Vigilance and the Price of Freedom

Peter. A. Hancock
James. L. Szalma, Ph. D.

When we have to act as a concerted group or use a common convenience, such as mass transportation then individual freedoms come into conflict with collective rights. Conjoint and reciprocal security intrinsic to social interaction is being sought now more visibly in aviation and somewhat less visibly in other forms of transportation and communication. Perhaps in advancing security in their own realm, aviation professionals can set the common example. The fundamental challenges for human factors in security are to:

1. Devise ways of distinguishing what potential and actual sources of communal threat exist
2. Provide valid and accurate assessment methods to distinguish such threats
3. Indicate avenues of action by which threats can be excised or rendered harmless.

To meet these challenges, we suggest three avenues to pursue in our collective efforts to combat terrorism:

1. Improve personnel selection and training
2. Design of systems to support sustained attention or vigilance
3. Possible control of aircraft beyond the cockpit alone.

In the present NAS, the pilot is in control and responsible, although control is also mediated by air traffic personnel who provide guidance and direction. Thus, one role of vigilance lies in the selection and the training of flight deck and ATC personnel to deny individuals who seek to usurp control for nefarious purposes access to air traffic control facilities and the commercial flight deck. Since this function has not yet failed, to our knowledge, political will is likely to be slow to react to this potential threat over known threats. Inevitably, concern has focused on public access to the flight-deck as this was the approach used by the September terrorists. In addition to physical barriers erected to exclude unauthorized individuals from entering secure areas, selection barriers must be erected for other individuals who work in the system and for whom the everyday vigilance of passenger control is easily circumvented. Security background checks and cross-referencing with emergent National databases should provide help in this regard with support from human factors professionals who are experienced in dealing with the problem of information overload. Screening personnel with ground access to aircraft and control facilities as well as those who fly in a professional capacity or have privileged access (e.g., flight attendants, Federal Air Marshals) will be a Herculean task.

The field of human factors considers the security problem as one of distinguishing signal from noise. In this context, the signal is the source of threat (a person or what he possesses) and the "noise" (or, more properly, the non-signal) all other forms of non-threats. Since the occurrence of threats are so rare, and non-threats so predominant, the detection process fits the scientific definition of vigilance (see Warm, 1984). A quintessential component of laboratory vigilance tasks is "event rate", or how often stimuli are presented to observers. In the case of passenger screening, this might be the number of people who pass through a detector per unit time. Embedded in event rate is "signal rate" or the proportion of events that are targets. In laboratory testing, realistic event rates are presented (e.g., one event every

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Peter Hancock is Provost Distinguished Research professor in the Department of Psychology, the Institute for Simulation and Training, and at the Department of Civil and Environmental Engineering at the University of Central Florida. He currently holds a courtesy appointment as a research scientist at the Massachusetts Institute of Technology (MIT) and as an Adjunct Senior Research Scientist at the Transportation Institute of the University of Michigan. Professor Hancock is the author of over four hundred referenced scientific articles and publications as well as editing numerous books. His theoretical works concern human relations with technology and the possible futures of this symbiosis.

Jim Szalma holds a Ph.D. from the University of Cincinnati in experimental psychology and has been a faculty member at Farmington on Long Island. He has just joined the University of Central Florida MURI-OPUS group where he directs a number of projects concerning stress and performance response. His particular expertise is on vigilance and response capacity, and he has published a number of papers in this area.

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two to four seconds) analogous to passengers passing through a reasonably high-speed detection system. Unfortunately, the signal rates typical of laboratory tasks are unrealistically high (e.g., as much as one to two per minute). Thus, laboratory results are likely to under-predict the performance of real screeners as lower signal rates generally result in poorer performance. In the real-world applications the occurrence of signals can be extremely low, perhaps an actual rate of one signal per ten years. Even after the recent catastrophes, government reports show that detection of actual threats remains remarkable low, demonstrating the continuing challenge of the problem. The fact that the actual success (or failure) rates are hidden may be one of the greatest protectors of the security process.

Parasuraman, Hancock, and Olofinboba (1997) addressed the problem of very low signal rates in their work on collision avoidance systems where the probability of a driver having a rear-end collision is estimated at one collision per fifty driving years. Faced with a vast dominance of non-signals, even very sensitive detection systems commit many false positive and even more false alarm responses. In the aviation security situation, false alarms would represent individuals who are singled out from the stream of passengers for further investigation, but who in reality pose no threat. Most passengers shrug off such extended evaluation as the contemporary price of safe travel, but this attitude is not likely to continue. A half century of vigilance research provides a sound database from which specific recommendations for security improvements can be made (Harris, 2002).

Recent techniques for analyzing detection performance, such as fuzzy signal detection theory (FSDT) can enhance the assessment of real-world systems. FSDT combines traditional signal detection theory (Green & Swets, 1966), with the mathematical specifications of fuzzy set theory (Zadeh, 1965), to generate fuzzy signal detection theory (Parasuraman, Masalonis, & Hancock, 2000). It formally permits events to be represented by a continuum, rather than by discrete, signal/nonsignal categories and allows observers to express uncertainty (e.g., "this is probably not a threat but I'm not absolutely sure"). FSDT incorporates this uncertainty into the detection model, offering a better fit for security concerns. (See also Szalma, Hancock, Mouloua & Parasuraman, 2002). At present, there is but one formal screening (at the security checkpoint) and the possibility of random selection for a second screening prior to boarding. It might be possible to monitor the behavior of individuals more frequently using video camera and machine vision systems, applying repeated, but unobtrusive FSDT assessments between passenger check-in and boarding to provide an on-going assessment of level of target "membership." If repeated observations trigger a threshold level, then the individual would undergo a much more intensive screening process. By making assessment an on-going process, rather than a single "all or none" decision, one could provide superior protection against possible seizure of control from the passenger compartment.

Recent advances in computer control have made it both feasible and practicable to control fly-by-wire aircraft from the ground. Largely under development for unmanned aerial vehicles (UAV's) (see Mouloua, Gilson, & Hancock, 2002), the possibility of ground-based control implies that the pilot on board need not necessarily be in control. With greater penetration of this capability, unauthorized individuals could usurp authoritative control of manned as well as un-manned aircraft. This represents an extreme threat, as the suicide of the perpetrators, seen in the September attacks, might not be required to gain a similar outcome. Human factors methods can be used to lock unauthorized individuals out of such control (See Hancock, 1998) and these efforts need to be pursued to an ever greater degree as efforts to implement datalink, the ground-to-air computer communications system are advanced. If the price of freedom is eternal vigilance, we would do well to know much more about vigilance, where it might fail and what can continue to make it successful. For its failure is not a price we can afford to pay. ■