Automation Effect

Experts are studying the effect of new and automated technologies on controller stress, focus and performance, reports Jeremy VanDomelen

Passenger and cargo air traffic is up across the globe, and showing few, if any, signs of slowing. At the same time, a growing number of manned, unmanned, tethered, and untethered civil and military aircraft – including myriad unmanned aircraft systems (UAS), space launch vehicles or rockets, and aerostats – are vying for access to airspace alongside current fixed-wing and rotary-wing platforms.

Air traffic management (ATM) systems worldwide are being modernised to accommodate current and future growth without sacrificing safety. A great deal of attention has been paid to the hardware and software innovations being integrated into next-generation ATM systems, and less so to the effects these new technologies will have on air traffic controllers – until now. A consortium of ATM experts is hard at work to understand the effect of new, automated, and even autonomous technologies on air traffic controllers.

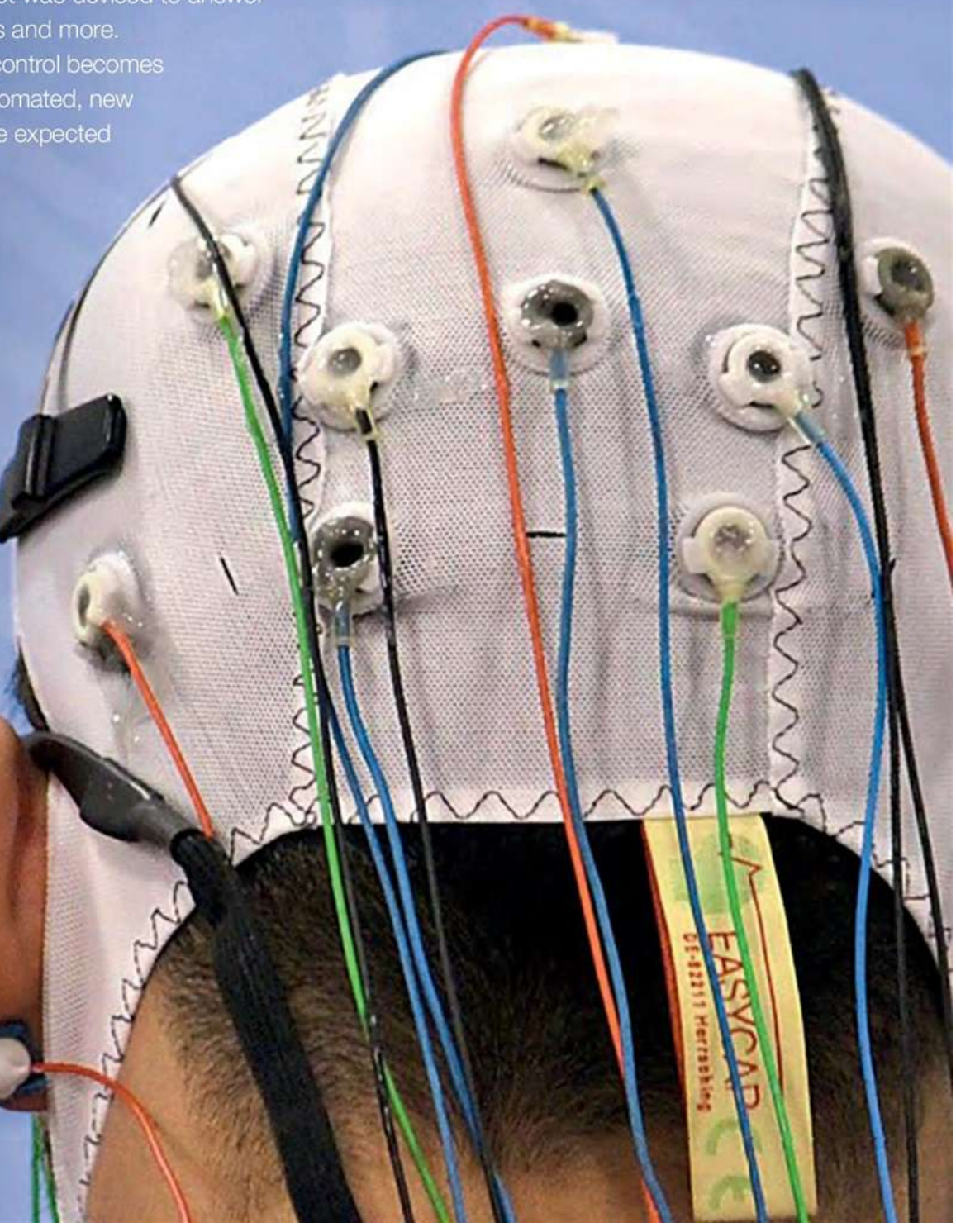
Air traffic control consistently ranks as one of the most stressful jobs, requiring complete concentration. Fatigue, attention failures, and other incidents brought on by stressors have caused errors, many of them significant, including accidents resulting in passenger deaths.

Consequences

Will the addition of technologies intended to ease controller workload and better ensure ATM safety and efficiency do precisely that? Or, will it have unintended consequences, such as making controllers' already stressful job more so or negatively impacting their ability to focus on the task at hand? The human performance 'neurometricS Toolbox foR highly automatEd Systems deSign', or STRESS, project was devised to answer these questions and more.

As air traffic control becomes increasingly automated, new technologies are expected to manage, with full or partial autonomy, tasks currently carried out by humans and to provide critical information to support humans' decision-making. This new scenario implies the need to redefine the roles and responsibilities of both technology and the controller, reassess the skillset required, revise training methodologies, and revamp human-machine interfaces to optimize interactivity.

New and automated ATM technologies are altering the roles and responsibilities of air traffic controllers 'from active control to monitoring of complex situations and managing unexpected system disruptions', according to officials overseeing the STRESS project. These changes are likely to affect controllers' stress level, emotions, attentional focus, and, ultimately, their performance.



The STRESS project is helping to determine the degree to which performance is impacted by looking at the human performance envelope (HPE), a new paradigm that considers a full range of factors, 'mapping how they work alone and in combination leading to a decreased performance that could affect safety'.

Specifics

STRESS is a Single European Sky ATM Research (SESAR)-funded project that falls within the framework of the European Union's Horizon 2020 research and innovation programme.

The 24-month project, spanning from June 2016 through June 2018, is designed 'to support the transition to higher automation levels in aviation, by addressing, analysing, and mitigating its impact on the human performance aspects associated to the future role of air traffic controllers', officials say.

The objective is to examine and understand the impact of new technologies and higher levels of automation on controllers' stress, attentional focus, and performance as they manage increasing volumes of air traffic. The STRESS project's end goal, ultimately, is to provide guidance on how best to design technologies that are 'compatible with human capabilities and limitations, ensuring the right balance between humans and automation in the future air traffic management system'.

STRESS benefits from ATM professionals who bring invaluable knowledge and extensive experience to the project through the SESAR 2020 Scientific Committee, STRESS Consortium, and participation in the study.

"My personal favourite [in the current SESAR exploratory research portfolio] is undeniably STRESS, a project which aims to find the ways to objectively measure controller stress, workload, and attention, and determine the correct balance between automation and humans," says Rita Markovits-Somogyi of HungaroControl and one of nine independent academics who make up the SESAR 2020 Scientific Committee. "I believe this area of research can bring us revolutionary new ways of thinking about how humans and machines can be integrated and may also bring about important safety benefits." (Read the full interview in 'Young, female and from the east: The new face of aviation research' at **ow.ly/Px-Qh30eThuO**.

Deep Blue, an Italian research and consultancy specialising in human factors, safety, validation, and scientific dissemination, serves as STRESS project coordinator. Sapienza University of Rome brings expertise in the measurement and analysis of neurophysiological signals and definition of indexes of human mental states and cognitive performance. The Ecole Nationale de l'Aviation Civile (ENAC), the French national school for civil aviation, provides access to ATM experts and a longstanding expertise in innovative interaction technology. Anadolu University adds its Faculty of Aeronautics and Astronautics state-of-the-art simulation environments and a deep knowledge of ATM needs. Lastly, Eurocontrol, including its safety unit, contributes quality experience in the application of human performance analysis to innovative concepts and deep knowledge in stress and fatigue management.

Structure

STRESS is divided into four phases, each centred on completing an essential element of the project. During the first six months of the study, the STRESS consortium completed the first phase: determining what ATM will look like in 2050. The future scenarios generated in this phase one serve as reference for the subsequent phases.

For phase two, which is nearing completion, the STRESS consortium set out to isolate the human factors that will be most relevant and impacted in the expected future scenario developed in phase one.

They established human performance indexes with which to measure stress, attention, mental workload, and type of cognitive control on tasks objectively using neurophysiological measurement tools, including electroencephalography (EEG), eye-tracker, and skin-conductance response measurement instruments. The indexes were then tested in an ad-hoc validation experiment. ▶

Handling Stress

Objectives

- To identify and validate neurophysiological indexes for monitoring in real time the controllers' mental state;
- To use them to study the impact of advanced highly automated system on controllers' performance envelope; and
- To provide automation design guidelines to support human performance during safe transitions from high levels of automation to low levels, and vice versa.

Phases

- Future scenarios – what will ATM look like in 2050?
- Human Performance Indexes – how can we objectively measure stress, workload, attention?
- Experiments – what's the impact of automation and its failures on controllers' performance?
- Design guidelines – how can we reach the correct balance between automation and humans?

Outcomes

- Future scenarios, completed
- Neurophysiological indexes, expected September 2017
- Human Performance envelope in future scenarios, expected March 2018
- Automation design guidelines, expected May 2018

Validation Study

The STRESS validation study took place at Anadolu University in Turkey over four days, from 6 through 9 June 2017. Sixteen ATC students were immersed in a simulated air traffic control centre environment, and asked to manage a realistic operational scenario designed specifically to induce different levels of stress and attention.

The consortium selected the radar environment in Anadolu, Turkey, and the en-route environment in ENAC in the context of Free Route Airspace as operational environments to be simulated.

The validation experiment used the Anadolu simulation platform with integrated measurement tools to measure stress and attention during normal and emergency air traffic control operations. The study supported the full and partial automation of controller tasks, including decision-making and implementing decisions via orders to aircraft. The neurophysiological indexes were used to evaluate the impact of automation on controllers' performance.

Measurement tools continuously recorded the participants' neurophysiological signals, collecting essential behavioural and performance data in real time, as they completed air traffic control tasks in different automation levels. Questionnaires were used to gather subjective data, such as the experimental subjects' perceptions and external experts' feedback.

Future functionality

Data gathered during the study is now being analysed to validate the human performance indexes, which will be used to assess air traffic controllers' performance in high automation scenarios during the STRESS project's next phase.

Information gleaned from STRESS and similar projects will help elevate the industry's understanding of human factors impacted by the paradigm shift to higher automation levels, and provide key guidelines to help technology companies engineer a future in which humans and machines complement one another. Automation is imminent, and industry is doing its part to ensure it is as stress-free and safe as humanly possible. ATM

Textiles technology to detect pilot stress levels

Smart textiles are be used to monitor stress levels in pilots as part of a major European research project involving Nottingham Trent University.

The university's Advanced Textiles Research Group – led by Professor Tilak Dias (pictured) of its School of Art & Design – will explore how smart textiles embedded in cockpit seats and pilot clothing can measure anxiety.

Indicators of stress including a variable heart rate, perspiration and body temperature will be monitored with a range of sensors which are embedded into the yarns which are used to make clothing and textiles.

As the heart rate is monitored via an electrocardiogram (ECG) sensor system, it will also be possible to monitor fatigue and tell when a pilot is losing alertness.

Professor Dias said: "By using smart textiles we're able to provide new prognostic and diagnostic techniques for pilot monitoring in a completely non-intrusive way.

"This will enable the collection of data which will indicate the psychological experiences a pilot goes through while navigating an aircraft, potentially through unknown situations."

The project – named Active Simulator Cockpit Enhancement (ASCENT) - is part wider research scheme to enhance cockpit simulators which is funded with £1.24 million from the European Commission. It is led by SerTec Engineering, Spain, with Paragon SA of Greece, and Nottingham Trent University in the United Kingdom as co-investigators.

Nottingham Trent University is responsible for the smart textiles development. Professor Dias will undertake the research with senior lecturer and researcher William Hurley.

Temperature measurement will be achieved with thermistors and resistance temperature detector (RTD) chips being embedded into yarns. A moisture sensing yarn will be developed as part of the research.

Invaluable

Hurley added: "The data collected via the smart textiles technology will be invaluable for the training and development of pilots and help pave the way for new technologies to be integrated into the cockpit quicker.

"By monitoring a pilot's mental state while testing any new technologies in a simulator, a better understanding can be developed of how these technologies can be integrated into a cockpit."

Areas to be investigated by the other institutions include eye-tracking technology, a lighting system to emulate the parallel ambient light of the sun, the design of a more user-intuitive cockpit, and more.

The development of this new technologies integrated into ASCENT will be possible thanks to funding from the European Commission within the Clean Sky Programme.