High Velocity Human Factors: Factoring the human being into future police technology

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Any sufficiently advanced technology is indistinguishable from magic. — Arthur C. Clarke

A group of scientists and researchers are studying an aspect of human performance that you have probably never heard of. This new field is called High Velocity Human Factors, or HVHF, and it will be a key factor in the future of law enforcement.

High Velocity Human Factors: A subset of Human Factors Science

High Velocity Human Factors is an emerging specialty within the discipline of Human Factors Sciences and psychology.[1] (What? You've never heard of Human Factors Sciences either? Don't worry, we'll explain it, and it really will play an important role in the future of law enforcement.) Human Factors Sciences studies human-machine (or human-systems) interactions in order to design machines and systems that are compatible with human capabilities and limitations. Human Factors Sciences combines and applies knowledge about human senses (including vision, hearing and touch), cognition/thinking (such as memory and decision-making) and physiology (load bearing, force exerting capacity and so on) to maximize the human-machine fit.

For example, Human Factors Science research finds that the size of the text on a cell phone should be at least 2.5 cm tall – to be readable at arm's length by a person with normal vision. Other applications include everything from the optimal placement-location-size-form of control buttons on a kitchen stove to configuring the information displays inside the cockpit of an F-16. The goal is make the technology and the technology-user interface as sensible and easy to use as possible.

HVHF takes Human Factors Sciences to a new level or a new environment. According to the mission statement of HVHF, the purpose is to address human behaviors, tendencies and ultimately performance in contexts such as law enforcement. Law enforcement represents one of the "mission critical domains" of human performance (firefighting, military operations and other high-stress environments).

The challenge is to maximize the role of the "human agent" in high-stress situations that involve high stakes, physical danger, incomplete information and an unpredictable future[2]. Whereas traditional Human Factors Science looks at human performance in normal operating conditions (a state of equilibrium), HVHF studies human performance in chaotic and volatile conditions (a state of non-equilibrium).

HVHF is distinct in that it integrates information from many different areas. Fields such as animal behavior, military psychology, and cognitive, biological and neural sciences are integrated into HVHF to understand and maximize human responses in critical, high-stress situations.

Fields such as animal behavior, military psychology, and cognitive, biological and neural sciences are integrated into HVHF to understand and maximize human responses in critical, high-stress situations. (AP Photo/LM Otero)

Traditional human factors research often focuses on creating systems and machines that could be used by different types of users. An example is computers, where an operating system such as Microsoft Windows made computers more understandable and usable for broader groups of the general population (home, business and school) than did the complicated DOS system. HVHF, on the other hand, addresses systems and machines for a single class of users — usually in mission critical domains — where multiple and changing situations are often encountered, as are challenges with multiple and changing stressors that provoke intense emotional reactions.

For example, the police cruiser of the future may have a digital dashboard to facilitate information in any form needed. In the situation of a car chase, the digital dash may get rid of or hide irrelevant information (sucha as alternator and odometer) and show or magnify relevant information such as current speed. This might be accomplished by having the speedometer enlarge and occupy the space where the other information previously was. Another example would be automatic "piping in" sounds that either increase arousal and awareness in such situations or serve to reduce arousal as appropriate.

Equilibrium, non-equilibrium and changes in velocity

As mentioned earlier, in HVHF terminology, quiet or low-stress situations are called states of equilibrium. Stressful situations are called states of non-equilibrium. And because mission critical domains are known to be characterized by long periods of quiet interrupted with unexpected, but generally limited, periods of great demand, they have been described as being characterized by "punctuated equilibrium." High "velocity" is seen as a central aspect of the situation and the response demanded of the individual in stressful situations (non-equilibrium events).

An example would be Boyd's famous OODA Loop of cognition, decision and behavior.

In low-stress situations the process of Observation, Orientation, Decision and Action proceeds steadily and smoothly. However, in high-stress environments, the process may speed up; it has been characterized as moving from a “trot to a canter to a gallop.” This increase in velocity, useful to a certain degree, can also give rise to inefficiency or error because of insufficient comprehension of the situation and rapid decision-making. HVHF looks at ways to manage a detrimental speeding up or to maintain adequate function despite the increased velocity.

The central tenet[3] of HVHF is that potentially aversive emotions (fear and anger) of high-stress situations affect cognition (thinking and awareness) and therefore affect behavior and performance in such situations (usually in a negative way). Events or aspects of events that have a high emotional intensity can “grab attention” or distract an officer from more critical aspects or important information in the situation. This has been called “cognitive rubbernecking.[2]

Enhancing situational awareness: The magic goal

Situational awareness or slips in situational awareness is a typical area of research in HVHF. For example, it is suggested that there are three levels where problems with situational awareness can occur.

The first level involves a failure to correctly perceive critical information. This may occur because there is no information available, or, if available, the information is difficult to detect or decipher; there is a failure to observe or monitor the information; the information is misperceived or misinterpreted; or there is memory loss.

The second level of failed situational awareness involves a failure to correctly comprehend or make use of critical information. This may be the result of the absence of a mental model or map on how to use or apply the information; the presence of a poor or incorrect mental model; or an overreliance on usual or standard modes of operation.

The final level is a failure to project future action or the state of the system. This can occur also because of problems with the mental model or because of decrements in information resulting from problems at the previous levels.

HVHF aims to find ways to prevent or counteract such occurrences. So examples of goals would be to design a system where:

- Situation-relevant information is provided — while suppressing irrelevant information — to the officer in a manner that stimulates awareness.
- The officer is made aware or directed to critical cues in the environment.
- The officer is trained to seek and use goal-relevant information to develop a correct mental model leading to an effective intervention plan.
- Information is provided to the officer on demand.
- There are minimal steps needed to access critical information.

The example was given earlier of a police car's instrument display during a high-speed chase being reduced to just an enlarged speedometer. In addition, the GPS display on the vehicle's laptop computer might be enlarged to contain only a map of the immediate area, the location of other police vehicles and planned roadblocks, and a simple display of the status of authorization by higher authority to make the pursuit.

From cockpit to squad car: "Mad scientists" or "real world technology"?

This might sound like science fiction or far-fetched dreams of mad scientists, but HVHF has produced several examples of real-world technology. Some very intriguing results in this field have come from futuristic and sophisticated work at Honeywell Laboratories in the augmented cognition program. [4] This program is focused on information transmission, reception and decision-making in high-stress situations. Special attention has been given to avoiding bottlenecks or clogging information leading to breakdown in communication, reception or understanding and processing.

Research has developed algorithms and instruments to measure the cognitive state of an operator in high-stress situations. For example, from brain wave sensors, there can be calculated an “engagement index” that measures the operator’s attention and vigilance on a task.

Let’s briefly look at two examples of demonstrated technology that have come out of the augmented cognition program that can reduce or prevent operator stress in high-velocity situations. These are the use of a “communications scheduler” and a “tactile navigation cueing system” in hostile environments. This research has been applied initially to pilots, but it can have direct application to many other mission-critical domains, including law enforcement.

The communications scheduler uses feedback on the operator’s attention and awareness to control the amount and flow of information going to the operator. The goal is to (1) avoid overload, (2) prioritize what is most essential to be communicated first or highlighted, and (3) resend information when there has not been acknowledgement of receipt or understanding of a message.

The tactile navigation cueing system directs the operator to a target location or away from dangerous situations or human subjects. However, unlike GPS systems using vision to read and direct, in this system the cues are given through touch or vibration. Small devices in the pilot’s seat create a vibration in different areas of the pilot’s back and thighs. The response from pilots from early trials was very positive, and research demonstrated that message comprehension and situational awareness was improved by 100 percent, and unwanted enemy encounters were reduced by 300 percent.

A lot of technology pioneered in the aviation world has found a place in the law enforcement community. Two-way radios, GPS, wireless computer systems, car cameras and radar guns are all examples of technology that was first used in aircraft and have since found their way into police cars. And there is every reason to believe that the products mentioned here represent the future of law enforcement and similar domains.

Fog, friction and high-falutin' terms

Readers are invited to look further into the area of HVHF sciences. The area can be compelling, fascinating and useful for those with a view to the future of law enforcement. Certainly, input and ideas from the experience of "the field" creates a partnership with HVHF scientists.

There is one caution for those who are interested in delving further into the arena of HVHF: The language in the writings can be pretty "high-fallutin," using complicated words, sentences and concepts. For example, one article stated: "…the team has developed a closed loop integrated prototype to address the performance advantages of a neurophysiologically driven system." Or, "…by looking at reptilian social behaviors he postulates a design language for police."

The first means that the research team found a way to use the body's physical and neurological reactions to improve performance, while the second says that even the social behaviors of reptiles can provide lessons for improving designs in equipment and performance of police officers (and that's not an insult — because our automatic, nonconscious, instinctive and reflexive behaviors are driven by the "older" portions of our brain that help us survive in emergency situations).

Despite this "fog and friction," however, HVHF is a welcome and critical development for law enforcement. Its research and applications are expected to provide significant upgrades and enhancements in the technology, function, performance and safety of police officers.

?The above material is that of the authors and does not necessarily represent the opinions, policies or practices of the authors' respective organizations.

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