Reducing VTS operator stress

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This paper on VTS (vessel traffic service) operator stress explores the relationship of stress to workload, stress-management strategies, and how cooperative human-machine systems can reduce stress. The trials detailed and the solutions offered are the result of work conducted by maritime group 'Designing Dynamic Distributed Cooperative Human-Machine Systems' (D3CoS) – a research project funded by the ARTEMIS Joint Undertaking. The goal of D3CoS (which concluded February 2014) was to create methods, tools, and techniques for developing distributed, cooperative, human-machine systems that reduce development costs and time. The project asked questions such as 'how can machines 'cooperate' with users during stressful and high workload situations that will result in higher safety', and 'what tasks can a system take on to ease the burden on operators?'

Why reduce operator workload?

In VTS areas that are not busy, operators may experience what is called 'underload,' meaning there are periods of inactivity that can lead to boredom and distraction. Here, organisations are not looking for ways to reduce workload, but rather to increase it. Some VTS areas, such as Singapore, Rotterdam, Hong Kong and the Dover Straits are remarkably busy. Other VTS centres are expanding their area of responsibility, which will increase operator workload, while not increasing staffing levels. But for those individuals who work in, or whose organisation is responsible for either a very busy area or a very large area, managing operator workload is important. Operators need to identify and respond to critical situations but if they are overloaded with tasks – no matter how appropriate to their responsibilities – they might not be alerted to circumstances that require their attention.

Why reduce stress?

In the short term, being stressed can make one more alert. Stress in an emergency situation can be a positive thing. Too much stress, however, can potentially lead to several negative consequences. In the short term, when stress has accumulated over a period, it can lead to headaches, bursts of anger, physical pain or discomfort, poor judgment, fuzzy thinking, and loss of precise motor skills. In the long term, stress can lead to a number of illnesses, including depression, anxiety, heart attack and stroke. The well-understood consensus is that experiencing stress in appropriately engaging situations is necessary and good, but if stress persists over a long period, the effects are overwhelmingly negative. Stress levels, therefore, should be managed and relieved in VTS operators to ensure safe shipping.

The need to reduce stress and the effects of stress in operators are well-known. It is why operators rotate positions in the Dover Channel Navigation Information Service and why the Maritime Port Authority of Singapore hands over operations to another operator every 45 minutes for its busiest VTS areas. It is also why the IALA VTS operator course V-103/1 Module 7 teaches VTS operators about the causes of stress and how to manage it.

How is operator workload and stress connected?

Some people point to the composition of traffic as a stressing factor. The berthing of a supertanker is more stressful than the berthing of a small container vessel, one harbourmaster noted. Others point to task type, not task load. A collision in one's area of responsibility creates more stress than multiple VHF requests for weather data, for example. The D3CoS project carried out trials with real VTS operators to understand the relationship between workload, type and stress.

These trials consisted of simulated VTS control tasks. They were conducted in two rounds, with experienced maritime traffic operators from Halifax, Canada and the Norwegian Coastal Administration acting as the VTS operators. They were instructed to control a specific area and execute realistic tasks with physical responses measured by connecting the operators to monitoring equipment. Operators also finished a post-testing questionnaire and the trials were recorded by video and audio. The operators completed four scenarios, each scenario increasing in workload, from an under load scenario, progressing to an overload scenario. Operators were asked to take ship reports by VHF while managing a traffic separation scheme with crossing ferry traffic as well as a precautionary area. Each scenario (task) lasted 10 minutes.

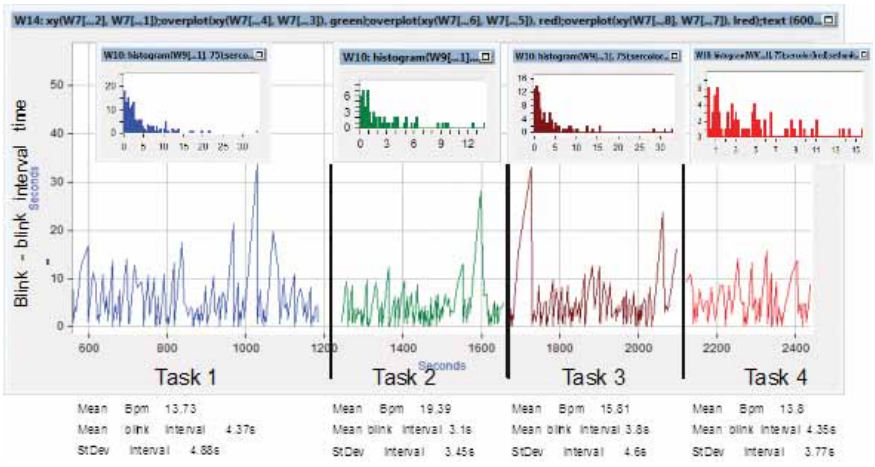
Figures 1 & 2 show the analysed data for one of the operators based on activities that are commonly understood to indicate a subject is under stress, such as blood pressure and breathing rate. Workload rises from task 1 to task 4.

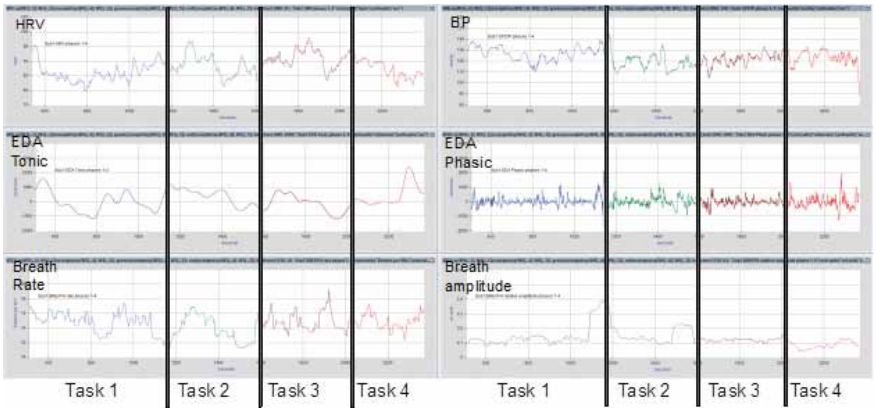
The trials found that when task load increased, so did the measurements that indicate stress. The operators' attention became increasingly narrow as stress levels increased, resulting in dangerous situations being missed, and in one case, a (simulated) collision was not identified.

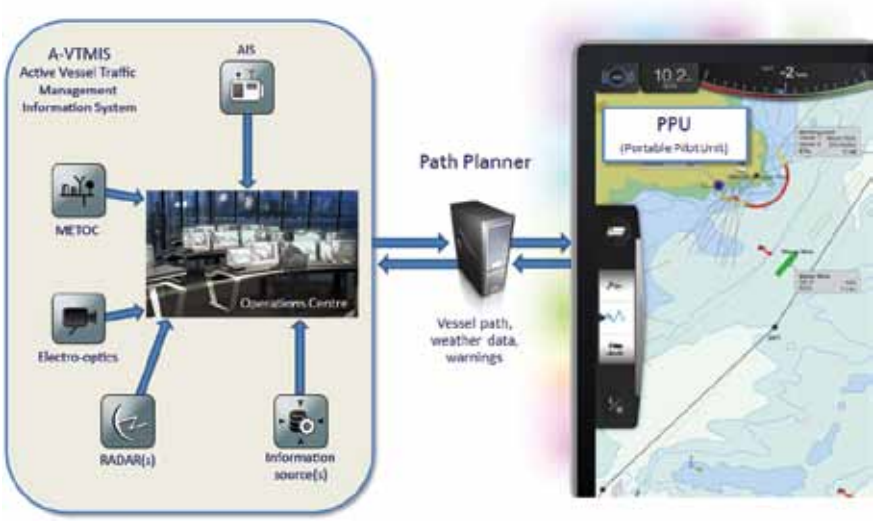
Technology developments

With the project establishing a link between workload and stress in the VTS environment, it moved on to the development of prototype technologies that could be used to reduce workload and therefore reduce stress – cooperative human-machine systems. Automation was key to the developed system as it can reduce the level of VTS operator involvement needed to send standard information such as vessel conflict and weather data, which in turn reduces the operator workload. The maritime group developed a means of communication between a shore-based VTS system and a ship-based system; specifically a portable pilot unit (PPU). This technology was used to develop an advanced Vessel Path Planner. Comprising an active VTS system (supplied by Kongsberg Norcontrol IT), a path planning server (developed by BMT), and a Marimatech PPU, the Vessel Path Planner works as follows:

- The pilot onboard a vessel requests a path from the VTS centre;
- The VTS operator draws a path for the vessel on the VTS system chart;
- The path planner receives the path and validates it based on chart data;
- If valid, the path planner sends it to the PPU;







Top (Figure 1): Blinking activity into the four task-load phases – blink per minute and blink-blink interval. Courtesy of Sergio Fonda, associate professor, University of Modena and Reggio-Emilia, Italy; Middle (Figure 2): HRV - blood pressure – EDA – breath, during the four task-load phases. Courtesy of Sergio Fonda, associate professor, University of Modena and Reggio-Emilia; Bottom: The advanced Vessel Path Planner, comprising an active VTS system (supplied by Kongsberg Norcontrol IT), a path planning server (developed by BMT), and a Marimatech PPU.

- The PPU displays the path and continuously sends the position of the PPU to the VTS;
- The VTS fetches forecast and current weather data for the path, which the pilot can access at any time directly from the PPU by tapping on that part of the path;
- Any warnings or conflicts detected by the VTS along the path, such as potential collisions, are immediately sent to the PPU.

Once the path is established and validated, the rest is automated. The VTS operator is not required to find and report weather data to the pilot, and should the VTS operator become engaged in a critical situation, any warnings relevant to the pilot are automatically communicated. Workload is reduced, and with a reduction in workload, stress is reduced.

On-going research

The cooperative human-machine system is a beginning. It is a prototype, and more research and development is needed to understand precisely what situations or criteria create high levels of operator stress. Kongsberg Norcontrol IT, as a maritime domain awareness software and VTS technology developer, with installations at many of the world's busiest ports and waterways, is well positioned to develop innovative new solutions in this area.

This paper was presented at IALA 2014 in May 2014, giving the company the opportunity to show some of its work within D3CoS, which will be put to use in future research projects and the VTS systems it develops.

About the author

Todd Schuett has been Kongsberg Norcontrol IT's training manager since 2000 and Kongsberg's project manager on D3CoS. A graduate from the University of Chicago, he has instructed hundreds of VTS operators from all corners of the earth and is an expert in the challenges and diversity found in port and coastal VTS operations across the globe.

About the company

KONGSBERG

Kongsberg Norcontrol IT maritime surveillance solutions improve the safety, efficiency and security of maritime transportation and its infrastructure by providing optimal situational awareness. Its solutions are in service with the world's leading maritime coastal organisations, most successful port authorities, and safest offshore operators. Kongsberg Norcontrol IT's innovative solutions and market-leader status have been earned through experience from over 240 projects, ground-breaking research and development, and challenging and cutting-edge projects.

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