organizational drift toward future system failures.

To further understand the current relationship that passengers (or the public in general) have to security (as well as to safety) in aviation we can use two concepts from economic theory. The first is that of "externalities", that is a cost or benefit imposed on people other than those who purchase a good or service [18, 19]. Passengers buy a ticket to fly from A to B and expect this to be a secure and safe means of transportation (For the airline industry to imply anything else would be to discourage a substantial number of passengers.). Since security and safety are expected from this product and criminal acts with severe consequences or accidents are rare (and this is stressed by the industry), consumers will see increased prices or procedural complications for flying as a negative externality. Of course, they do understand the need for baggage-screening and de-icing, but in day-to-day travel the meaning of these procedures often seems lost, as noted on consumer behavior "the tendency to trade-off costs and benefits in ways that damage their future utility in favor of immediate gratification" [20]. The paradox is that for the airline industry it is of great importance to be secure and safe to a level where passengers do not even consider potential threats when they make their decision to travel. As this level is achieved, however, passenger tolerance for increased costs and inconveniences to further reduce threats is declining. This explains the fundamental difficulties that everyone (security managers, pilots, cabin crew, screeners, etc.) involved in working with security encounters in day-to-day operations when trying to maintain the balance between production demands and the protection provided by the security system.

The tendencies described by the theory of externalities can be further reinforced by the theory of "lemons" [21]. This describes how interaction between quality differences and asymmetrical information can cause a market where guarantees are unclear to disappear. When quality is indistinguishable beforehand to the buyer (due to the asymmetry of information) incentives exist for the seller to pass off a low-quality good as a higher-quality one. Since the nonoccurrence of adverse security and safety cannot be guaranteed, the quality of security and safety operations is known to very few (and in the case of security we do want to keep this a secret) there is no incentive for any consumer of airline transport services to select airport or airline based on if they are more secure or safe than other. This explains the pressure put on the security and safety operations as it is unlikely that they ever will be able to provide evidence of the value they bring to the consumer [22].

3 EXPERIENCES FROM AVIATION HUMAN FACTORS OF RELEVANCE FOR SECURITY

3.1 Relation to Regulation, Standardization, and Procedures

Economic theories of human behavior provide us with some understanding of its potential problems with regards to security and safety. A seemingly reasonable response would then be to try to control human behavior. This means using laws, regulations, standardized procedures, manuals, guidelines, and other similar means to increase the reliability of human behavior and limit the risk it may induce in systems. Aviation has a long tradition of negotiating global regulatory frameworks that can ensure a high minimum level of safety [23]. Manufacturing and maintenance of aircraft, medical and other requirements for staff (pilots, cabin crew, air traffic controllers, etc.) selection and training as well as practically all operational aspects are guided by extensive regulation and enforced by aviation authorities. The regulations stipulate that all operators also should have standard operational procedures (SOPs) for all aspects of operation. In aviation these procedures are regarded by crews as the main source of safety and regulations demand that they are regularly practiced to a satisfactory standard in simulators, mock-ups, or classroom teaching.

Many think that regulation, standardization, and proceduralization are the main guarantors of aviation safety. Even though this might be historically true, the situation has always been more complex. While these efforts promote predictable organizational and individual behavior and increase reliability they do not promote the flexibility to solve problems encountered in present complex sociotechnical systems [24]. Also, a blind adherence to regulations and procedures neglects the fact that much work has to be done in addition to, beyond or contrary to prescribed procedures [24]. A procedure is never the work itself, it cannot be that human intervention is always necessary to bridge the gap from written guidance to actual application in context. Note how the "work-to-rule" strike is not uncommon as a form of industrial action in aviation. Yet the commitment to rules and procedures is generally strong in aviation (although there are weaknesses in this commitment in some parts of the world). However, there are signs that further increase of aviation safety may need other methods than those used to achieve current levels of safety [25]. Most potential system failures in aviation have been anticipated and addressed by technical protection and procedural responses. But ill-defined, unexpected, and escalating situations have proved to be far more difficult to manage successfully and have resulted with tragic outcomes. An example of this is the in-flight fire on Swissair 111 [26], where the flight crew tried to follow procedures until the situation was entirely out of control. This accident showed that an overfocus on procedures and lack of training of general competencies needed in an emergency may conspire to turn a difficult situation to an unmanageable one.

When putting security systems together, training staff to achieve increased standardization and procedural adherence may be an intuitive and relevant first step. But further consideration is necessary. A profound understanding of human performance issues (including topics such as perception, decision making, communication, cooperation, and leadership) should be helpful to security staff for increasing the overall effectiveness of security operations. Such training should go beyond operational and procedural aspects, instead providing security staff with an increased awareness of the individual, group, and system limitations that may induce weaknesses in the security system. This training should be recurrent and closely integrated with other training as well as with an effective operational reporting system (see below).

3.2 Relation to Technology and Automation

As has been, and still is, the case for aviation safety, security seems to be driven by a reliance on technology to solve problems and increase efficiency (increased use of advanced identity cards, biometrics, surveillance cameras, sensors, background checks, data mining and for aviation specifically refined screening techniques, computer aided vetting of passengers, etc.). Focusing on technology is a prominent feature in the modern history of aviation safety [27]. The experiences of this development can provide some helpful guidance for security. Two important phases will be used as examples of the problems involved in the relation between aviation safety and technology.

The first great technological step of improving the safety of modern air transportation depended upon increased understanding of the physical stresses on aircraft frames as well as of fundamental physiological and psychological processes affecting pilots. As aviation entered the jet-age, safety increased due to the superior performance and reliability of jet engines compared to piston-engines. To be able to fly faster and higher than before did, however, have unforeseen consequences and in-flight break-up of aircraft (such as the Comet accidents in the 1950s) put the focus on the risks of structural failure. This focus on fundamental engineering and manufacturing issues corrected previous design flaws for coming generations of aircraft. Another accident type was that connected to approaching an airport in darkness. This induces the risk of the so-called black-hole illusion, where the airport is perceived as being lower than it actually is. Accidents of this type were frequent until there was a push for instrument landing systems on more airports, improved instrument design, and more warning systems, which reduced the risk of this type of accident. Also, the opportunities for effective flight simulation provided by the technological development meant that this type of approach and landing could be practiced effectively. In both cases, the measures taken were relevant and had positive effects on aviation safety. However, aircraft accidents were steadily occurring even after these measures had been implemented. These accidents involved failures of communication, cooperation, and leadership problems, such as the United 173 accident at Portland airport or the Air Florida 90 accident at Potomac Bridge where the captain's decisions were accepted by other crew members in spite of their awareness of the risks involved. The existence of these types of problems was well known to the industry but previously obscured by the search for technological solutions. They did, however, become addressed through increased focus on Human Factors and the implementation of CRM-training in the industry.

In the 1980s, the arrival of modern computer technology in large transport aircraft was supposed to solve safety problems and reduce costs. New aircraft were equipped with computerized Flight Management Systems (FMS) which were supposed to not only reduce the workload of the pilots, but also monitor their actions and prevent actions that would risk the safety of the aircraft. The most important learning point to come out of the technological revolution in the cockpit was that changing the conditions for work always may solve some known safety problems but it will always create new ones [28]. Although the introduction of the new technology was a part of an overall trend toward greater safety it was also involved in a number of incidents and accidents where a mismatch between the human operator and the automation was the primary cause [29]. This included accidents with mode confusion (such as China Airlines at Nagoya and Air Inter at Strasbourg), programming errors of the FMS (Boeing 757 accident at Cali, Colombia), and aircraft upset (conflicting aircraft and operator control of the aircraft, such as the JAS Gripen accident in Stockholm). Again, the focus on technological solutions obscured the essential focus on its effects on the role of the human operator. There is a lesson here. As pressure mounts to make security more cost effective, time effective, and less inconvenient, the history of aviation automation may serve as a reminder that new technology alone is seldom the solution.

3.3 Human Performance, Communication, Cooperation and Leadership-Training and Reporting

An area where aviation safety has made significant progress is in training their operators in understanding potential safety risks associated with human performance, communication, coordination breakdowns, and leadership. Such training has been facilitated by the availability of well-investigated cases of aviation accidents. Gradually this type of training has gained increased recognition, both within aviation as well as in other safety-critical industries. The mandatory and recurrent training of Human Factors–related knowledge and skills is today a hallmark of the aviation industry and has become a model for similar training in maritime transportation, nuclear and chemical industry as well as health care.

The emergence of the concept of Cockpit Resource Management in the late 1970s was precipitated by a number of disastrous accidents (e.g. the most disastrous of them all, where 583 persons became victims as two aircraft collided on the runway on the island of Tenerife). This became the start of a systematic approach to train crews to understand aspects of human performance, communication, cooperation, and leadership of importance to aviation safety. Later, the concept was renamed CRM, to involve also the cabin crew (This too was precipitated by accidents, such as the Kegworth accident, where information from cabin crew on visible effects of engine problems did not make it into the cockpit to augment the pilot's knowledge of the situation.). Analogously, engineering and technical staff have developed the concept of Maintenance Resource Management (MRM). In many countries, annual recurrent CRM courses are mandatory for maintaining active status for an airline pilot's license. Currently, there are ongoing discussions as to if CRM should be made available or even mandatory also for other categories of staff involved in operations, such as schedulers, coordinators, and management. The initials CRM would then stand for Company Resource Management.

Gradually, the focus of CRM-training has been turned to prevention and management of human error, based on the same content as previously but more explicitly framed around understanding error. This has included teaching of various accident models. Although the success of CRM is difficult to quantify in terms of fewer accidents or incidents or in any other measurable terms of increased safety or economic gain, the great interest from other industries (maritime transport, nuclear, chemical, and health care) in the concept seem to confirm its appeal.

One of the lesser discussed benefits of CRM-training is that it widens the understanding of human performance and, as a consequence, the willingness to report events and incidents. To create an overall effective system for safety (or security), it is important to first create an organization that is curious regarding error rather than one where punishment expected and thus reporting is avoided. Curiosity is a sign of willingness to learn why a certain event occurred and a starting point for learning for the whole organization. In aviation, it is not uncommon that crews report their own errors even though there would have been no way to detect that an error had been committed; since there is no good reason that other crews should have to experience the same error. The benefits of this type of reporting and of CRM-training are not easy to quantify and might be more convincingly argued in connection to examples from operations. In the period of 1997 to 2001 one of the four terminals at Sky Harbor airport in Phoenix, Arizona, had 125 security lapses [30]. The Transportation Security Administration (TSA) screener workforce alone consists of 45,000 employees at 448 airports [31]. From aviation safety we would conclude that this type of events will not disappear. But by complementing increasingly effective technological solutions with equally effective training and reporting there will be less of them.

Recurrent training of both security and safety (first aid, evacuation, fire-fighting, CRM) is mandatory for airline crews. These training events not only reinforce practical skills but also serve as important reminders of the threats and risks surrounding airline operations. It also gives crews the opportunity to discuss recent security- or safety-related events and come up with solutions to operational problems. If carried out according to its intentions, recurrent security, and safety, training strengthens organizational values and attitudes regarding their areas. Security staff could also benefit from systematic recurrent training of CRM-type, focused less on strict operation of technological equipment and more on Human Factors aspects of work.

3.4 Models and Culture

Beyond the training of individual operators, research efforts to understand (and increase) safety have focused on formulation of models that can explain how accidents occur and how they can be prevented. Traditional models have relied heavily on statistical analysis and vast representations of actions in search of a "root cause" for an accident. Also, they commonly rely on "folk models", that is general explanatory labels that only rename a phenomenon and do not actually provide any deeper analysis [32]. In recent times, highly influential models have focused more on "soft" organizational factors such as the norms and cultures in organizations and the effect of the balance between production and protection and how it is played out interactively between levels of an organization.

In the last decade, the concept of "culture" has received increased attention in safety research. People now refer to the lack of a sound "safety culture" as a reason for incidents and accidents. The focus on safety culture was preceded by attention in managerial literature on "organizational culture" or "company culture" [33]. From this the concept safety culture emerged and has been embraced in many industries. A safety culture is characterized as an "informed culture", that is the organization collects and analyses safety-related data to keep it informed on the safety status of the organization [34]. In particular, the following aspects of a safety culture are highlighted:

- *Reporting*—is considered of fundamental importance in the organization.
- *Just*—unintentional acts are not punished which creates trust to report.
- *Flexible*—ability to adapt to new information and changing circumstances.
- *Learning*—ability to extract learning from safety-related information.

There does not seem to be an equivalently researched and accepted "security culture", although this probably should be a term as relevant as it has proved to be for safety. Certainly, the concept seem to be implicitly present, as indicated by this statement: "because enhancing security depends on changing the beliefs, attitudes, and behavior of individuals and groups, it follows that social psychology can help organizations understand the best way to work with people to achieve this goal" [35].

Learning is, however, a dialectical aspect of culture. In the balance between production and protection the learning from day-to-day operations may easily be the contrary of that implied by Murphy's Law, that is, that things that can go wrong usually do. Actually, in normal operations things that can go wrong do not and there is a risk of learning the wrong lesson from this. Operators might interpret incidents as proof of safety and that it is ok to "borrow from safety" to increase production output. Production pressure on performance of "normal work" gradually effect standards and norms of this work in favor of production. This is the risk described by the model of "organizational drift" toward failure for complex sociotechnical systems. In security, drift of normal practice may create opportunities for those who deliberately want to cause harm to people and property.

Aspects of safety culture are present also in research on high reliability organizations (HROs) such as aircraft carriers and air traffic control [36]. One of the conclusions of this research is that stories that organizations tell about their own operations reveal something about their attitude and ability to learn from incidents. In HROs, incidents are seen as signs of weaknesses in the system and they are used by the organization to extract information about how to become safer. In other organizations incidents may be taken as evidence of the strength of the safety system and lead to the conclusion that nothing needs to be changed. From this it could be claimed that something that is needed for security operations, particularly for training, is "good stories", both about the failure and success of its operations. While aviation safety has been able to use cases from well-investigated and publicly presented accidents, this is not the case for security.

There are a number of models and research results regarding safety culture and HROs that should be fruitful for security operations. The similarities of the conditions and performance of security and safety operations mean that learning from each other should be mutually beneficial. Both represent operations where seemingly everything is done to prevent adverse events, where adverse events are extremely rare (and potentially disastrous). Also, for both the operators have to maintain a high level of skills, knowledge, and awareness to keep day-to-day operation secure and safe as well as readiness to manage unusual and unpredicted events. The potential for systematic and recurrent Human Factors training for security as well as for joint security and safety training for staff from both types of operations should be explored.

4 CONCLUSION

Security and safety share fundamentally important features as operational activities with the goal to protect people, property, and the smooth economical functioning of organizations and society. Safety has been a focus of operations where risks have been overwhelmingly obvious since their inception (e.g. aviation, chemical, and nuclear industry) and demands on the safety of these operations have gradually increased. The demand for increased security has escalated recently and comprehensive development of it as a field of operations, beyond potential technological progress, is needed.

In spite of distinct differences in the nature of threats (intentional/unintentional), there are many areas (use of standardized procedures, human factors training, modeling for increased understanding of adverse events) where knowledge and experiences from safety operations can fruitfully spill over to security. To establish cooperation between these two fields, for example on regulatory and procedural development, training and simulation, as well as operational evaluation, would be to produce synergies not yet known today.

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Science and Technology for Homeland Security: Skills and Knowledge Management

Science and Technology for Homeland Security: Teamworking and Collaboration

Risk Communication

Social and Psychological Aspects

Qualitative Representation of Risk

Risk Perception

Human Behavior and How it Adjusts Our Actions in Complex Events in Both Positive and Negative Ways

Human Perception and Attention in Information-Rich as well as Eevent-Overloa Situations

Human Sensation and Perception

Human Information processing

Decision Making Models

Naturalistic Decision Making, Expertise, and Homeland Security

Situation Awareness and Mental Workload in Homeland Security Settings

Human Behavior and Deception Detection

Experience and Decision-Making in Homeland Security

Cognitive Work Analysis

Human-Centered Design Approaches for Homeland Security Applications

Training and Learning Development for Homeland Security

Decision Support Systems for Homeland Security
Organizational and Process Design
Roles and Responsibilities