No. 569 | Jan-Feb 2019

THE ERGONOMIST

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ASSURING OUR AIRSPACE

Dealing with changing demands for aviation research 14

NUCLEAR KNOW-HOW

Understanding people-centred tasks in decommissioning 16

HEALTHCARE HELP

Getting guidance to where it's needed 22

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CONTENTS

The magazine of The Chartered Institute of Ergonomics & Human Factors

NEWS AND CURRENT AFFAIRS

APPLIED ERGONOMICS AND HUMAN FACTORS

COVER IMAGE: ALAMY

RESEARCH MATTERS

CIEHF NEWS

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FROM THE PRESIDENT

Make a difference

Neil Mansfield
CIEHF President

@profnjmansfield

It's that time of year when we review what we did in 2018 and look forward to what we want to achieve in our professional and personal lives. Through CIEHF, many members have found the opportunity to make a difference by taking on roles to develop our profession, and to participate in CIEHF initiatives that improve people's lives via ergonomics and human factors. Two years ago, I discussed the position of President of CIEHF with previous post-holders and decided to make a difference by standing for the role.

You will see elsewhere in this issue that it's time to start early planning for our next AGM, where we elect future Presidents and members for other key roles for the Chartered Institute. In an effort to make it easier for members to participate, Council have decided to work with a dedicated company who will provide independent electoral services for the next AGM. This will not only make it easier to vote, but also to nominate and stand for roles.

Whilst there are of course responsibilities associated with trustee and other elected roles, there are also great opportunities to work alongside others with an enthusiasm for ergonomics and human factors. It's enlightening to learn of our initiatives, and it can also be highly enjoyable! As you consider your future in 2019, why not consider standing for an elected role and making a difference through our Institute?

There are great opportunities to work alongside others

FROM THE EDITOR

A certainty in uncertain times

As we look ahead to 2019 and the uncertainties it brings for many of us, especially in the UK, one thing we can be certain of is the growing reach and influence of our amazing discipline. Take the sectors and topics covered in this issue just as an example: archaeology, rail, road, energy, healthcare, aviation, nuclear, wellbeing, manufacturing, accident investigation, children's development, and more.

Caroline Raynor and colleagues take us into the fascinating world of archaeological excavations and dealing sensitively with human remains. She explains how a people-centred approach to construction of the facility for cataloguing, washing and movement of the fragile skeletons has resulted in a truly fit-for-purpose environment.

A report back from our aviation safety event in November by Barry Kirwan and Will Tutton highlights the emergent risks and new technologies that the sector is having to deal with, from drones and future sky taxis, to growing potential cybersecurity threats.

The task analysis work described by Tim Southam gives us an insight into safety-critical activities on drilling rigs. Another high hazard area laid out in detail, this time by John Lovegrove, is that of nuclear decommissioning and the ergonomist's vital role in ensuring that all the human elements of the complex procedures involved have been considered.

There are a growing number of clinical guidelines written to assist healthcare professionals but just how usable are they in real life? This is the topic of a piece by Giulia Miles and Bryn Baxendale who look at a variety of initiatives to make guidelines more accessible at the point of use.

Two research projects consider very different aspects of safety. Lucy Milson investigates the effectiveness of autonomous vehicles in avoiding collisions with motorcyclists, and Alison Messenger looks at how young children manage stairs.

A look at ergonomics in Brazil and a day in the life of an office ergonomics specialist round off the issue.

My thanks to all contributors and readers of *The Ergonomist* for your support throughout the year. Happy 2019!

Tina Worthy
editor@ergonomics.org.uk
@ciehf

A DAY IN THE LIFE OF AN...

OFFICE ERGONOMICS SPECIALIST

Sukhneet Assee from Humanscale

During my early career in product design, I gained experience in design, product evaluation and compliance to standards. I'm passionate about the design of human-environment interfaces, anthropometry and how the built environment can contribute to worker health and performance. I also have expertise in programme and project management. Now, my role as an ergonomist at Humanscale includes many different tasks, and not one day is the same as the next. This is what makes it fun and exciting, as I get to meet new people every day. I've always enjoyed helping people, so when I'm either training or facilitating an ergonomics assessment, I feel like I'm helping people with the preventative approach that ergonomics can bring.

Founded in 1983 by CEO Robert King with a focus on high-performance tools that support a healthy, more active way of working, Humanscale has a global reputation for designing intuitive products which improve the comfort and health of office workers, allowing workstations to adapt to the user, not the other way around. The Humanscale consultancy team consists of more than 30 consultants from different backgrounds, including human factors, interior design, biomechanics, physical therapy and kinesiology.

Day to day I help organisations develop proactive ergonomics programmes that aim to minimise absenteeism, reduce workplace injury and encourage productivity. Healthy workplaces ensure employees are looked after by their employers, from the quality of the environment (including light, air, acoustics and heating), to provision of the correct tools to do the job in hand. Enlightened businesses have become increasingly aware of the benefits of ensuring that employees are supported and looked after in all areas of their lives, recognising that happy and healthy employees are also more productive.

The research-based training and assessment programmes that I help set up aim to improve worker comfort while lowering the risk of injury, which can become a huge cost to an organisation if not managed well. I primarily work with clients to build and develop their ergonomics programmes, whilst selling our services through key stakeholder meetings and presentations. The programme's success depends on an organisation's ability to transfer knowledge to employees. To that end, I help employees make the behavioural changes necessary to work more comfortably and with less risk. An effective approach entails a focus on workstation design and employee education.

I deliver a two-day 'Train the Trainer' course in office ergonomics which is designed to enable individuals to carry out competent ergonomics assessments. On day one, I help attendees to identify and mitigate common musculoskeletal risk factors. I show participants how to evaluate workstations for fit and make adjustments to improve worker comfort. We also discuss basic human anatomy, common musculoskeletal disorders, components of ergonomically designed workstations, and a review of current ergonomics research. On day two, emphasis is placed on the ergonomic assessment process. I run several group activities that focus on delivering employee education, affecting behavioural change and handling objections. The day culminates with a mock workstation assessment where skills learned throughout the course are applied.

Education is at the heart of our work ethos and I believe that a small amount of learning can go a long way, especially when teaching people about the basic principles of ergonomics and what to do to keep well at work. This is especially true in today's working culture, where people are moving from fixed workstations to more agile methods of working, using mobile devices and varied locations.

My professional interest lies in the office environment, where challenges are not limited to physical discomfort but also the psychosocial catalysts such as stress, which has a huge impact on health. Care for employees is evolving, as we learn more and more about what 'healthy' means. We're very aware about the benefits of exercise and healthy diets, and more recently mental health is now much higher on the agenda too. It makes sense that these concerns are investigated and addressed at our places of work

Sukhneet Assee is an Associate Ergonomist with Humanscale UK & Ireland. She has an MSc in Applied Ergonomics from the University of Nottingham.

I help people with the preventative approach that ergonomics can bring

Data display for anaesthetists

Healthcare professionals in intensive care units and operating rooms are responsible for several patients at once but monitoring multiple patients can be challenging when you need to move around out of sight of monitoring equipment. The portability of a hands-free head-mounted display could allow monitoring of vital signs constantly and independently of location. A project to develop such a system was carried out by Paul Schlosser, an MSc student at the Institute Human-Computer-Media, Julius-Maximilians-Universität Würzburg, Germany, for which he has won the 2018 Dieter W Jahns Student Practitioner Award from the Foundation for Professional Ergonomics.

Paul worked with the Department of Anaesthesia and Critical Care at the University Hospital of Würzburg to complete his project 'Multiple Patient Monitoring with a Head-Worn Display: Improving Supervising Anaesthetists' Situation Awareness in the Operating Suite'. Paul evaluated the potential of a head-worn display that showed multiple patients' vital signs and alarms to allow supervising anaesthetists to continuously monitor their patients' status. The Head-Worn Display supported the anaesthetists in developing and maintaining situation awareness, helping them to detect patient deterioration, to make informed decisions on treatment, to set priorities dynamically and even to check the occupancy of the operating theatres.

Paul said: "I really appreciate this prestigious honour at such an early stage of my academic career... it will most certainly boost my application for a PhD position." Read more at **http://bit.ly/2U7TBE4**

The runners-up included Sara Pazell from the University of Queensland, Australia for her project on 'Good Work Design - Strategies to Embed Human-Centred Design in Organisations', and Husam Muslim from the University of Tsukuba in Japan for his work on 'Human Factors Issues Associated with Automation Interventions in Safety-critical Situations during a Lane-change'.

A helping hand in your early career

If you're a student and you're submitting a paper or poster to a conference next year, you could get up to £500 to support your travel to the event, through the CIEHF's John R Wilson Travel Bursary. There's no closing date but only three awards are available in any one year so keep it in mind. Find out more at **http://bit.ly/JRWaward**

IMAGES: ISTOCK/GETTY/SHUTTERSTOCK

Intelligent mobility

As driverless, electric transport becomes more prevalent and smart technologies help us to navigate and connect with the places we live and work, the University of Nottingham has launched a new initiative to ensure such innovations lead to sustainable, healthy and productive cities of the future.

With a virtual presence, TMC@Nottingham (Transport, Mobility and Cities) is the first of its kind in the UK to run in partnership with the Transport Systems Catapult. The University itself will become a living test bed for several of the TMC activities to support its future vision as a smart campus.

As part of the initiative, a data-driven approach in human factors is supporting research in behavioural segmentation and predictive modelling techniques to support personalised journeys of the future and the design and evaluation of human-machine interface technologies for driverless vehicles.

CIEHF Fellow and co-founder of TMC@Nottingham, Professor Sarah Sharples said: "Understanding passenger decision-making and needs is important for identifying appropriate levels for embedding new technologies. Our capabilities include the systems modelling of passenger experience and the modelling of social media interactions. We've carried out research into passenger movement and accessibility to enhance the overall passenger experience."

Highly efficient transportation requires smart systems with digital communication infrastructure, sophisticated sensor systems, computer-based modelling, data science and artificial intelligence tools. Digital communications infrastructure will support highly connected mobility within cities.

Beata Szoboszlai, Head of Academic Engagement, Transport Systems Catapult, said: "Bringing industry, academia and government closer together to address the challenges facing modern transport systems and cities is a vital piece of the puzzle both to creating sustainable solutions and ensuring the UK leads in this area." Read more at **http://bit.ly/2KPwQkb**

Expected to create 50,000 jobs by 2020, the offshore oil and gas sector is among the top areas expected to see a hiring boost in tropical Brazil. With a large workforce, and introduction of a new occupational safety evidencing system, **Rosane Acacia Pereira Otsuka** believes the future is looking good for Brazilian ergonomists

An ergonomics perspective from Brazil

Samba, soccer and politics – three big topics that evoke the passion and spirit of the Latin-American country of Brazil, and for the last 150 years, it has been the largest global producer of coffee. With a population of 208 million, Brazil has the largest population in Latin America and half the population of South America. And whilst Brazil is the fifth largest gold producer and exporter of 'Ouro Negro' oil in the world, as a country, it falls worryingly short when it comes to occupational safety.

Whilst renewables are by far the fastest-growing fuel source, providing around 14% of primary energy, Brazil's National Agency of Petroleum, Natural Gas & Biofuels, states in its latest report that Brazil must boost its oil and gas activities to generate economic growth while these fuels still have significant value.

Pre-salt oil deposits are located offshore under deep, thick layers of rock and salt and require substantial investment to extract. With the discovery of pre-salt reserves in 2006, in the Santos, Campos and Espírito Santo Basins, the sector has gained even greater visibility in Brazil, with prospects for growth and generation in direct and indirect jobs in the national chain of offshore goods and services. The exploration & production sector, in particular, is expected to see a boost including 44 offshore production systems which are scheduled to start operating in Brazil by 2030, according to the Federation of Industries of the State of Rio de Janeiro.

With complex industry comes greater risks, which the Public Ministry of Labor (MPT) and other oversight bodies are now taking measures to mitigate. These measures aim to ensure decent working conditions in line with safety standards and with regard to laws and legislation. One example is the 'black gold project', set to establish strategies for the performance

of agencies such as the MPT, combatting labour irregularities for workers involved in exploration vessels and oil exploration platforms.

Brazil's Regulatory Standard NR-17, published in 1978 by the Ministry of Labor and Employment, provides parameters that allow "the adaptation of working conditions to the psychophysiological characteristics of workers, in order to provide maximum comfort, safety and efficient performance". In Brazil, ergonomists use their understanding of the human-machine interface to design and adapt equipment to ensure it functions in the best way possible for people, and investigate and recommend tasks and activities to take account of human capabilities and limitations.

We carried out a recent project using the Ergonomic Analysis of Work framework with the aim of providing recommendations to a large oil and gas company, to improve the biomechanical working conditions of their employees in accordance with Regulatory Standard NR-17. A survey of the ergonomic conditions was carried out through physical analysis of workstations. Observational data and photography, filming, and interviews with employees involved, were analysed alongside the furniture, equipment, machinery, tools and environmental conditions, with the purpose of identifying cumulative occupational injuries in the spine, upper limbs and lower limbs.

Working in offshore operations is incredibly complex, both in the technical requirements of the roles, and the long hours, social deprivation, space and confinement issues. The risks in offshore activities are diverse, including those from continuous work; there are not many non-working hours on an offshore rig as they operate continuously. We also considered the high cognitive and physical impact on the workers.

For this study, we observed the three large areas of activity in Navy, Maintenance and Drilling, in which 95% of the crew were male. We quickly identified three areas that required urgent ergonomic intervention. Shift work was the first as workers operated in 12-hour shifts for 14 days or longer, with breaks of 15-minutes for every three hours of work. This regime, combined with a change of shift every seven days, can seriously disrupted the workers' circadian rhythms, leading to reduced performance.

IMAGE: ALAMY

Offshore oil field at sunset off the coast of Brazil, Rio de Janeiro Campos Basin

We hope to see better prevention of risks and the development of a healthier workplace

From a physical workload perspective, there were high physical stresses, from repetitive effort and poor posture over long periods of time, to lifting and loading movements that caused muscle pain, including from rotary table operations and connecting ducts. There was also the ongoing issue of continuous exposure to noise and various climatic conditions (rain, intense sun) and chemical exposure (in the mixing of cementing fluids, for example).

From an organisational perspective, there appeared to be management and team interaction problems. These included difficult operational logistics with maintenance, arrival of ship supplies and delays in the issue of work permits, and a lack of clarity in the demands of supervision and training.

Unfortunately, there is limited time to analyse and understand the demands of work, which makes the job of the ergonomist difficult. There's a great deal of paperwork for shipments and landings, making more in-depth studies challenging and in addition, with each shipment there is often an exchange of teams.

One of the recommendations for improvement would be the use of automatic probes which, in addition to requiring a more technically qualified workforce, would reduce the physical requirements and offer a better quality of life at work. However, such a measure in the current economic climate would be unfeasible due to initial expense together with high taxes and debt in the country. There is also the issue of resistance in changing part of the operating system.

However, with the arrival of *eSocial* - a nationwide programme led by the Brazilian government to streamline the transmission of HR and payroll-related information from companies to the government in a centralised framework - there is hope for raising awareness of ergonomics and reducing the current negative attitudes surrounding the investment in occupational safety by the oil and gas companies.

From January 2019, when *eSocial* goes live, companies will need to take a new approach to occupational hazards and the identification of ergonomic risks. Compulsory for companies, taxpayers and public agencies, the system requires the registration of ergonomic factors such as stressful situations, repetitive movements and intensive work. Through this, we hope to see better prevention of risks and the development of a healthier workplace. We want to see the work environment more precisely controlled, resulting in benefits to the wellbeing of all employees.

Such measures are a challenge for ergonomists right now. In order to take forward the identified risks present in the workplace and the risks related to occupational activity of workers, there needs to be more clarity in the methodology used, as well as a better definition of the ergonomic risks. Whilst a challenge, the prospects in the near future for Brazilian ergonomists in this sector are very positive, with the future *eSocial* system requiring greater technical expertise and recognition of the ergonomist's specialisation.

Rosane Acacia Pereira Otsuka
is an Ergonomics Consultant & Physiotherapist

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CHIEF EXECUTIVE'S PERSPECTIVE

Aiming high but with focus

As 2018 draws to a close we begin to summarise the detail of what we have done as a body this year against our objectives within our Delivery Plan. And that brings into sharp focus the fact that our over-arching current strategy, 'Towards 2020' expires in 12 months' time. Our vision within that document, of 'Ergonomics Everywhere' which was agreed during a session with our Council members (our trustees) at Loughborough Design School in the summer of 2014, needs revisiting, renewing and refreshing.

In August of this year following a planned canvass of members nationwide, I invited four members to work with me and form a Strategy Working Group (SWG) to deliver a new strategy. That work began in October by bringing members Jean Page, Ian Rowe, Jim Taylour and trustee Will Tutton together with the rest of Council for a day of thinking about some options for a viable path forward. Following that day, current trustees Becky Charles and Bob Bridger offered to join the SWG to make a group of six and to provide the essential bridge back to Council.

We held our first meeting this month. Three more meetings and a further opportunity for all trustees to come together with the group will take place between now and September next year. At that time Council will be invited to endorse the strategic plan put forward which will take your Institute through from 2020 to 2025, a period riven with political and economic uncertainty.

Having a plan is fundamental to our aims of making a measurable impact in the right areas at a cost we can afford, fulfilling our charitable and Royal Charter obligations at the same time. It also means that if people change (our President changes every year, for instance, with no President remaining within the Executive Committee for more than three years) then the plan ensures continuity and transparency.

So, what can individual members do? You can begin by looking out for at least two webinars that will explain progress to date and invite questions. You can also lobby individual trustees with ideas (a list of all trustees is on the CIEHF website) or lobby the SWG directly. Or you can put your view to me.

There is a growing consensus that a more focused plan than we currently have would help. Breadth is part of the ergonomist DNA, but a good strategy identifies specific areas where timely opportunity can be united with capacity, a challenge all bodies face. Agreement to focus on some things does help in ruling other topics out, something the Institute has not been so successful at in the past. Aim high but aim with focus. I'm looking forward to seeing the plan evolve and to ensuring the plan fits fully with our capabilities.

I think that a greater integration of human factors into healthcare and a greater emphasis on the benefits human factors can bring to increase productivity as well as worker safety and wellbeing may well figure in this thinking. Human factors has long underplayed the productivity card and now, with next March looming into view on the European political stage, would be a good time to bring that card into play.

We have seen some tremendous hard work from many volunteers over the past year. My particular thanks to that group, and thanks to every member for your support via your membership this year. I hope it has increased your satisfaction about being involved in our discipline and being part of our community. Enjoy the Christmas season, and very best wishes for 2019.

Steve Barraclough
Chief Executive of the CIEHF
s.barraclough@ergonomics.org.uk

IMAGE: SHUTTERSTOCK

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Chartered Institute of Ergonomics & Human Factors

70 YEARS OF ERGONOMICS 1949-2019

Keeping tracks in top condition

Two rail workers grinding a section of welded track

Network Rail is rolling out more than 330 new grinding machines to help reduce manual handling injuries – the second-highest cause of lost-time injury for Network Rail's staff. Grinding removes layers of metal from the railhead to keep the track in good condition.

The grinding machines are portable pieces of equipment used by Network Rail's welding teams to reprofile the surface of a rail after a section has been replaced. The old grinders were heavy and had to be tilted and held in position, so workers were at risk of injury and fatigue. The new grinders are self-supporting on the rail and are designed to be quieter, lighter and easier to handle, at the same time reducing hand-arm vibration.

Network Rail's Safety, Technical and Engineering team, including engineers and ergonomics specialists, designed these new machines to be easier to operate, with the grinder itself significantly lighter at 55kg, than the old MP12 grinders which weighed in at between 70 and 86kg. The new machines also include a power pack, support arm and two sets of 'ergo handles' providing an improved, safer handling height for users.

The design, a collaboration between Network Rail, manufacturers Robel and maintainers Torrent, was commended in a recent competition run by the Health and Safety Executive (HSE) and the CIEHF and was showcased at HSE's first Work-Related Musculoskeletal Disorders Summit earlier this year.

Dr Elizabeth de Mello, Network Rail's senior ergonomics specialist and CIEHF Fellow, said: "The way in which these grinders were designed – with ergonomics at the heart – is an industry-first and demonstrates Network Rail's continued commitment to improving working conditions for staff.

"By working collaboratively with Robel and Torrent we have launched a new design that will help to maintain our railways for years to come. It's fantastic to be able to demonstrate the importance of human factors within all industries, including rail, and the positive effect our practice has on workers' health and wellbeing."

Robert Cox, Network Rail's senior engineer, welding and plant, said: "These machines show our commitment to staff and to wellbeing. They also show that innovation and great design is at the heart of improving the equipment we provide. As part of the project, we had nominated welders within the team whose input was vital in ensuring the overall success of the project." ●

IMAGE: ALAMY

AI in anti-submarine warfare

Thales is sponsoring a PhD at the University of South Australia's Behaviour Brain Body Research Centre to look at artificial intelligence (AI) and its application to the future of anti-submarine warfare. The research is a joint UK-Australia initiative that will help to optimise AI within complex maritime combat systems in support of human operators.

As Australia's maritime environment becomes more congested, the effective use of advanced AI will help operators to maintain their optimum level of effectiveness during periods of sleep loss, fatigue and high or low workloads.

With the end goal to find ways to ensure that the operator remains central in the maritime mission system, the results from the research will be integrated into spiral

The end goal is to ensure the operator remains central in the maritime mission system

capability improvements for Thales's sonar technology. CEO of Thales UK Victor Chavez said the research could be used in the Royal Navy's upcoming platform and maritime combat system procurements.

The University's Vice Chancellor, Professor David Lloyd said: "As defence and other industries increasingly integrate AI systems, expert research from the Centre will help to inform how people work best in these new environments, optimising operational performance and ensuring worker wellbeing."

Read more at **https://bit.ly/2ScpTw7** ●

"Are we doing the right aviation human factors research, and are we doing it right?" Opening the fourth Human Factors in Aviation Safety conference, **Barry Kirwan** posed this all-important question. After two days of learning and best practice sharing, Barry, together with **Will Tutton**, believe we're making huge strides towards the answer

Advancing aviation research

The view of many of the industry's top aviation experts, from pilots, air traffic controllers, trainers and engineers, to safety and human factors specialists, was unanimous: the world's airspace is changing as we deal with higher volumes of aircraft than ever before and move into a new age of digital aviation. How do we support these advances as a discipline, to ensure that human factors is embedded in the right places and makes maximum impact? And are we listening hard enough to those working on the front line to ensure progress is made in the right areas?

The findings from the latest Observational Platform for Technical and Institutional Consolidation of Research in Safety (OPTICS) report were presented at this conference which led to the question: is European aviation safety research delivering? We set out in 2013 to determine if Europe was doing the right aviation safety research to deliver us towards a safer future, in accordance with the goals cited in Europe's vision for aviation, Flightpath 2050. Four years later the team has analysed 243 safety research projects from all over Europe, and indeed, many of these projects are moving us in a safer direction, whether focusing on adverse weather, drones, human factors or resilience. From the resulting 'Top Ten' hit-list of urgent and strategic research needs, three are hugely pertinent to human factors: human-centred automation, new crew and team concepts, and passenger management, along with drones and cybersecurity as two key emergent issues where fast-track human factors research is needed.

Ultimately, the research found that human factors needs to be better harnessed, used more strategically and brought in as an equal partner to resolve key risks. One of the biggest takeaways from the OPTICS report, and from this year's conference, was that we face many challenges not uncommon to other sectors for example, getting our voice heard at Executive Board level, and being involved at the start of projects rather than towards the end. There are

also some huge opportunities in the wake of new, disruptive technologies that could put our profession firmly on the transformational agenda of aviation companies around the world, if our profession responds appropriately. But we must find simpler ways to talk about our work, such as by using the language of other professions, and be better ambassadors for the discipline.

Tackling headline issues

From drones and future sky taxis, to growing potential cybersecurity threats, we need to tackle 'headline' issues that CEOs are worrying about, including emergent risks and new technologies. Human-centred automation could be an example of low hanging fruit for human factors to harvest in 2019 via a 'state-of-the-art' report on automation, autonomy and AI, helping the industry engage more with human factors. Regulators such as the European Aviation Safety Agency (EASA) are also hungry for evidenced human factors information they can use to inform regulations, on a range of issues from automation and autonomy, to cockpit design, to fatigue.

Sarah Booth, from Clockwork Research demonstrated such an approach, as she shared her work at Cathay Pacific to evaluate the fatigue-related implications of reducing long-haul flight cover from four to three pilots. This work has now been adopted by the airline and embedded in their long-haul flight operations.

Another strong example with concrete outcomes for the industry, is the work being done at Jersey Airport. Peter Moore and his team are working towards the Channel Island's first ever EASA-certified remote tower for a relatively unique situation. Supporting the air ambulance service, business and tourism, the airport must never close, so a remote tower forms a significant element of the airport's contingency planning. Utilising eye-tracking technology, Peter and his team have identified the most effective monitor screen size to help increase the efficiency of Air Traffic Control Officer (ATCO) visual scan patterns and response times on a remote tower workstation. This work supports an increase in their performance and therefore the amount of traffic they can safely handle. Crucially, this work is now feeding into new EASA regulations.

Eye-tracking technology emerged as a key theme this year, and raised a crucial question: how can we use it to understand more about human performance? The technology has been tested now for 30 to 40 years, and many presenters talked about its application this year, but where should it really be used in our research?

Rhian Williams-Skingley and Courtney Jaeger of NATS showcased practical outcomes from the use of eye-tracking research, this time in the field of ATCO training where their study has identified gaps in their gazing behaviour. Gaining greater insights into where the controller is looking and for how long, NATS is applying the findings to new projects to support the transition of trainees from paper-based training to live operational systems, where the technology introduces greater amounts of automation requiring different visual scanning skills and habits.

Ensuring safe landings each and every time

Regulators are hungry for evidenced human factors information they can use

Replacing legacy approaches

There was much audience discussion on this theme during the conference, concluding that since this technology has come of age, we should be considering a CIEHF White Paper on human performance to outline accepted good practices, and highlight where objective methods (for example, psycho-physiologically-based approaches including eye tracking) could replace legacy approaches.

The digital age has made information storage and transmission easier than ever before but according to BAE Systems' Rob Becker, a vital, yet somewhat overlooked, part of the cybersecurity ecosystem is the human user. According to IBM, 73% of all breaches in cybersecurity can be traced back to 'user error' either through misconfiguration of programmes or misuse. His presentation covered the main threats to the civil and defence aviation sectors in cyberspace, highlighting a hugely important area for human factors to consider in 2019. Professor Chris Johnson of Glasgow University not only discussed cyber attacks, he practically showed us how it was done, culminating in a plea for more human factors involvement in this area, and also in developing the field of security culture.

While researchers are dedicating huge amounts of time talking to controllers, pilots, engineers and others in the aviation field, pilot and flight instructor Rick Drake added a note of caution. He believes there is a balance to be achieved between the technologically possible, and potentially commercially-driven use of new technologies, and the ones that will be truly accepted by the pilots flying the planes. "As pilots, we tend to stick with what works," he said. This is arguably an area where we should be reflecting on where we appropriately use user-centric methods approaches. This was an aspect that was excellently drawn out by Vicky Banks from the University of Southampton who demonstrated her work on involving the user in the Open Cockpit research project, using commercial line pilots rather than test pilots (as is sometimes the case in new cockpit development).

The closing session concluded that human factors research and practice is needed more now than ever before, particularly in civil aviation, and we need to raise our game, not just addressing issues but solving at least some of them once and for all. The conference committee will be reflecting on these issues and looking to see how we can focus on practical outcomes, decoding our world into irrefutable business cases that will rightly transform the future of aviation safety.

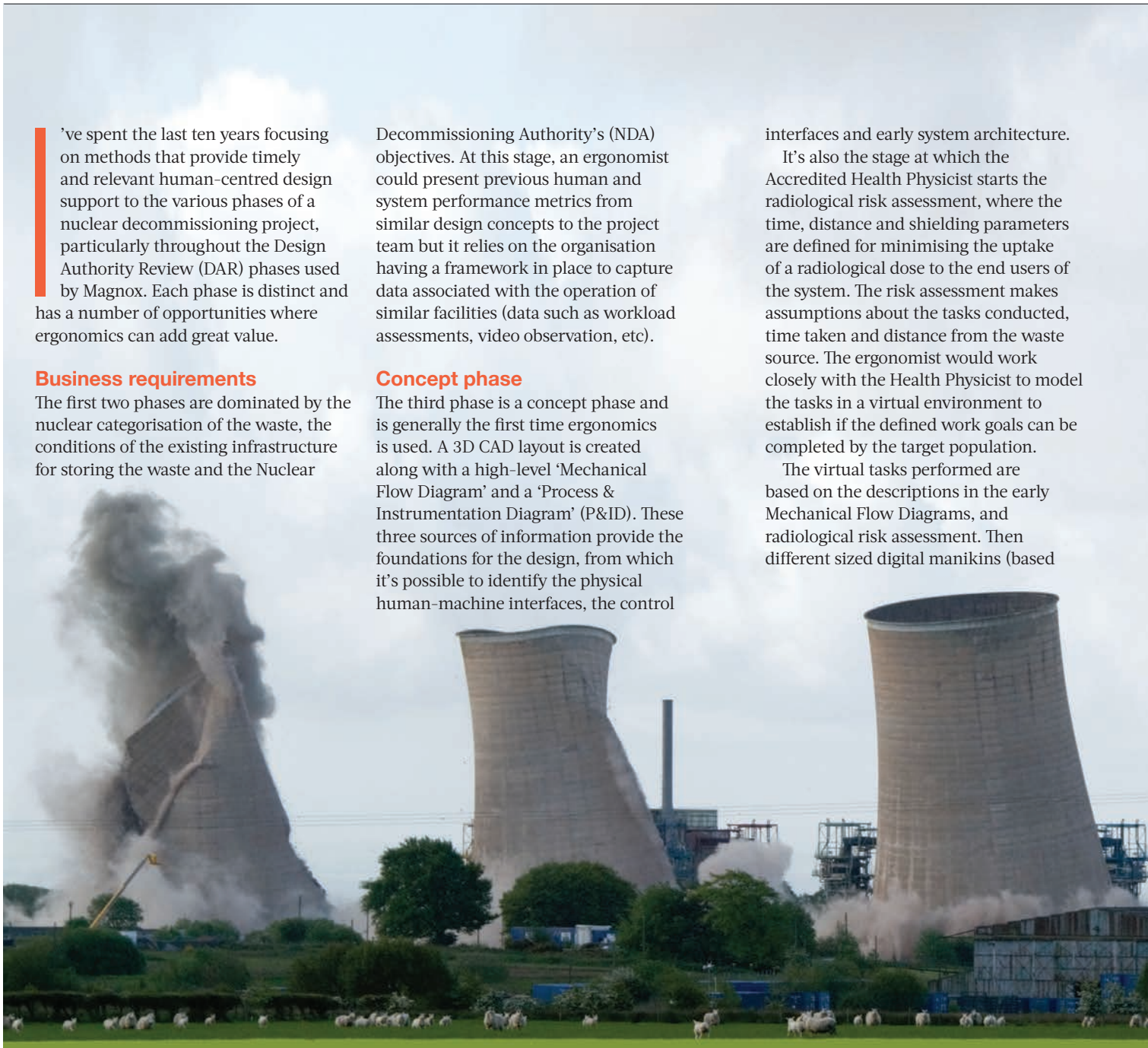

Barry Kirwan is Safety Research Coordinator at EUROCONTROL.

Will Tutton is a Senior Principal Human Factors Specialist at Dstl (part of the UK MOD).

Further reading

http://www.optics-project.eu/products/reports/

IMAGE: ALAMY



How to decommission a nuclear power plant

In a project as safety-critical as nuclear decommissioning, ergonomics can provide vital input, says **John Lovegrove**, as well as ensuring maximum engagement with the all stakeholders. Here, he explains the different stages associated with such a project

I've spent the last ten years focusing on methods that provide timely and relevant human-centred design support to the various phases of a nuclear decommissioning project, particularly throughout the Design Authority Review (DAR) phases used by Magnox. Each phase is distinct and has a number of opportunities where ergonomics can add great value.

Business requirements

The first two phases are dominated by the nuclear categorisation of the waste, the conditions of the existing infrastructure for storing the waste and the Nuclear Decommissioning Authority's (NDA) objectives. At this stage, an ergonomist could present previous human and system performance metrics from similar design concepts to the project team but it relies on the organisation having a framework in place to capture data associated with the operation of similar facilities (data such as workload assessments, video observation, etc).

Concept phase

The third phase is a concept phase and is generally the first time ergonomics is used. A 3D CAD layout is created along with a high-level 'Mechanical Flow Diagram' and a 'Process & Instrumentation Diagram' (P&ID). These three sources of information provide the foundations for the design, from which it's possible to identify the physical human-machine interfaces, the control interfaces and early system architecture.

It's also the stage at which the Accredited Health Physicist starts the radiological risk assessment, where the time, distance and shielding parameters are defined for minimising the uptake of a radiological dose to the end users of the system. The risk assessment makes assumptions about the tasks conducted, time taken and distance from the waste source. The ergonomist would work closely with the Health Physicist to model the tasks in a virtual environment to establish if the defined work goals can be completed by the target population.

The virtual tasks performed are based on the descriptions in the early Mechanical Flow Diagrams, and radiological risk assessment. Then different sized digital manikins (based

Demolition of four cooling towers at Chapelcross Magnox nuclear power station in Annan, Scotland

IMAGE: ALAMY

on 5th percentile females and 50th and 95th percentile males) perform the tasks within the virtual space. The virtual task simulations identify the workspaces, physical space required to complete the necessary actions and the identification of the loads associated with performing the tasks.

The P&ID is transcribed into a virtual control console to build up an early picture of the information available to the end users and whether or not it's satisfactory for them to control the plant to the performance level expected. It also provides the basis for a training simulator that can be used to familiarise users with the new system and to measure their response to alarms, alerts and prompts. It's also possible to add in the alarms and safety trips required to maintain the integrity of the plant and safety of the end users and general public.

Detailed design

Next is a detailed design phase, where the concept design and early human factors recommendations are input into the design cycle and the end user work organisation requirements are developed (such as Training Needs Analysis, operating and maintenance instructions, action on receipt of alarms). During this phase, fundamental design changes may occur and it's important that the ergonomist assesses the impact of those changes on the human-machine interfaces, control sequences and process steps by re-running some of the earlier analysis where the design has changed.

The detailed design culminates in a hazard and operability study (HAZOP) to identify the issues associated with the frozen design, and any outstanding issues are identified as actions. As a result of these, the ergonomist may identify trials to substantiate or qualify the operability and maintainability of the design during acceptance testing and 'inactive commissioning'.

Inactive commissioning

The inactive commissioning phase is the final dress rehearsal before the plant goes active and is the perfect opportunity to ensure the end users are familiar and comfortable with running the plant, for example during operations, maintenance, troubleshooting and recovery. This phase can often be shortened because of programme demands and it's important that the ergonomist prioritises user trials related to safety-critical tasks, that the end user understands their role in averting a potentially hazardous scenario, and that they know how to respond and make the plant safe before investigating the cause of a particular event.

The inactive phase also provides a good opportunity to dip test the work organisation, the quality and accuracy of the operating instructions, and the end users' competence and confidence in their own abilities to run the plant. The end users have to feel confident that the plant will behave as expected and within the operating parameters. Changes to the operating parameters, such as increasing the speed of a process to hit deadlines, must be fully tested and checked and the end users briefed before implementation. An effective measure of the end users' competence and confidence can be achieved using a workload index tool to identify the perceived demands on them.

Eye tracking software can be used to record how the end users interact with the human-machine interfaces, control consoles and operating instructions. Use of this software can determine the effectiveness of the operating instructions and control console design, and valuable lessons can be learnt for future projects.

Active commissioning

This phase is the first time that the plant equipment comes into contact with the waste medium and issues often arise associated with unknown characteristics of the waste (such as lumpy resin). There are usually a pre-determined number of waste packages that require processing during this period and any problems arising are worked through by changing some of the operating parameters. It's extremely important at this stage to ensure that the operators are fully briefed on the emergent issues and the necessary parameter changes. The operating instructions and training material are updated to reflect those changes.

Operations phase

This is where the project team hand the plant over to the operations team to run until the cessation of the planned decommissioning campaign and an end point is agreed with the NDA. During the operations phase, all the information associated with the decommissioning campaign is recorded for each waste package and collated as a through-life record, which stays with the package until final disposal.

The ergonomist should periodically visit the decommissioning facility throughout the operations phase to pick up on changes in system and human behaviour as the campaign progresses. There may have been changes to the configuration of the plant, workarounds implemented to remedy failing equipment, inconsistent waste characteristics or even resource issues such as fewer operators available to run the plant. It's worth re-running the workload index to see if the workload has altered from the initial study during the inactive commissioning phase. The learning during the operations phase is vital for designing out issues on future iterations of the plant.

De-plant and decontaminate

Finally comes the de-planting phase. The end condition has been reached and the facility is initially decontaminated and then de-constructed into modular sections either for disposal or for re-use at another location on site or even transported to another site, if the safety case allows it. It's generally the realm of Health Physics to survey, decontaminate and confirm that the facility is safe to de-plant. An ergonomist could add value by capturing how easy it is to decontaminate and de-plant the equipment. Requirements would then be fed back into the design phases of similar projects.

John Lovegrove is a human-centred designer with an education in ergonomics. He has experience across multiple industries and has worked in nuclear decommissioning over the last 10 years

This article follows John's first piece, 'The right approach' in *The Ergonomist* Mar-Apr 2018, where he explored the overarching decommissioning tasks and the requirement to understand the system and roles performed.

Preserving the past

As part of the HS2 archaeological dig - the UK's biggest ever excavation - **Caroline Raynor**, **Jason Bicknell** and **Andrew Foster** give us an exclusive tour of a new archaeological facility supporting the sensitive process of excavating and preserving remains from over 61,000 burials

Archaeologists, particularly those working within commercial archaeology, have often been swift to adopt new forms of technology. Laser scanning, 3D-photogrammetry and unmanned aerial vehicles have all been added to the archaeological toolkit over the past decade, even if they're still used in tandem with a trowel.

However, archaeological processes which have become commonplace over the last hundred years of the discipline, are rarely challenged or scrutinised and therefore not readily subject to change. One such area is 'finds processing', specifically the way in which human and cultural remains are processed and managed prior to post-excavation assessment and analysis.

Commercial archaeology in the UK is inextricably linked to construction and developer-led programmes of work. HS2, or High Speed Two, is Britain's new railway that will connect the city centres of London, Birmingham, Manchester and Leeds. 345 miles of new high-speed track is expected to carry over 300,000 passengers a day, that's around 100 million a year, when fully operational in 2033. The recent commencement of works on HS2, where archaeology is taking place on an unprecedented scale, has given cause to re-assess these post-excavation processes and effect a major change by implementing lean practices and ergonomics to improve efficiency and reduce waste. Uniquely,

IMAGES: SHUTTERSTOCK

this approach has been led by the construction team.

HS2's Enabling Works contract is the focus of this study where a huge programme of works is currently underway in St James's Gardens, Euston. This former post-medieval cemetery site was in use between 1789 and 1853 and closed as a result of the Metropolitan Burial's Act of 1853. Although only in use as an extra-parochial burial ground for St James's Piccadilly for 64 years, the site is believed to have received around 61,000 burials. An extensive programme of archaeological investigation, the largest in the UK to date, will generate many artefacts and human skeletons which will be assessed and studied by a specialist team of osteologists. Archaeology and civil engineering works are being delivered by the Costain-Skanska Joint Venture with a key mandate to carry out the works with dignity and respect.

Squeezed for space

The immediate challenge was to a design a site-based facility which could efficiently cope with the influx of skeletalised remains and artefacts, particularly when space on site in Central London is extremely limited.

The Costain-Skanska project LEAN practitioner, principal archaeologist and business improvement consultant, all worked with the key suppliers to produce an outline process. This was supplemented by site visits to existing archaeological processing facilities to witness current industry work practices. It was evident that no prior ergonomics considerations had been given to facilities of this kind. Interviews and discussions with field archaeologists helped to identify how we might improve their working environment. The aim was to apply lean practices and ergonomic design to the process of managing and handling archaeological artefacts.

The facility comprises laboratories on the ground floor and offices on the first floor. A production line approach was adopted with the 'loading' of the artefacts closest to the dig site and the 'output' point closest to the site haul road, allowing for easier loading and transportation at the end of the process. The laboratory contains four key work areas all of which can be readily accessed by ramps for ease of movement.

Arrival process

The first room is a pre-store facility, used for receiving all artefacts and skeletalised remains from the archaeological excavation. When the excavation process is complete, the artefacts and remains arrive in archaeological 'finds bags' with digitally-generated unique context finds numbers which follow the items through the process. Once booked into the pre-store area, the artefacts are placed on bespoke racks for storage and pick up. The racks were designed using anthropometric data to specify maximum height and gangway widths to accommodate access.

All through-routes in the facility were designed to allow two people to pass each other while carrying trays of artefacts without risk of collision. In the drying room, an additional 0.6 metres was added to the thoroughfare to permit the removal of trays whilst people pass along the route at the same time.

Protecting the integrity of the archaeological data set by limiting cross contamination was key to the design process. Dimensions between rack surfaces were determined by the calculated height of an excavated set of adult human remains (skull diameter being a key determinant). Utilising the pre-store as a depository for recycled finds bags allows the team to collect additional supplies at the same time as depositing previously dug materials, as well as reducing waste and materials cost.

The painstaking work of moving skeletal remains

Archaeology and civil engineering works are being delivered with a key mandate to operate with dignity and respect

Accommodating capacity

The overall facility arrangement was designed around peak site outputs. Flow rate into the facility has been calculated by estimating the distribution of a known number of burials across the site per metre cubed and understanding the average productivity rate of a field archaeologist in each set of conditions.

The pre-store capacity is used to level off the facility operating flow rate to ensure those working in the next area (the finds processing/wash room) are loaded to 100%. This is necessary to alleviate fluctuating outputs from the dig site, where it's anticipated that variations in burial density across the cemetery, combined with the archaeological sampling strategy, will see an irregular flow into the facility.

Using a first-in first-out inventory control system, bagged skeletalised remains are taken into the finds processing area and placed at one of seven workstations on the 'unprocessed' work bench. The remains are removed from their bags and the bags washed and placed for collection and placement in the pre-store area. The remains are then carefully washed by hand in a mesh topped water tank in the central area of the workstation. Once clean, each skeleton is arranged across three lined trays containing the original unique identifying context number. These are placed on the 'processed' or clean work bench ready for collection and transportation to the drying room.

The observation of current processes, together with interviews, showed a very clear desire by people to work in a standing position. To accommodate this, the washing area working surface is set to the top of the recommended range for kitchen work surfaces. The standing areas in front of the wash tanks have adjustable height plinths with anti-fatigue matting to allow the space to be suitably adapted to individual needs. All tools are placed on a shadow →

The temperature and humidity-controlled drying room with its colour-coded racks

board which forms part of the workstation minimising stretching, reaching and fatigue. The washroom floor is tanked and sealed with drainage channels to allow effective management of water and to aid cleaning at the end of each day. The floor has been designed to the same standards as those used for public swimming pools and shower areas.

Due to the sensitive nature of the activities, where working with human remains is carried out in line with a strict set of legal and ethical mandates, there are no windows in this room aside from small hopper windows at ceiling height to encourage air flow. A series of archaeologically-themed stickers with vivid colours applied to the interior wall provide a more pleasant working environment.

Optimal conditions

Washed remains are collected and taken to the third room in the linear process - the drying room. This room is temperature and humidity-controlled and populated with bespoke drying racks designed and built on site. Each shelf location has space for three trays of 45 by 35cm which together hold an adult skeleton. Battens are used to separate storage bays and guide the trays as they are inserted and removed at the beginning and end of the drying process. All shelves are lined with a fine gauge nylon mesh to reduce friction on the base of the tray, easing handling and reducing the risk of musculoskeletal strain as well as preventing accidental co-mingling of remains. This is important as each skeleton must remain separate to ensure the integrity of the osteological data set. Trays placed to the rear of shelves can be retrieved using a simple tool which hooks onto the lip of the tray.

A takt time approach has been applied to the end-to-end processing of the facility. The drying cycle for an adult skeleton is a maximum of five days although this can vary depending on several factors including age, sex, bone density and the effects of time on the bones. To remove complexity and reduce the risk of unbalanced workload, all skeletal remains remain in the drying room for the full five-day period.

Archaeology is taking place on an unprecedented scale on the HS2 project

The capacity of the drying room accommodates an output in line with the peak flow of the excavation. Each bay represents a day of archaeological processing activity where seven people each handle and wash eight sets of remains. The layout has been designed to allow the processors to introduce new material to the room without clashing with the osteology team who will be removing skeletal remains and artefacts for analysis in room four - the osteology lab. Each bay is visually and physically demarcated using colour coding to avoid confusion and make the division clear.

Once removed to the osteology lab and work room, the post-excavation analysis process begins. Here, each osteologist has a designated desk space designed to accommodate the three trays carrying a single skeleton. Space has been allowed for osteometric boards (which are used for forensic measurement), photography and microscope work as required. These facilities fully meet the requirements for the process of effective rapid osteological analysis. Once assessed, the skeletal remains are carefully boxed in line with UK archiving standards and Historic England guidelines. Archival boxes are palletised ready for removal to a permanent archive.

The archaeological excavation is just starting and a 12-month period of assessment and feedback will provide data to assess the suitability of the design and generate ongoing input to manage any improvements. A key outcome of this work is to show that two historically disparate sectors, that of archaeology and construction, can learn from each other to achieve productive and efficient facilities. By working together and sharing learning, we're aspiring to design archaeological practice in a way that has never been attempted before.

Caroline Raynor is Principal Archaeologist for Costain-Skanska and Work Package Manager delivering the archaeological programme at Euston. She has a particular interest in uniting archaeology and engineering.

Jason Bicknell has an extensive track record of applying LEAN and Business Improvement programmes into a diverse range of industries such as IT and rail but this is his first foray into archaeology.

Andrew Foster has a proven track record of sustainable business improvement and has a hands-on approach to systemic design and organisational solutions.

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- Parallel sessions including talks, workshops and discussions on the following themes: rail, aviation, health, automotive, defence & security, manufacturing, technology, safety culture, cognition, health & wellbeing, tools, methods
- 4 keynote presentations
- More than 20 poster presentations
- Doctoral Consortium featuring latest PhD research
- Riverside setting in historical Stratford-upon-Avon

Institute Lecture by Dr Lauren Morgan, University of Oxford

Lauren is a lecturer in Human Factors and Patient Safety in the Nuffield Department of Surgical Sciences at the University of Oxford and she is director of their Postgraduate Certificate in Patient Safety. Recently Lauren has led presentations to the GMC on human factors and, as a result, she has now been invited to design their programme of work to integrate human factors into their work processes.

Donald Broadbent Lecture by Dr Nicola Millard, Head of Customer Insight & Futures, BT Global Services Innovation Team

Nicola combines psychology with futurology to try and anticipate what might be lying around the corner for both customers and organisations. She has been with BT for over 25 years, working her way around the business including research, user interface design, customer service and business consulting. She was involved with the first application of AI into BT's call centres, BT's initial experiments with home working and developing new ways to measure customer experience.

Keynote by Professor Paul Salmon, Fellow of the University of the Sunshine Coast

Paul is director of the Centre for Human Factors and Sociotechnical Systems at the University of the Sunshine Coast. He has spent almost 20 years conducting applied human factors and ergonomics research in areas including transport, defence, sport, cybersecurity, urban design and disaster management. Paul's current research is focused on better understanding of major societal issues.

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Creating better clinical guidelines

Accessibility of clinical guidelines is critical to their safe and effective use by healthcare professionals. Human factors brings essential input that's currently missing in the writing and implementing of such guidelines, as **Giulia Miles** and **Bryn Baxendale** explain

Clinical guidelines recommend how healthcare professionals should care for patients with specific clinical presentations. They can cover any aspect of a condition and may include recommendations about providing information and advice, prevention, diagnosis, treatment and longer-term management. Guidelines may be produced at a national level in response to expert consensus based on critically-reviewed evidence or developed locally in response to specific, identified needs that are pertinent to the organisation, clinical service or patient demographics.

Guidelines are accessed by a wide range of healthcare professionals who will have varying levels of experience and expertise within the topic covered. They are typically made available to clinicians via an organisation's intranet as well as in paper format and these will be accessed during routine clinical work or at times of urgent or rare critical events. Increasingly, clinicians may also access guidelines via personal smartphones or other devices that have not necessarily been approved by the organisation governance mechanisms in which they work.

The National Institute for Health and Care Excellence (NICE) have published renewed standards about developing guidelines that concentrate primarily on scrutinising and assuring the evidence and content of clinical guidance to be published. However, less attention has been paid within the healthcare sector to examine the accessibility and usability of clinical guidelines within the work context.

A multidisciplinary approach has been taken at Nottingham University Hospitals NHS Trust (NUH), a large acute NHS teaching hospital with approximately 15,000 staff, to inform and improve the accessibility and usability of clinical guidelines. NUH has over 500 current clinical guidelines and clinicians are advised that: "Clinical guidelines are guidelines only. The interpretation and application of clinical guidelines will remain the responsibility of the individual clinician."

With this in mind, the key challenges for the organisation include:

- Maintaining a current relevant list of guidelines and managing the large number of guidelines required to address the complexity and diversity of healthcare conditions and presentations.
- Ensuring guidelines address the needs of a wide range of potential users and their contexts of clinical work.
- Lack of a robust method to implement guidelines and ensure they are appropriately understood and applied. Current practice relies on retrospective review often as part of serious incident investigation.
- Ensuring that guidelines are accessible when required at the point of care to clinical staff via a number of different routes.

The Trent Simulation and Clinical Skills Centre (TSCSC), based at NUH, has developed a unique multidisciplinary approach to address the issue of clinical guideline design and accessibility by bringing together clinical, human factors and simulation expertise and experience in one team. A number of interventions have been undertaken by the TSCSC team to address some of the key challenges.

Development of a guidelines app

As a teaching hospital, the clinical workforce consists of permanent qualified staff such as nurses and medical consultants as well as a large percentage of doctors in training who can rotate every four to six months between different specialties in the same trust as well as across different trusts in a region. Each trust will have their own approach to guidelines, and doctors in training have to adjust rapidly to their new contexts and clinical environments.

At NUH guidelines were previously only accessible via the Trust's intranet and access to computers in clinical areas was limited often only to two to three fixed computers on a ward, in shared offices or other communal areas away from the clinical environment. The intranet provided an element of version control by ensuring that only up-to-date guidelines were made available in only one place but in practice this resulted in guidelines being relatively inaccessible at the point of care. Guidelines were frequently printed and kept locally with the risk that out-of-date guidelines were being used to inform decision-making. Increasingly medical

staff would also access non-approved guidelines via their personal smartphones.

NUH supported the development of a NUH Guidelines App which could be downloaded by NUH staff to personal or Trust devices thereby improving access to guidelines at the point of care. The app was designed using a human factors user-centred approach to ensure easy navigation through the volumes of guidelines available. It included mechanisms to flag when guidelines had been changed reducing the risk of out-of-date guidelines being in circulation. The app also supplemented and enhanced usability of intranet-based content and provided an accessible and quick reference that met organisational assurance requirements. Doctors in training gave high approval ratings to the app and its use increased in its first year.

Using simulation to assess policies

Nursing staff reviewed a draft intravenous drug administration policy prior to implementation and took part in a simulated drug administration scenario of either an infusion or direct injection. Participants completed a post-simulation questionnaire and took part in semi-structured interviews. The study identified a wide range of factors relating to the usability of the policy. It was able to show that simulation using simple scenarios allows the safe evaluation of new policies and engages front line staff in designing their own healthcare system.

Assessing a draft guideline

A combined human factors and simulation study was designed to assess whether a draft hyperkalaemia (high potassium levels in the blood) guideline was safe and effective for the intended users, uses and use environments. Thirty-six doctors and nurses participated in a multi-stage approach:

1. A high-fidelity hyperkalaemia simulation scenario was run during an existing Foundation Year doctors' simulation course. The scenario was observed by the TSCSC team and afterwards participants completed a short questionnaire and fed back comments.
2. Experienced medical staff visiting the TSCSC on this or similar courses were asked to read through a paper copy of the guideline and complete a questionnaire about accessibility and clarity of the guideline.
3. A low-fidelity workplace-based simulated scenario for nurses was designed and set up in a clinic room on an acute medical admissions ward. Nurses were observed undertaking a task requiring use of the guideline after which they completed a short questionnaire and fed back comments.

Findings from the study identified a series of issues relating to accessibility of key information, design and flow of algorithms and charts contained within the guideline, and unclear or confusing language and instructions. Recommendations identified from the testing of both guidelines were reported to the relevant clinical committee and changes were implemented.

Clearer pathways needed

Usability for a diverse community of staff needs to be considered from the outset when developing any clinical guidance. TSCSC's involvement in the guideline testing took place when the organisation was at the point of final approval and implementation. Earlier engagement of the multidisciplinary team in the process would allow enhanced user engagement and identification of needs with a better understanding of context of use to inform design iterations.

These studies were essentially opportunistic, coming about based on conversations amongst a small network of colleagues. There is a need to develop a clearer pathway within the organisation for the 'commissioning' of such work and also in ensuring that reports are widely shared and learning is applied across the organisation.

There is currently no methodology to measure the impact and value of a combined human factors and simulation approach in healthcare. Developing a tool that's able to clearly measure and demonstrate the value and clear benefit is essential to ensure that this approach has recognised validity and provides the organisation with robust evidence to support the use of scarce resources for such work.

Giulia Miles is the Centre Manager of the Trent Simulation & Clinical Skills Centre (TSCSC) at the Queen's Medical Centre Campus, Nottingham and holds an MSc in Human Factors and Ergonomics for Patient Safety from Loughborough.

Professor Bryn Baxendale is the Director of the TSCSC and a Consultant Anaesthetist.

Further information

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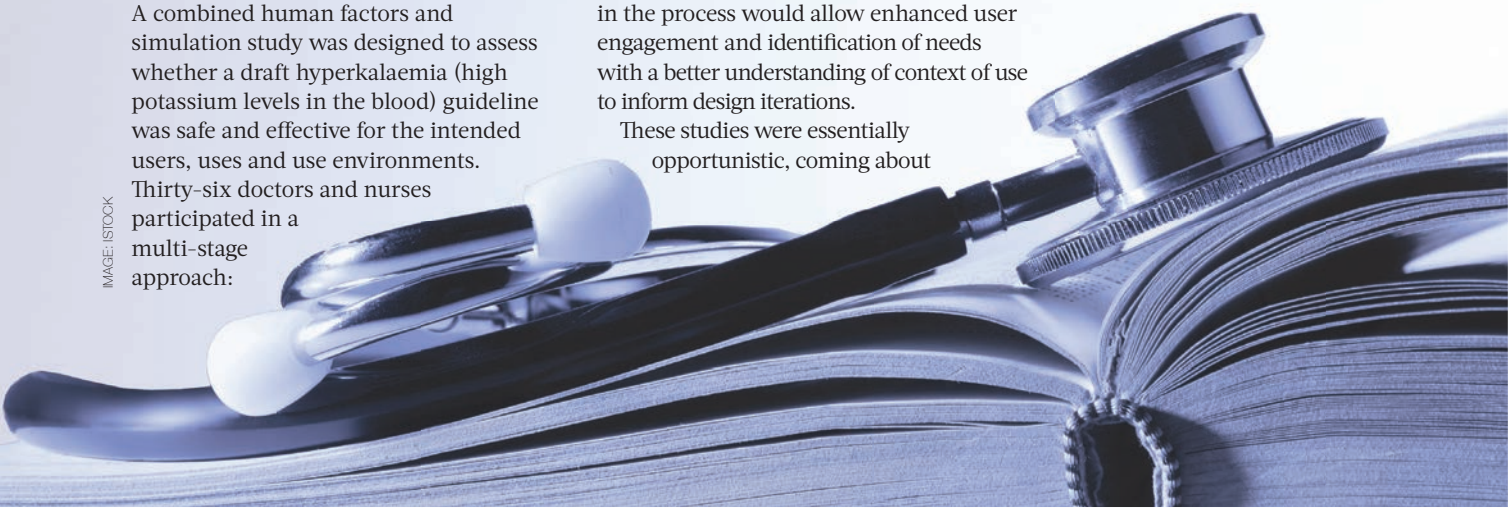


IMAGE: ISTOCK

Reducing the risk of human failure

We know from experience that it takes time and a great deal of investigative work to understand the true causes of tragic events such as Piper Alpha, the Tornado mid-air collision in 1988, or the Herald of free Enterprise. **Tim Southam** describes a study to better understand the complexities of 'human failure' to minimise major accidents

Many of us embark on the relentless pursuit of delivering incident-free operations in every sector but so often the focus is only on the behaviours of the operators, where clearly the operator has been set up to fail through poor design or unworkable procedures. Do we really learn the lessons of experience? Do we spend money wisely to stop it happening again? The uncomfortable truth is that many organisations are still not at a level of safety performance that they should be and this, in part, can be attributed to not applying human factors engineering design principles early in a project. This is still a problem today even with the Health & Safety Executive's focus on demonstration of a process of understanding human failure within a safety case.

The benefits of addressing human factors engineering issues are threefold: improved management of major accident hazards; reduced risk of occupational illness and accident; and more immediately, optimised operator performance.

It's now widely accepted that the human contribution to accidents and loss-producing events is significant. Figures of 80 to 90% are often quoted as being due to, or associated with, human failure. However, these figures have little meaning, since they fail to answer some basic questions such as: Where do the problems occur? How and why do they occur? How can they be prevented, reduced or mitigated against?

The workers are responsible for keeping the underbelly of the oil rig in good shape

IMAGE: GETTY

Identifying safety-critical tasks

Safety-critical tasks can be thought of as those where human causal factors and personnel activities have a contribution to the management of Major Accident Events. We ran a workshop on the Ocean GreatWhite drilling installation to investigate generic and rig-specific tasks using a methodology taken from the Offshore Technology Report, OTO 1999 092, 'Human Factors Assessment of Safety Critical Tasks', together with Energy Institute guidance.

Stage one of the workshop was to identify the key operational tasks performed on the installation. This took many hours and provided the input for an assessment of task criticality based on the following five criteria:

1. The hazardous nature of the system where the task was being performed.
2. Sources of escalation.
3. Changes to the operating configuration.
4. Potential for equipment damage.
5. The need to not defeat protection devices.

However, this is often where the first challenge starts, in that not everybody understands what constitutes a major accident hazard, or indeed understands what a safety-critical task is. The participants involved in the first stage of this workshop were often different and from different shifts. Some participants had a knowledge of the whole installation, whilst others were individual engineers and operations personnel involved in the drafting of the procedures. Valuable time was consumed in deciding and condensing a long list into one that was manageable, to demonstrate for the safety case, the process of understanding the causes of human failure.

Stage two of the workshop was decomposition of the tasks into their component parts to build up a Hierarchical Task Analysis. This was where the generic core activities list could be modified to rig-specific activities. A flowchart depicting the subtasks required to conduct the task was produced for each core activity.

The final stage required identification of the key sub-tasks where a human error could occur which had the potential to contribute to a major accident hazard. Once these critical subtasks were identified, the next step was to consider the type of error, the potential consequences of the error in terms of loss, the measures in place for error recovery and the measures in place for risk reduction.

Using the task list

There's an increasing requirement for drilling rigs to be able to operate globally in different geographical sectors with different regulatory authorities, and many drilling companies are now looking to make an amalgam of all the pertinent parts of the various regulator's safety case requirements. This includes a 'core activities list' of safety-critical activities that occur across a company's installations. This generic list would form a consistent baseline starting point and, using this workshop methodology, would undergo the development of Hierarchical Task Analysis diagrams to depict these tasks and sub-tasks together with a Human Reliability Assessment. This would enable any minor changes in rig-specific or client-specific requirements to be integrated very quickly.

By conducting the criticality assessment using the core activities list, it's possible to focus time and resources on those tasks identified as high criticality. In terms of major accident events, this means that the most important tasks can be analysed to enough depth to demonstrate that they are adequately managed. In real terms on the Ocean GreatWhite drilling installation, this meant the top 30 tasks out of a potential 301 were analysed in detail.

Benefits of this approach

The workshop methodology facilitates meaningful interactions between operators and rig management working together to describe the practical interactions between the operator and the systems. The operations personnel are then able to develop procedures for the various conditions and to gain real understanding of the characteristics of each by working on the Hierarchical Task Analysis.

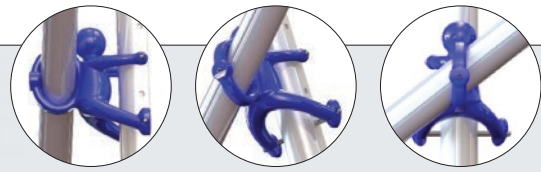
The outcomes of the task analysis are very specific and tangible. Any recommendations or findings are linked closely to the task step and the required result is made clear. The methodology enables the demonstration of a robust and consistent approach to identify how human factors engineering could contribute to prevention of a major accident event on an installation. A further benefit is that the task lists generated could be used to develop or modify the operating procedures across the whole drilling fleet more consistently to make a more cost-effective use of time and resources.

Hierarchical Task Analysis and Human Reliability Assessment would normally satisfy the compliance requirements from national regulators for evidence that human factors has been adequately considered in design. Despite recent improvement notices for lack of human factors engineering in safety case submissions, this process allows projects to demonstrate that consideration has been given to reducing the human factors risks and the potential for human failure to a level that can be shown to be as low as reasonably practicable, through engineering and design.

If we really mean to stop accidents and harm to people and put into practice the sentiments that are always felt after a disaster, then let's make the overriding statement "no harm to people, plant and environment" a reality, then we need to start walking the talk and ensure that human factors engineering is integrated into all projects. It's an opportunity to minimise the potential for human failure by making our projects user-centric from the start. ●

Let's make "no harm to people, plant and environment" a reality

Tim Southam is Principal Consultant at Human Risk Reduction Services Ltd. Tim has extensive experience in risk management in public and private sector industries. Previously he was an RAF pilot flying fast jet aircraft such as Jaguar and Tornado. He retired to carry out human factors research at Farnborough, becoming involved in projects including helmet mounted displays, human workload and spatial awareness.



The KiddieRail adjustable rail retainer

Taking those first steps

The biomechanics of stair use have been studied in detail for adults but less research concerns children. **Alison Messenger** and **Gordon Brand** describe a study about fall prevention in young children

Having an idea is the easy bit, making it a reality is the difficult bit! Many people never see it this way and fail to understand exactly what it takes to turn a sketch on the back of an envelope into a viable product proposal. Inventors sometimes see design as just an artistic method of expression that has no considered creative input nor application of any logical thinking processes. Some profess that little or no research is required, as they have done it all, without record, and that a few sketches would be enough to persuade any potential investors.

Without a programme of planned research, we would have no basis for developing ethical user-experienced design. Therefore, with all projects, we always work closely with our ergonomist and start with trying to understand the actual issues that the client is trying to resolve. If we see enough potential within the design intent, we develop a suitable programme of ergonomics research to help establish specific design parameters.

For one recent project, we were approached by an inventor to develop a system to help children to use a staircase. They were adamant that their idea of using blocks to reduce the height between steps would work. A research programme was established to examine how the block would be used by children and to study their stair climbing behaviour.

A focus group of willing children aged from six months to five years was brought together, along with their parents. A staircase with a small number of steps and a conventional hand rail was constructed. We also built the inventor's blocks and positioned them as the inventor intended. The children were observed while ascending and descending the staircase with and without the blocks in position. It became apparent very quickly that these blocks were not appropriate as they couldn't be securely attached to the tread. More importantly, the inventor had not fully considered how children's stair climbing ability develops as they grow. It had been assumed that a child uses a staircase like a mini adult, using alternate feet as they moved up and down the staircase. In fact, children do acquire this movement but only after progressing through several different movement patterns, from crawling to climbing up a step one leg at a time and then moving on to the next step.

Existing research suggests that the adult method of alternating feet while climbing up and down the stairs is refined sometime around the end of the child's third year. Full mastery of the technique may not occur until four or five years of age. At this age the blocks weren't big enough to support enough of the foot. (Stairs support upwards of three quarters of an adult foot.) Running the tests with the inventor present allowed them to really understand that their idea had some flaws.

Our ergonomist suggested that we develop an adjustable handrail that could be raised or lowered depending on the stage of the child's development. Whilst watching the children ascend, we noticed that they tended to reach up to grab the rail and then pull themselves up almost vertically. Adults tend to pull themselves up parallel to the rail.

For adults, recommendations for banister height are based on hip height for adults but current recommendations suggest one height of 600mm for all children. Our design, the KiddieRail, has equally spaced brackets secured to the wall or banister that have a sequence of holes in the sides. Small metal bars pass through these holes to which a 'climbing man' is attached and a hand rail passes through an oval aperture on the man's back. The design means there is both horizontal and vertical adjustment of the rail and the banister can be positioned and angled to suit the developmental stage of the child. The rail could be positioned high and moved down when a child reaches an age where a more parallel pull would be more beneficial. Not only did it work intuitively but it also allowed the younger children to ascend quicker and gave them far more confidence descending.

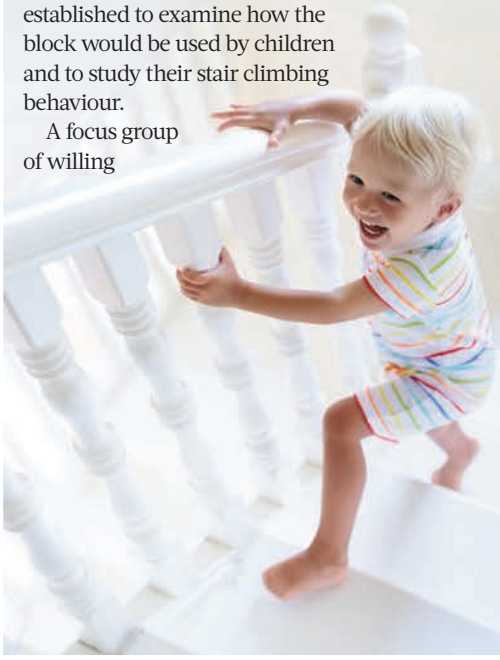


IMAGE: ISTOCK

Alison Messenger is is a course leader in in the Built Environment at the School of Art, Design and Fashion, Solent University.

Gordon Brand is an Industrial/Product Designer and an Associate Lecturer at Solent University on the BA Product Design Course. The KiddieRail won the Baby Products Association Innovation Award for 2016 and was exhibited at the Gadget Show that year.

Circumventing collisions

In the UK, on average, there are six deaths and 94 serious injuries every week involving motorcycle riders; a startling statistic when motorcyclists account for just 1% of all road users. **Lucy Milson** presents her research into the impact autonomous vehicle design could have on motorcyclist safety in the future

Could technological advances in automated driving and intelligent transport systems decrease the number of fatal accidents? Currently, according to research, more than 90% of crashes are caused by, or contributed to by 'human error'. Mistakes routinely made by human drivers are predicted to be at least reduced if not eliminated by the introduction of autonomous vehicles, subsequently removing the error and reducing the frequency of fatal accidents.

My project focused on four fatal collisions that involved a car and a motorbike. These were selected from over 70 West Midlands Police Reports reviewed as part of the selection process. Those where the accident involved contact with vehicles other than cars, had no other vehicle involved other than the motorbike, or involved a pedestrian fatality or a pedal bike, were excluded from consideration.

The first step of the analysis was to extract key details from the selected crash reports. This information included the direction of travel of vehicles involved, the location of contact on each vehicle and the road system where the crash occurred.

Following this, sketches and visual representations were used to hypothetically substitute three models of autonomous vehicles into each crash scenario: General Motors, Google Waymo and Tesla. These were selected

IMAGE: ISTOCK

based on the accessibility of information surrounding the proposed configuration and functionality of the sensors and cameras. For many companies, information surrounding such details are confidential due to ongoing research and development.

A set of five key questions was developed in order to standardise the application of the autonomous vehicles to each scenario. This approach enabled each analysis to follow the same structure and therefore result in a more cohesive comparison. The questions included: Which sensors and cameras were likely to be active in this scenario? Was the coverage (area and distance) of the sensors and cameras adequate to detect the hazard? Were there any blind sports or obstructions?

All three autonomous vehicles were substituted into all four of the case study scenarios. The perceived performance of each vehicle, based on published information, was compared to enable an understanding of its anticipated functioning within each scenario.

The Bow Tie method is a risk evaluation method that can be used to analyse and demonstrate causal relationships in high risk scenarios. In this project it was used to analyse and identify the key causal factors in collisions between motorbikes and cars and identify any gaps in the current configuration of the autonomous vehicles in relation to their ability to mitigate these causal factors. A Bow Tie diagram was drawn for each autonomous vehicle in each crash scenario and a subsequent single Bow Tie diagram was drawn.

The Bow Tie diagram highlighted that there are systems present on all three autonomous vehicles, such as 3D mapping on the Google Waymo, Enhanced Autopilot on the Tesla and Machine Learning on the GM vehicle, that do not provide a common mitigation for all four scenarios included in this analysis. Existing preventative measures in the road environment, including speed limits and 'SLOW' road markings, have the purpose of reinforcing laws and subsequently reducing the likelihood of accidents occurring. But they are not used in conjunction with the preventative features on the autonomous vehicles. Autonomous vehicles rely more heavily on technologies within the vehicle such as radar, LiDAR (where light is used to measure distances) and camera systems, to navigate through the road system safely and detect hazards.

The Bow Tie analysis highlighted that all three autonomous vehicles have the capability to detect nearby potentially hazardous vehicles earlier than a human driver might and quickly enough to allow for corrective decision-making and crash mitigation.

Autonomous vehicles have the capability to detect nearby hazardous vehicles earlier than a human driver might

The Google Waymo could be considered the most consistent vehicle, with the ability to identify hazards at long range and continuously map surroundings, with behaviour prediction technology making it likely to be capable of at least mitigating each of the crash scenarios studied. In contrast, the Tesla left unanswered questions surrounding its effectiveness and reliability in these crash scenarios. The hand-over of control to the occupant was identified as the key issue within Tesla's autonomous configuration and further research is required to understand whether function allocation in this way is appropriate in high hazard scenarios. The GM autonomous vehicle was found to have features capable of mitigating the crashes but more information relating to performance and sensor range is required to fully conclude the effectiveness in each scenario.

For all autonomous vehicles to be capable of handling a range of scenarios with a variety of different road users and pedestrians, a consistency in the guidelines surrounding the design of autonomous vehicles is needed to ensure that all autonomous vehicles meet a defined and acceptable level of safety.

This analysis has highlighted the potential for autonomous vehicles to mitigate fatal crashes, but it has also identified several areas and questions where further research is required. One of the key areas surrounds the human-machine control, particularly the potential requirement for handover of control in emergency scenarios and the associated time required for the occupant to take control, assess the situation, decide on the most appropriate action and carry out that action. There is also discussion to be had surrounding the ethical decision-making of an autonomous vehicle if there is a situation where there are two possible fatal outcomes in an unavoidable crash.

With the likes of BMW now developing driverless motorcycles, to be used by car manufacturers who want to use them to train their driverless cars to interact with motorcycles, what does 2019 have in store for road safety?

Lucy Milson has a BSc in Ergonomics (Human Factors Design) from Loughborough University and is currently working as a Graduate Human Factors Consultant at Atkins SNC Lavalin. The study outlined here was part of her final year project. She submitted it to the Sean Morley Memorial Award for undergraduate projects and dissertations with a road safety theme. In October she was awarded the runner up prize and award for Best Dissertation.

Further reading

Singh, S (2015). Critical reasons for crashes investigated in the national motor vehicle crash causation survey. NHSTA.

Anderson, J M et al (2014). Autonomous Vehicle Technology: A Guide for Policymakers, Santa Monica, Calif: RAND Corporation, RR-433-42-RC.

Nielsen, D S, (1971). The cause/consequence diagram method as a basis of quantitative accident analysis. Danish Atomic Energy Commission Research Establishment.

JOURNAL EXTRACTS

From journals available to members as part of their benefits package

That sinking feeling

1 When it snows in the UK, we either greet it with excitement or see it as an inconvenience depending on how it impacts what we have to do. But many have no choice but to work outside in snowy conditions, so research has been carried out to predict the energy costs of human work and travel over snow as it can be of significant value to the military and other agencies planning work efforts in the snow.

We know that a thin layer of hard packed snow can be slippery and that it's harder to walk or drive through deeper snow. Differences in moisture content and volumes can cause snow to seem heavy or light, and easier or harder to compact. Skis and snowshoes were developed specifically to make movement over snow covered surfaces easier by reducing sinkage, as even moderate reductions in sinkage can reduce energy costs. But predicting sinkage is difficult, as it's dependent on both snow depth, density, slipperiness (traction), and the type and weight of footwear and winter clothing.

Research suggests that activities in snowy environments generally require up to 20% more energy than similar activities in more moderate or warm conditions, mainly caused by increased physical exertion rather than cold exposure itself if someone is dressed adequately. For this reason, working in the cold requires a higher calorific intake.

Perhaps counter-intuitively, researchers noted that the metabolic costs for wearing arctic clothing appears to be greater when wearing it than when carrying the equivalent mass! They concluded that the additional energy cost was related to the friction between layers or a 'hobbling' effect of the additional clothing.

P W Richmond et al, Terrain coefficients for predicting energy costs of walking over snow. Applied Ergonomics, *74, Jan 2019, pp48-54, https://doi.org/10.1016/j.apergo.2018.08.017*

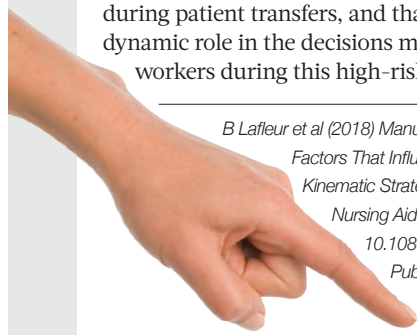
IMAGES: ISTOCK

Understanding patient handling

2 High occupational injury rates are major concerns for healthcare workers where musculoskeletal disorders (MSDs) are the biggest contributors. Patient handling tasks, which consist of manual patient lifts, transfers, and repositioning, are one of the leading causes of MSDs in healthcare workers. The use of mechanical aids such as hoists and transfer boards has been demonstrated to improve musculoskeletal comfort and reduce musculoskeletal injury rates.

Research has shown that, despite the existence of mechanical and administrative interventions, manual transferring of patients still occurs frequently. Constraints such as a lack of available devices and appropriate training, additional time needed, and patient comfort reduce the use of mechanical aids when performing manual transfers. However, there is less available evidence about worker-specific factors such as whether physical or psychological factors of the healthcare worker, or patient, can influence decisions associated with manual or mechanically-aided patient transfers.

A study was carried out to examine factors that influence the decisions and approaches employed by healthcare workers during the task of patient transfers. Findings suggest that grip strength may be a useful predictor of perceived work capacity, that older workers may adapt more protective lifting strategies during patient transfers, and that patients play a dynamic role in the decisions made by healthcare workers during this high-risk occupational task.



B Lafleur et al (2018) Manual Patient Transfers – Factors That Influence Decisions and Kinematic Strategies Employed by Nursing Aides, Ergonomics, *DOI: 10.1080/00140139.2018.1550215. Published online 23 Nov 2018*

Turbulence and touchscreens

3 Use of touchscreens on the flight deck has been steadily increasing, but their usability may be severely impacted when turbulence increases. Most previous research focuses on using touchscreens in static conditions, but a study by researchers at the University of Southampton assessed touchscreen use during turbulent representative motion, generated using a 6-axis motion simulator.

Touchscreens were tested in centre, side and overhead positions to investigate how turbulence affected error rates, movement times and accuracy, and arm fatigue and discomfort.

Performance measures such as error rate, movement time and workload increased and usability decreased significantly, with screen position and increasing turbulence level. The researchers say further study of touchscreen use in flight decks appears worthwhile, given their potential for integrating a large number of functions into a single system, enabling more efficient use of space and consistency of information presentation.

LL V Coutts et al (2018) Future Technology on the Flight deck: Assessing the use of touchscreens in vibration environments, Ergonomics, *DOI: 10.1080/00140139.2018.1552013. Posted online 23 Nov 2018.*

Give me a break

4 Neck and shoulder disorders are a considerable health problem amongst frequent microscope users. In healthcare, research has shown that regular microscope usage was the second most common cause of intraoperative pain (after posture) amongst surgeons that require magnifying equipment to operate. There is emerging evidence that microbreaks can help prevent a surgeon's fatigue and deterioration of performance associated with prolonged surgery. Researchers investigated the neck and shoulder discomfort experienced during prolonged microscopic activity and assessed the benefits of minibreaks.

They used a subjective measure of time to fatigue and pain in the neck and shoulder regions as well as objective readings from a surface electromyogram (sEMG). Participants in their study were given structured exercises to carry out at regular intervals during a task using a microscope. A control group were given no exercises. It was found that microbreaks delayed the sensation of pain in the neck and shoulder region while reducing the overall sEMG muscle activation.

Researchers suggest that the exercise regime, which can be carried out in 30 seconds, may benefit the neck and shoulder muscles of any worker who performs prolonged tasks in a seated position.

A Vijendren et al (2018) The Ipswich Microbreak Technique to alleviate neck and shoulder discomfort during microscopic procedures. Applied Ergonomics, *available online 4 May 2018.*

Neck and shoulder disorders are a considerable health problem amongst frequent microscope users

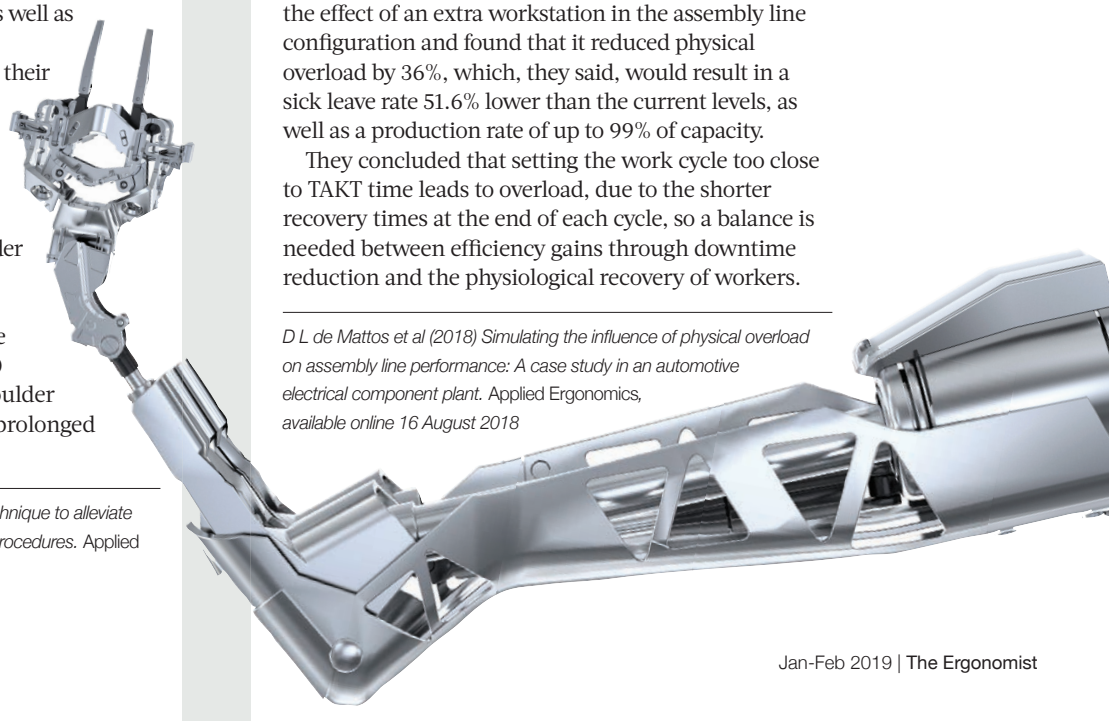
Balancing workload with efficiency

5 Whilst many assembly jobs are becoming more automated, there are many that have too many variables to make increased automation viable. One of these is vehicle assembly. Each vehicle passing along stations on a production line has a manifest attached to it that lists the parts needed depending on the exact specification chosen by the customer. Rarely are two consecutive vehicles the same, so it's often still a manual job to pick and fit the part. The amount of time a worker has to do the task depends on the TAKT time, that is, the production rate required to meet demand (or how quickly the line passes by their workstation).

At one Brazilian vehicle plant, the workstations of the electrical harness production line were set close to the TAKT time and as a result, due to physical overload of the workers, sick leave rates were high and the production rate was only 42%. Researchers investigated the effect of an extra workstation in the assembly line configuration and found that it reduced physical overload by 36%, which, they said, would result in a sick leave rate 51.6% lower than the current levels, as well as a production rate of up to 99% of capacity.

They concluded that setting the work cycle too close to TAKT time leads to overload, due to the shorter recovery times at the end of each cycle, so a balance is needed between efficiency gains through downtime reduction and the physiological recovery of workers.

D L de Mattos et al (2018) Simulating the influence of physical overload on assembly line performance: A case study in an automotive electrical component plant. Applied Ergonomics, *available online 16 August 2018*



Chartered Institute of Ergonomics & Human Factors

Notice of Annual General Meeting

The AGM will take place at 17:15 on Tuesday 30 April 2019 at the Crowne Plaza, Stratford-Upon-Avon for the following purposes:
- To receive the minutes of the 2018 Annual General Meeting.
- To present the Annual Report and approve the year end accounts.

Elections are held at the AGM for vacant positions on Council and the Professional Affairs Board (PAB). These bodies meet four times per year and all terms are for three years. Nominations are sought for positions on the Executive Committee, Council and PAB.

Executive Committee positions
- President Elect
- President*
- Treasurer

*As no nomination was fulfilled at the time of election at the AGM in 2018, the President Elect's position was filled through co-option. Therefore, nominations are open to elect both a President Elect and President this year.

Council positions
- Up to seven Ordinary Members, who must be either Registered Members or Fellows (or Retired, or Honorary Fellows)
- One Technical Member Representative

Professional Affairs Board positions
- Up to four members, at least one of whom must be a Registered Member, the rest may be either Registered Members or Fellows (or Retired, or Honorary Fellows).

Nomination procedure
Nominations will open on 18 February 2019 and must be made following the procedure set out at www.ergonomics.org.uk > About us > Governance. The closing date is 15 March 2019.

Proposals for changes to the General Regulations
Proposals for changes by Ordinary Resolution to the General Regulations should be sent to the Chief Executive no later than 25 February 2019. The current General Regulations can be found at www.ergonomics.org.uk > About us > CIEHF Documents.

Stephen Barraclough, Chief Executive, Chartered Institute of Ergonomics & Human Factors

Why you should consider nomination

Each elected position comes with a different role and set of responsibilities and each is open to Registered Members, Fellows, Retired Registered Members and Fellows, and Honorary Fellows. You'll need to bring good communication, analysis and judgement skills and in return, you'll learn much about how a charitable membership organisation works, you'll meet many peers and you'll have a unique opportunity to help shape the future of the CIEHF and the discipline.

Read on to understand more about what each role entails and whether one of them could be right for you.

- **Role: President Elect**
  Length of term: 1 year
  Contact time: 8 face to face meetings per year
  Responsibilities: The President Elect works with the President and Chief Executive and within the agreed strategic and business direction in preparation for the President role. The President Elect deputises for the President and is a member of the Executive Committee.

- **Role: Role: President**
  Length of term: 1 year
  Contact time: 8 face to face meetings per year
  Responsibilities: The President acts as an ambassador and advocate for the CIEHF and the discipline. They represent the organisation and members to wider stakeholder groups in conjunction with the Chief Executive and develops relationships that benefit the Institute and its members. The President acts as Chair of the Executive Committee and Council and is a member of the Honours Committee. The following year, the President becomes the Past President whose role is to support the President and continue as a member of the Executive Committee. The Past President acts as Chair of the Honours Committee.

- **Role: Treasurer**
  Length of term: 3 years
  Contact time: 8 face to face meetings per year
  Responsibilities: The Treasurer provides governance oversight of our finances to ensure they are used in the best interests of members and the CIEHF and in accordance with the Charter, Strategic Plan and Delivery Plan. The Treasurer oversees our budget and investments and is a member of the Executive Committee.

- **Role: Council Member**
  Length of term: 3 years
  Contact time: 4 face to face meetings per year
  Responsibilities: Each Council member is a Trustee of the CIEHF and provides oversight of operational, financial and strategic affairs. Trustees provide opinions and ideas and ensure good governance.

- **Role: Member of the Professional Affairs Board**
  Length of term: 3 years
  Contact time: 4 face to face meetings per year
  Responsibilities: PAB Members provide advice, opinion and ideas on professional matters relating to the discipline and take a full part in PAB meetings.

For a full list of all our volunteer roles, including responsibilities, time involved and many other details, visit www.ergonomics.org.uk > Get involved > Volunteering.

REGIONAL NEWS

SOUTHERN

Accident investigation

Emergency workers at the scene of an overturned tram near Sandilands Tram stop in Croydon

The Rail Accident Investigation Branch (RAIB) has been operational at Farnborough since 2005 following a recommendation by Lord Cullen, after the 1999 Ladbroke Grove rail accident, to provide an independent investigation body to identify causal factors into rail accidents and incidents and improve rail safety.

On 17th June, Simon French, RAIB's Chief Inspector welcomed 26 human factors practitioners and academics to the Farnborough site. He emphasised that human factors was integral to the investigations carried out. Mark Young, RAIB Inspector and Chartered Ergonomist, gave an overview of the RAIB and provided a summary of the investigations into the fatal tram accident at Sandilands Junction, Croydon in November 2016. The factors leading to an overspeed situation, as in this instance, were complex and Mark said that, in many cases, human performance causal factors could only be considered as possible or probable as evidence as they are difficult to prove conclusively. (See the full report at http://bit.ly/Sandilands2016.)

We were shown the kit that's taken to accident sites in a specially modified van to obtain the required data and measurements to assist the investigation. In this case the derailed tram was moved from Sandilands Junction to the RAIB site to enable the detailed investigations to take place. RAIB Inspector Richard Brown explained why and how it was necessary to identify the forces that resulted in seven passengers being fatally injured when they were ejected through the windows and doors.

The Air Accident Investigation Branch (AAIB) is also located on the same site as the RAIB. AAIB Inspectors Lisa Fitzsimons and Toni Flint provided a tour of the AAIB hangar identifying some of the high profile aircraft accidents that have been investigated recently and summarised the causal factors. The accidents included the EC 135 helicopter which crashed on the Clutha Vaults pub in Glasgow in November 2013 and the Hawker Hunter which crashed at Shoreham Airshow in August 2015. We also saw the wreckage from a variety of general aviation accidents, for which the investigations are still ongoing.

Professor Paul Salmon who is visiting the UK from the Centre for Human Factors and Sociotechnical Systems at the University of the Sunshine Coast, Australia gave us four case studies that the Centre has worked on. Paul also emphasised the importance of a systemic approach in his accident investigations. He covered a broad area including level crossing accidents, rail safety, sport and outdoor recreation accidents, and autonomous vehicle accidents. He illustrated the power of Jens Rasmussen's AcciMap technique as a tool to capture the various causal factors from a total systems perspective.

An open forum session gave us the opportunity to share concerns about the quality of fault reporting data and the use of methods like AcciMap to assist in accident investigation.

So, a most educational day which, although focused on rail investigation, was completely transferable to other domains. Our thanks to the RAIB for hosting this event. ●

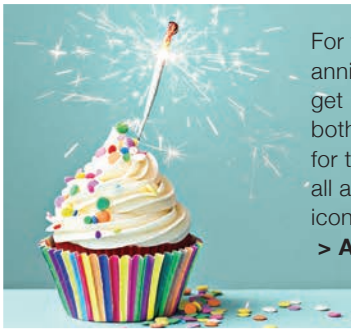


IMAGE: GETTY/SHUTTERSTOCK

For those that haven't already heard, we're celebrating our 70th anniversary in 2019 with a number of different activities designed to get members engaged in helping us to raise awareness and interest, in both the Institute and the discipline. We're starting off with an appeal for two-minute videos taken on a smartphone that illustrate ergonomics all around us. The smartphone itself is a great example with its apps, icons and touch controls! Find out more at **www.ergonomics.org.uk > About us > 70th anniversary.**

70 YEARS OF ERGONOMICS 1949-2019

Jaguar F-Pace and Range Rover Evoque

IMAGE: SHUTTERSTOCK

MIDLANDS

Vehicle production at Jaguar Land Rover explained

See how vehicles are made first hand. Jaguar Land Rover will host a Midlands Regional Group event on the morning of 6 February 2019 in Solihull. You'll receive a welcome drink and introduction before being driven to the brand new Jaguar Land Rover 'Body In White' facility.

Here, you'll join the assembly as aluminium body panels are formed into lightweight architecture. Next, you'll meet Jaguar Land Rover's robotic army, riveting, sealing and welding in perfect sync, with overhead platforms ensuring a first-class view.

Then on to the extensive logistics of Trim and Final, where everything comes together. Here you'll view glazing, engine and wheel fit and final testing where vehicles are finished and recognised as customer ready. The tour will conclude at The Range Rover Story Exhibition, taking you through five decades of a truly British Icon from the 1960s to the present day. Find out more at **www.events.ergonomics.org.uk**

CIEHF events at a glance

For more details of all CIEHF events, see our website at **events.ergonomics.org.uk**

Eligible for CPD Lifelong Learning

EVENT	WHEN & WHERE	DETAILS
Jaguar Land Rover	6 February 2019, Solihull	A fascinating tour of the whole car assembly process from welding panels to painting to fitting seats, wheels and final trim.
Ergonomics & Human Factors Careers Day	27 February 2019, Birmingham	The very best of careers guidance, options and opportunities, featuring talks about work in different sectors and a lively Jobs Fair.
Applied Ergonomics Conference	25-28 March 2019, New Orleans, USA	Share best practices with other professionals in ergonomics, healthcare, safety, human resources and risk management. (Supported event)
Doctoral Consortium	29 April 2019, Stratford-upon-Avon	A day for PhD students to present their ongoing research to their peers and to learn from each other, and from a PhD Masterclass.
Ergonomics & Human Factors 2019	29 April – 1 May 2019, Stratford-upon-Avon	Celebrating our 70th anniversary with a line-up including Masterclasses, keynotes, presentations, posters, discussions, drinks, BBQ, dinner, quiz and more.

Please note that some events details may be subject to change after publication. Please check the events website for up-to-date information.

MEMBERSHIP

Our latest professional members

We congratulate the following members whose applications for professional membership of the CIEHF over the past few months have been successful. All have submitted comprehensive details about their qualifications, experience and achievements. Those listed also have Chartered status.

Registered Members

- Claire Ford
- Craig Hudson
- Erik Sommarstrom
- Heather Page
- Heikka Manskikka
- Jaina Mistry
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CONTENTS

The magazine of The Chartered Institute of Ergonomics & Human Factors

NEWS AND CURRENT AFFAIRS

APPLIED ERGONOMICS AND HUMAN FACTORS

COVER IMAGE: ELECTA UNITY

RESEARCH MATTERS

CIEHF NEWS

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FROM THE PRESIDENT

Increasing expertise

Neil Mansfield
CIEHF President

@profnjmansfield

For many years I taught university students the importance of European Standards, European Directives and the 'CE' mark. This would highlight that one of the central themes of EU membership was a common framework for occupational health risk assessment, monitoring and control. At the time of writing, the UK Government still appears far from reaching an agreement on the nature of the withdrawal of the UK from the European Union, which could change this common framework. I hope that by the time you read this there will be clarity on the political future of the UK, but I fear that like many generations of university students, the final document will not be ready for hand-in until the last minute, and that an extension might be requested!

Whatever the outcome of the Brexit negotiations there will remain a need for qualified (and Chartered) experts to be consulted to ensure that workplaces are fit for purpose and to maximise the health, performance and wellbeing of users. Trained experts are needed across the many sectors in which members work from healthcare to mining, from oil and gas to transport. Expertise in the increasingly complex environment in which ergonomists and human factors professionals operate can be gained via training from CPD through to completing full CIEHF-accredited taught programmes, providing a foundation for a career in the discipline.

The CIEHF supports those looking to investigate a career in ergonomics and human factors through the annual Careers Day, being held in Birmingham at the end of February. This is designed not only for students completing degrees in ergonomics but also those who are looking to upskill in the area. It draws together experienced people who can give insight on their career journeys potentially on the lookout for new staff. I look forward to meeting many of you there.

CIEHF supports those looking to investigate a career in ergonomics

FROM THE EDITOR

Highlights and insights

In the build-up to our showcase Ergonomics & Human Factors 2019 conference taking place at the end of April, we feature in this issue just a few of the highlights from a presentation programme that covers an amazing breadth of topics and sectors, from enabling prolonged space travel to detecting and managing cyber threats.

Our cover story explains the critical role of human factors in designing equipment to deliver ground-breaking radiotherapy treatment. Dan Jenkins talks us through the techniques and processes used to ensure the final design is fit for purpose and highly effective for staff and patients.

We make countless decisions every day but what influences those decisions most, especially if we don't have all the information? Neil Buchanan and Arthur Stewart take us through the tricky topic and how it affects safety awareness.

Gemma Aiuto-Turner talks about the vital, but often hidden, aviation operations sector where a new apprenticeship scheme is helping to develop much-needed skills.

In healthcare, there's a look into the work of the UK's Healthcare Safety Investigation Branch, and a detailed and interesting insight into hospital pharmacy practice in Cambodia from Alda Hummelinck.

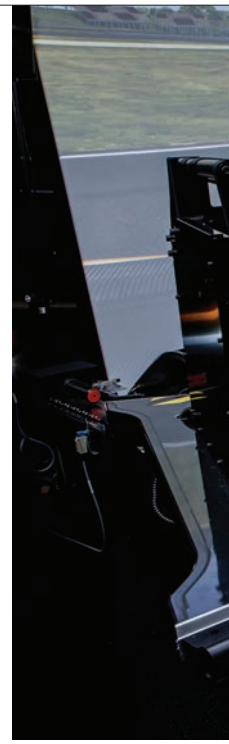
There's also a unique perspective on the work of the Maritime & Coastguard Agency as witnessed by members at one of our Regional Group events. Filip Florek takes us through a working day as a User Experience Designer at McLaren, and finally, Hannah Whitney explains how important a placement has been to her as an undergraduate and where it's now taking her.

Tina Worthy
editor@ergonomics.org.uk
@ciehf

A DAY IN THE LIFE OF A...

USER EXPERIENCE DESIGNER

Filip Florek, Senior User Experience Designer, McLaren Applied Technologies



It's 7am, I arrive at the McLaren Technology Centre in Woking where I work for McLaren Applied Technologies, one of three businesses in the McLaren Technology Group. I walk through a spotless long white corridor thinking about my daily agenda. I pass the racing team's Composite Workshop and enter the McLaren Applied Technologies Design Lab. The office is almost empty at this time. There are no windows in this part of the building, so I sometimes feel like I'm in the Discovery One spaceship from Kubrick's *Space Odyssey*.

Having grown up in a family of engineers and artists, I've always been interested in both the technical and creative sides of product development. So, after spending 16 years in human-computer interaction working in various positions as a software developer, user interface designer and new product introduction engineer among other roles, I joined McLaren in search of a new challenge.

Let's start with the facts, it's impossible to have an ordinary day at McLaren, no two days are the same, things rarely repeat! What comes to mind that we all share, are our ways of thinking and the methods and processes we apply. My role is within the design function, home to nearly 30 talented designers and engineers. The design function is comprised of three key discipline areas that focus on the front-end of the product development cycle: Insight & Strategy, Product Design and Design Engineering. Each discipline overlaps and compliments the next to form a connected backbone through to market delivery.

The team has embraced a philosophy of 'data-driven design', generating insights that drive the user-focused development process thanks to quantitative and qualitative data taken from people, the environment or objects, but our work must focus on the bigger picture too. Myself and my colleagues from the Insight & Strategy team identify and analyse the opportunity space (markets, users, technology and trend research) to define the value proposition for our business units, the vision and the overall design process to drive innovation in the company.

As a user experience designer, my job is to observe and ask questions, to understand people, businesses and technology to ensure that we design things that are safe, usable, desirable and have a real purpose. My job requires a comprehensive understanding of research methods and routinely involves searching for information about people's behaviour, their expectations, the tasks they perform, the processes they follow, and the living or working environment and equipment they use, ultimately generating solutions to problems. I'm also responsible for defining, applying and leading UX methodologies and processes within the McLaren Applied Technologies business.

Drawing on a heritage leading the digital transformation of motorsport through electronics and data systems, McLaren Applied Technologies develops expertise in electronic systems, telemetry, simulation, predictive analytics and design. Here, I have a unique opportunity to be involved in a variety of projects across multiple sectors including automotive, motorsport, public transport and health, so my work can be surprisingly varied.

I'm currently focused on several ergonomics projects including a decision support system for drivers to maximise human performance and situational awareness and to optimise the information flow, as well as an integration of biometric tools to support

I'm responsible for defining, applying and leading UX methodologies and processes

Design workshop session with users

Testing session in the vehicle dynamics simulator that features McLaren's motion algorithms

our young drivers' development programme. In the past, I've been involved in the human-machine interface development for an assistive robotic solution, a definition of the client requirements for the combustion engine controller and even the design and implementation of the connectivity service with a train operator to enhance the communications for both passengers and trains.

As a designer and an engineer, I focus my attention on interactions between people, especially where they involve technology as an intermediary. I believe that these interaction touchpoints are the key elements to building trust between people and things; that's why understanding physical, social and cognitive human performance, and people's needs, values and limitations, has become so important in my career.

But effective UX and interaction design requires trust and real collaboration between researchers, designers and engineers with the confidence to transform insights into ideas, concepts and prototypes and it's not always a smooth ride. It's a world of compromises, legacy thinking and systems, and can often be frustrating and exhausting, and can lead to increased costs, increased risk of failure or potentially a product that doesn't match the user needs or market strategy. So, to ensure that product development is successful, I use evidence-driven methods and focus on understanding the oscillating needs, benefits and behaviours of users using both qualitative and quantitative methods. After all, it's harder to argue with objective metrics than subjective opinion. For me, the development process starts and ends with the people that the design is for.

User-centred design (UCD) has a rich 50-year history underpinned by academic work. Summarised in 1969 by Raymond Nickerson, when the potential for computer-based technologies was first being fully recognised: ''The need for the future is not so much computer-oriented people as for people-oriented computers''. It's so true in today's world, but over time, design has become synonymous with defining the look or feel of something. My first project in public transport is a good example. When I was introduced to the project team one my colleagues said: "Ah, you're here to make things look nice!" Does it sound familiar? It's a real challenge. I believe that the role for designers is to enable all stakeholders to understand what it is they must build. Representing the UX discipline and the UCD approach, you demonstrate your values to non-designers, both internally in your organisation and externally with your clients and partners. The best way to show it is by involving them in the process.

For example, when conducting research for our client in public transport, we've been visiting a train depot, immersing ourselves in the operators' professional lives and the problem space they operate in. Through accelerated ideation, prototyping and user engagement, we quickly built an in-depth knowledge of how the people there think, feel and react to ideas and experiences. We developed an understanding of their lifestyles and mapped their behaviours, as well as their decision-making rationale. Equipped with this knowledge, we become real user advocates, bringing their voice and opinion into the development. We then iteratively evaluated our designs by taking them back to the client to understand how they would use the product and how it would impact their jobs. Taking this approach ensures that we bridge the gap between work-as-imagined and work-as-done – such an important aspect in the development process. By doing this, we've effectively de-risked the development process.

Going back to my day, it's now somewhere between 4pm and 5pm and my day here comes to an end. From time to time I walk across the boulevard where I can see the famous McLaren F1 road car on display among another 20 or more automotive engineering sculptures. McLaren F1 redefined the very concept of the supercar when it was launched in 1993. Its spiritual successor, the McLaren P1 that sits on the other side of the boulevard, would do the same 20 years later. And there's the MP4/1 Formula 1 car that introduced the carbon fibre chassis to Formula 1 in 1981.

A year for me is made of hundreds of these moments and I could never capture them all. But after just 18 months here, I'm fully involved in some of the most exciting projects of my career, and I'm looking forward to what the future brings for both myself and for McLaren. ●

Filip Florek has over 17 years of hands-on design and engineering experience across automotive, manufacturing, travel and financial sectors and holds an MSc in Industrial Automation & Robotic Systems and a Certificate in Human Computer Interaction..

Further reading

Visit https://www.mclaren.com/appliedtechnologies/lab/

A human factors perspective from Cambodia

Working hard to come back from unimaginably difficult times, Cambodia is showing its resilience despite its limited resources. With just nine central and four district hospitals supporting the capital's 800,000 residents, **Alda Hummelinck** discusses progress being made towards greater medication safety

Most of the Khmer people, the ethnic group to which the great majority of Cambodians belong, live in rural villages either as rice farmers or fishermen. A tenth of the population live in the capital Phnom Penh, so Cambodia's population density is extremely variable. Following the devastating activities of the Khmer Rouge regime of the 1970s, in which around a quarter of the population were killed, Cambodia remains one of the poorest countries in the world.

Spanning isolated and mountainous provinces, as well as pockets of populated and fertile areas, the country's healthcare needs and services vary greatly. The charity, Transform Healthcare Cambodia, supports training and education to help Khmer healthcare staff to improve patient safety with the resources available to them. Advances have been made in several areas and there is a significant interest in learning how to reduce risk. Population health is a key priority set out in the 'Cambodia Health Plan' and there are numerous opportunities for the charity to support this.

The World Health Organisation (WHO) has carried out extensive work around the inappropriate use of medicines, including a failure to prescribe in accordance with clinical guidelines (where they exist) and patient non-compliance, and errors such as mixing up look-alike or sound-alike medicines. It's thought that these often occur as a result of human factors issues such as ineffective systems or poor environmental conditions, lack of skilled staff, technology or clean equipment, but also the organisational structure and culture.

As a practising pharmacist, I volunteered to scope out the potential opportunities to help improve medicine safety by reviewing current practices in one hospital pharmacy from a human factors perspective. It was clear, after just a few days' observations, that many of the WHO's concerns applied here.

Pharmacy practice

The hospital has two separate pharmacy departments: one for

IMAGE: ISTOCK

inpatients and one for outpatients. Each department receives supplies from the hospital's central store every fortnight, which, in turn, receives supplies from Phnom Penh every three months from a very limited formulary set by the Ministry of Health. Within this formulary there are no liquid medicines, no inhalers and no items requiring refrigeration, and it does not offer medication for long-term conditions such as hypertension, epilepsy or diabetes, for respiratory conditions such as asthma, or for severe pain.

Many drug therapies considered routine in the UK may not be available at all in Cambodia or are only available in one fixed, often high strength. As a result, sometimes patients may be given 'make do' treatment at doses much higher than they might need or can tolerate. If the central store runs out of medication before they receive further supplies from Phnom Penh, or if non-formulary medication is needed, additional supplies may be purchased from local private pharmacies using the very limited hospital budget but only after going through a strict approval process.

All patients that come to the hospital are required to visit several desks to register and be assessed to see if they need to be admitted to hospital or if they can be seen in the outpatient department. Because there are currently no robust systems to record and retrieve patients' medical records or their past medical histories, each visit is treated as an entirely new and independent episode of care, complicating the handover of any earlier diagnoses or treatment successes or failures to the next treating physician. However, the hospital has plans in place to organise record storage so that they can be retrieved when needed.

Dispensing medication at the pharmacy

Outpatient consultations

After an outpatient consultation where medication has been prescribed, the patient takes their prescription to the pharmacy. The medication is dispensed and issued to the patient by healthcare professionals, usually nurses, from a range of pre-packed sachets and medicine strips placed near them.

Behind the dispensing hatch, loose tablets are pre-packed into standard sachets and quantities, and stored next to each other on the shelves. Many of them look very similar and could easily be mixed up. Often the only distinction between neighbouring sachets is the handwritten indication, for instance 'clomipr 25' (clomipramine 25mg) is on the shelf next to 'chlorpro 25' (chlorpromazine 25mg).

Population health is a key priority set out in the 'Cambodia Health Plan'

Strips of tablets are not dispensed into boxes or labelled, instead they are bound together with an elastic band and dosing instructions are handwritten on the back of just one of the strips with a marker pen. This raises concerns such as whether the instructions are legible to start with, whether they remain legible once the patient pops out any of the tablets from the strips, and whether the patients or their relatives can read them in the first place.

At the point of issue, the patient is told how often to take their medication but no additional advice is given such as whether to take with or without food or whether there are any side effects to be aware of. This is considered the prescriber's responsibility, as well as carrying out clinical checks for allergies, dosing (particularly for children), interactions or contraindications before prescribing the appropriate medication.

For repeat prescriptions, the patient is expected to return to the hospital each time and be seen by a doctor for ongoing assessment. However, long-term conditions, such as hypertension or diabetes, are often not treated because there is no public awareness about the condition or the risks if left untreated, or because suitable treatment is not available.

The inpatient process

For inpatients, medication is prescribed and added to their medical notes during each morning's ward round. This is then transcribed onto a pharmacy order form and one day's medicine supply is →

Nurses hand out medication to patients on the ward

ordered from the pharmacy. The order is signed off by five senior members of hospital management including the head of pharmacy and the hospital director. Medicines are provided by the pharmacy in trays with a designated but poorly-labelled section for each medicine. Where labels are illegible, staff stated that, even though some of the tablets look identical, they rely on their experience to know what medication is in each section.

Back on the ward, staff make up small plastic sachets each containing an individual patient's daily medication, and each sachet is likely to contain multiple doses of multiple medicines. Sachets are subsequently stapled closed and labelled with the patient's bed number and name. Nursing staff then go around the ward, handing each patient their sachet of medicines and explaining what the tablets are and how frequently they should take each one. If the patient does not understand, the nurse will return later to explain these instructions to relatives or ask other patients' relatives for support. Medicine taking is considered part of the patient's social care, alongside washing, dressing, feeding and taking to the bathroom, all of which are the relatives' responsibility, not the nurses.

Wards are not issued with their own medicine stocks, other than those for emergency use. However, when a patient is discharged or has passed away, wards keep and store any medication left-overs in self-labelled pots. In theory, wards are not supposed to keep any medicine stock and as there is no pharmacy presence on the wards, there is no oversight of whether the pots contain what they say they do, when tablets were added to each pot or when they expire.

Several issues were also identified with the preparation and administration of intravenous medications, including poor hand hygiene and aseptic technique, lack of labelling of pre-prepared syringes for injection, inadequate prevention of needle stick injuries and record keeping.

Improving quality of care

Although many issues were identified during this brief review of practices, there are many potential starting points from which we can work alongside our Khmer healthcare colleagues to further review current practice and to develop simple, low-cost strategies for reducing risk in many of the instances described here.

The WHO have identified that unsafe medication practices and medication errors are a leading cause of avoidable harm in healthcare systems across the world. However, in-depth discussions with several senior clinical staff in this hospital suggested that they may not appreciate these hazards, and our observations appear to confirm a widespread lack of awareness of the risks associated with the use of medicines.

Possibly because of this lack of risk awareness, the provision of clear information and advice to patients to support them in their medicine-taking is not considered an essential part of care. There is also no role for the pharmacy to provide any prescribing support, supervision, teaching or medicines information to clinicians or ward staff.

Staff show enthusiasm and engagement in designing patient safety improvements

Whilst healthcare resources are so limited, it's unlikely that provision of these services will be available for some time, but for charities such as Transform Healthcare Cambodia, there's an opportunity to support low cost changes that may mitigate many of the risks in this area.

However, staff show enthusiasm and engagement in designing patient safety improvements, despite the challenges they face, and their enthusiasm and motivation in their work with the charity to make sustainable changes within the resources available is impressive.

A Safety Champion role could be developed to provide oversight of medicine management practices across the hospital, raise staff awareness of practices that could be considered unsafe and put forward sustainable solutions, empowering the Khmer healthcare teams to lead the change. Education and the co-design of simple and effective changes could be put in place to support staff in doing the right thing and in helping them understand the reasons behind them.

The findings of this review will be used by the charity to support the development of a work stream that will help Khmer healthcare staff understand and manage the human, task, equipment and environmental risk factors they face whenever they handle medicines. This new work stream will aim to plant seeds of change that will have a cumulative impact, not only on growing patient safety culture, but also in improving patient outcomes.

Alda Hummelinck is Lead Pharmacist with the Out of Hospital Care Clinical Directorate at North Tees and Hartlepool NHS Foundation Trust. Transform Healthcare Cambodia (THC) originated at the hospital where Alda works and she volunteers, along with other health professionals from the North of England, to travel to Cambodia as part of THC's charitable work. At the hospital in Cambodia, the group splits into work streams such as patient safety, resuscitation, paediatrics, alcohol-related disease, community care and the building of a sensory room. Alda chose to carry out the pharmacy work study described here in addition to her work with the patient safety work stream.

CHIEF EXECUTIVE'S PERSPECTIVE

Growing an engaged and unique community

Maintaining Chartered status is fundamental for members who have put in a good deal of hard work to achieve it, and understandably so. Chartered status requires continuous professional development for it to be maintained, and this has been demonstrated admirably by the significant number of members who have logged some great CPD activities via our website last year. In fact, I'm pleased to report that almost 85% of our Chartered members recorded their CPD activities from 2018 in this way.

The Institute understands that setting time aside to do this is not always easy and we thought very hard about how to design and provide a new, easier, more secure, more accessible, online method of recording CPD for members, including logging individual plans for the future, an integral part of CPD. Careful thought also went into communicating from the outset when we launched the system in April 2018, just how it would work best for members, including through webinars made available live and by recording to all members and by emailing regularly and concisely. A significant effort also went into securing, training, briefing and co-ordinating our qualified volunteer members who assess CPD. These volunteers are a very valuable and key part of the whole process, so thank you to them.

I'm sure you can appreciate that managing a project to co-ordinate effort across the many parties involved, including members of our Professional Affairs Board, our Membership Manager, our IT support colleague Ian Houseman, and our many assessors, requires much hard work and co-operation from all. We must all work to shared deadlines to be able to demonstrate that we have a rigorous and auditable way of upholding the standards that our Council agrees. By doing this we act in a way expected of us, and the value of Chartered status for those who merit it is protected. By keeping to the deadlines we set, you can help us to make the most of the time and resources available to us and to do the best job we can.

We exist in part, to support our members with their professional development so, as we have introduced such a radical change in our CPD criteria, recording method and assessment process, we have endeavoured to assist our members as much as possible by providing more opportunity this year to gain or retain their Chartered status by improving their CPD activity descriptions, helping them to tease out and reflect on the real learning behind their achievements during the year.

Here, at the very start of the year, it's a good time to encourage you to compile CPD progressively over the year but at times that suits you. There are lots of national and regional CIEHF events and things to read and learn that will enable you to do this, so that come December there's less need for a frenzied dash to bring together the learning and planning that has progressively taken place throughout the year.

Recording CPD is intrinsic to your professional status, and the Institute is proud of being able to demonstrate a growing, qualified, engaged and unique community that meets the standards we have set for ourselves. An expanding body of unique expertise reinforces our standing as a body to be listened to and helps CIEHF make an impact on the world around it. Please continue to be part of that.

Recording CPD helps members tease out and reflect on the real learning behind their achievements

Steve Barraclough
Chief Executive of the CIEHF
s.barraclough@ergonomics.org.uk

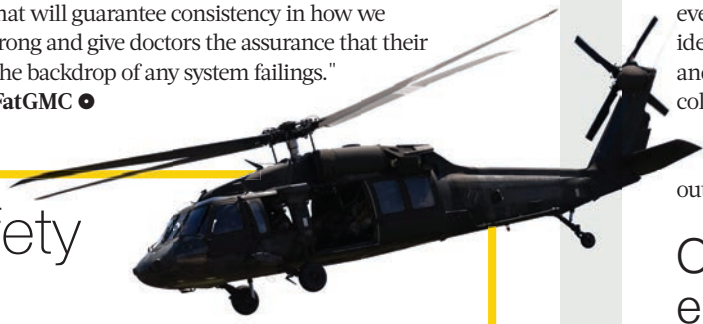
IMAGE: SHUTTERSTOCK

Human factors training for investigators

All of the General Medical Council's fitness to practise decision makers, case examiners and clinical experts are to receive human factors training and advice on modifying investigation processes, as part of a collaboration agreed with Oxford University's Patient Safety Academy. The work paves the way for the GMC to draw on Human Factors experts when it chooses to investigate doctors, and where systems issues need to be better understood in order to do so.

Charlie Massey, Chief Executive and Registrar of the GMC, said: "This collaboration will make sure that Human Factors is hardwired into our investigations so that the role systems and workplaces play in events is fully and evenly evaluated in assessing context following serious failings. That will guarantee consistency in how we investigate after things have gone wrong and give doctors the assurance that their actions will be seen clearly against the backdrop of any system failings."

Find out more at **http://bit.ly/HFatGMC**



Aviation safety recognition

Bill Johnson, the US Federal Aviation Administration's chief scientific and technical adviser for human factors in aircraft maintenance systems, has been awarded the Flight Safety Foundation – Airbus Human Factors in Aviation Safety Award.

His research has extended into many domains, including civil aircraft, military helicopters, space vehicles, military electronics and the electric power industry. One of his best-known efforts involved developing and conducting advanced technology maintenance human factors training for Lufthansa Technik and its 10,000 employees and 30,000 external customers worldwide.

Bill was praised for his extensive work in, and significant contributions to, human factors research and development, with a focus on human performance in the maintenance and repair of complex systems.

Commenting on his award, Bill said: "A major contribution to continuing flight safety is our keen focus on the human in the system. Examples include the design of the aircraft and support equipment, attention to process and procedures, work scheduling, fitness for duty and the diligent attention to trying to do things right, all of the time."

Read the full story at **https://bit.ly/2BAMP2w**

IMAGES: ISTOCK

Influencing the workplace

Canary Designs, a CIEHF Registered Consultancy, has built a community of 'workplace influencers' to improve conditions for employees across Wales. The ergonomics consultancy aims to unite company owners, architects, product designers, industrial designers, engineers, HR, software developers, project managers and other professionals who have an impact on office and workplace environments.

Founder and director John Lovegrove said: "Our plan is to bring people together on a regular basis to discuss key issues that impact on the strategy and day-to-day operations of workers and companies of all sizes in different sectors. By getting everyone in the same room we can share ideas via a series of talks, presentations and videos, while networking and collaborating to help businesses become more effective in terms of people, performance and productivity." Find out more at **www.canary-designs.co.uk**.

Occupational ergonomics event

The International Society for Occupational Ergonomics and Safety (ISOES) will be holding its Annual International Conference on 12-13 June 2019 in New Orleans, USA. Join practitioners, researchers and students from various industries and academic settings. Keynote presentations are featured as well as break-out sessions to fit the needs of those responsible for ergonomics and the safety of their workforce.

Participants receive peer-reviewed publications that includes the latest research presented at the conference. Individuals interested in presenting their research or case study are invited to submit an abstract of no more than 350 words emailed to isoes2019conference@gmail.com before 28 February 2019.

FROM ANIMALS TO ASTRONAUTS

Whether it's centuries-old manual work or use of the latest technological innovations, the presentations at our Ergonomics & Human Factors 2019 conference will explore the incredible breadth of the discipline, as these programme highlights demonstrate.

Roadmaps for prolonged space travel

1 While SpaceX gets set to test its Crew Dragon capsule ahead of its next mission to carry astronauts to the International Space Station, potentially as early as this June, Martin Braddock from Sherwood Observatory asks the big question: "Could the future see deep space travel in a craft with an e-crew, devoid of many of the established physical and cognitive boundaries that apply to human astronauts?"

Living and working in a confined space in microgravity, especially on long duration missions aboard the International Space Station, has harmful physiological and psychological effects on astronaut health. They may receive, on a single mission, exposure to a cumulative radiation dose normally received over a lifetime on Earth.

Although the risks of living in microgravity and receiving elevated levels of radiation are reasonably well defined and mitigation measures can be deployed, our current anatomy and physiology are a major constraint to travelling in deep space and for colonising other planets such as Mars. It's unrealistic at the moment to contemplate continuous missions of greater than one year, and to mitigate against current constraints, space agencies have outlined roadmaps to introduce artificial gravity and develop strategies for increasing human resistance to radiation. In parallel, the concept of whole brain emulation and 'uploading' of human consciousness on to a platform within the rapidly growing field of artificial intelligence is one scenario which may remove the future requirement for a human crew.

Martin has explored incidents and accidents which have resulted in astronaut injury because of poor ergonomics in space. He's considered the timing of deployment of technology roadmaps and has drawn together multi-disciplinary fields to project a future whereby deep space travel may be carried out by an e-crew.

See Martin's poster presentation on Tuesday 30 April.

Improving responsiveness of touchscreens

2 Though touchscreen technology first appeared in the mid-1960s, it would take about two decades for it to become integrated into consumer devices. Today, touchscreens have become ubiquitous; they're used on all manner of devices we encounter such as mobile phones, ATMs, vending machines, gaming devices, parking meters and of course, computer displays. But what if this technology was not accessible to you?

Phil Day from NCR Corporation has carried out a formative investigation into the use of projected capacitive touchscreens with upper limb prostheses. The study found a difference in performance between two types of touchscreen and between different types of prosthesis. Currently, there's a significant level of variability in upper limb

IMAGES: ISTOCK

prostheses in terms of appearance, materials, articulation and usage, and there's also a variety of terminal devices that can be attached.

There's some anecdotal evidence from the field that different generations of touchscreen appear to have different responses to a given prosthesis, with the prosthesis reported to work with one touchscreen and not with another. Finding a solution that works for everyone is challenging, says Phil, and some initial explorations are needed to better understand the scope of the problem. This early work demonstrates the potential problem that exists in using touchscreens with a prosthetic device and explores some possible solution areas. ●

See Phil's poster presentation on Tuesday 30 April.

Stamping out cyber threat

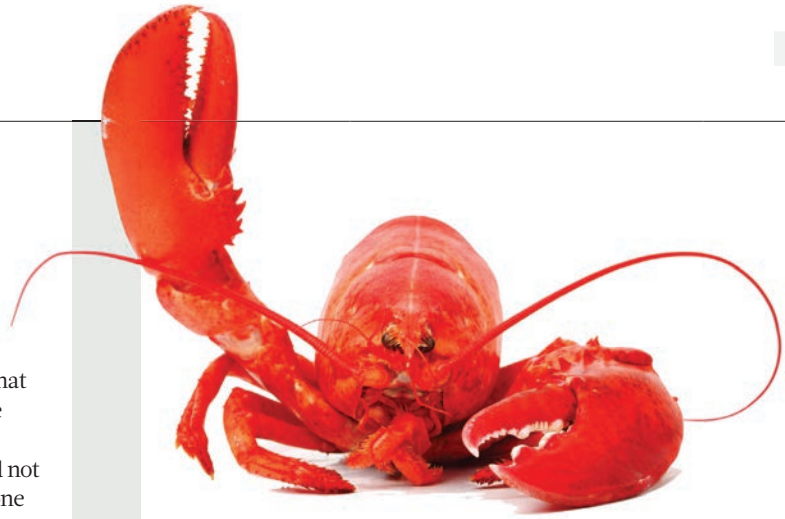
3 In December 2013 a breach of security by hackers resulted in over 40 million customer credentials being stolen from point-of sale systems across more than 2000 stores of US retailer Target, resulting in substantial financial and reputational losses.

The importance of information security and the requirement to design resilient security systems is arguably one of the greatest technological challenges of this century. However, the human and organisational factors contributing to information security are still poorly understood.

Andrew Wright of Corporate Risk Associates says that this is primarily due to a lack of research and an absence of suitable techniques to assess complex digital systems. He's applied the Systems-Theoretic Accident Models and Processes (STAMP) technique to the security breach in a study to investigate the causal factors, and to demonstrate the benefits of the technique to information security applications.

A number of critical control flaws were identified through the STAMP analysis including poor communication and co-ordination of new threats and vulnerabilities, inadequate learning from past events, a lack of proactive security management to understand and learn from system successes and good practices as well as system failures, and ineffective management and co-ordination with the supply chain. ●

See Andrew's paper presentation on Wednesday 1 May.



Protecting Scotland's fishermen

4 Lying at the heart of the UK's fishing industry, Scotland's inshore lobster season is about to begin. Running from April to early June, it comes with its own specific set of challenges for fishermen, and it's a risky occupation, bringing with it a high incidence of work-related musculoskeletal injury.

While the industry is regulated worldwide, the safety focus is on larger vessels, which is significant given that most of the commercial fishing is carried out by crews using smaller vessels. There is also very little research investigating the impact of the activity on the health and wellbeing of small boat fishermen. Given that such operations are less industrialised and involve strenuous physical labour over long hours, this area deserves further study.

Helen Vosper of Robert Gordon University has put together a case study of small boat lobster fishing off the North East coast of Scotland. She took a flexible approach combining task and postural analyses with qualitative data, and identified task elements that posed risks to musculoskeletal health. Following on from this, she developed strategies for risk reduction.

From hooking the marker buoy and lifting the lobster pots from the water, to removing the catch and disposing of old bait, the study found that back pain was especially prevalent, with all respondents identifying issues, both at work and rest. One fisherman reported suffering from wear and tear in the lower spine, while another described muscle pain and strain in the lower back. Shoulder pain and knee problems were also identified.

Helen's research is particularly timely in the current financial and political environment, which has resulted in lower seafood prices while fuel costs have significantly increased, threatening any profitability. This may be further exacerbated by the UK's departure from the European Union, which is likely to result in barriers to export both through

IMAGES: ISTOCK

physical borders and trade tariffs. Improving health and wellbeing may result in fewer fishing days lost to injury which is good news, provided that the industry can survive.

See Helen's paper presentation on Wednesday 1 May..

Effective lifesaving approaches

5 There were over 16,000 in-hospital adult cardiac arrest events reported in 2016/17, and according to the Resuscitation Council (UK), high quality chest compressions and early defibrillation are key lifesaving interventions within the resuscitation process. Lena Kerle from the University of Nottingham carried out research with an NHS trust to evaluate an external Advanced Life Support defibrillator. The investigation sought to evaluate the impact of systems factors on the usability and safe use of a defibrillator and monitor during adult resuscitation in a hospital setting.

A systems approach, which combined the Systems Engineering Initiative for Patient Safety (SEIPS) model and the onion model, was used as a framework throughout the study. Merging these two models resulted in six components of the work system being identified: people, equipment and devices, tasks and jobs, workspace, environment and organisation. A mixed methods approach was applied to understand the complex work system and the processes around defibrillator use including expert consultation, device design evaluation, task analysis, semi-structured interviews with expert users, and observations of simulation resuscitation training. A key outcome of this study is a representation of defibrillator use in the developed framework, which incorporates the interaction of factors relevant to defibrillator use on the six components.

The design of a defibrillator must be highly intuitive and robust for a dynamic clinical environment. Essential impact factors on the safe and efficient use of the defibrillator are non-technical skills of resuscitation providers such as teamwork, explicit task and role allocation, leadership as well as effective and open communication.

See Lena's paper presentation on Tuesday 30 April.

Reducing farmers' exposure to risk

6 Livestock operations pose a high risk of injury and death in agriculture, especially for farmers working alone. Such operations accounted for around one in five fatal industrial accidents recorded in 2017/2018 in the UK, according to the Health & Safety Executive.

Ilinca-Ruxandra Tone and Amy Irwin from the University of Aberdeen's School of Psychology say that, while in other high-risk industries non-technical skills (NTS) are recognised as important for safe and effective task performance, more research should be conducted to investigate how these findings apply to farmers, who, it's been suggested, are highly tolerant of risk.

The researchers' current study investigates farmer risk perception and risk management strategies, including NTS, in four types of cattle-handling operations where risks relate to the farmers themselves, their equipment, the environment and animal characteristics. Based on an initial sample of 50 farmers from the UK and Ireland, recruited through farming forums and organisational contacts to take part in an online qualitative study, participants were presented with eight scenarios, two per category of risk, and asked to report their reasoning for proceeding or not, and to detail any risk management strategies used.

Thematic analysis was used to identify patterns and showed that farmers appeared to evaluate risk in the light of animal welfare and duty. Scenarios concerning faulty equipment and animal characteristics were perceived as too dangerous. Farmers reported using NTS such as task management, situation awareness, and decision-making to reduce risk. Farmers also considered facilities important for safe completion of livestock operations. These findings suggest that future interventions should aim to frame risk based on farmer priorities and to formally raise awareness about the importance of NTS.

See Ilinca-Ruxandra and Amy's poster presentation on Tuesday 30 April.

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The future of radiotherapy treatment

Millions of people worldwide benefit from radiotherapy every year, and the treatment cures more people than cancer drugs. **Dan Jenkins** and colleagues describe a project in which human factors played a critical role in the design of new equipment that delivers the therapy to patients

The Elekta Unity, the world's first high-field imaging MR Linac

Every so often, an opportunity arises to design systems that are truly transformative. Often as the result of the introduction of a fundamentally new technology, these revolutionary systems allow new tasks to be conducted or they allow existing tasks to be completed in a new way. The design of new systems opens exciting possibilities for human factors practitioners. It also brings up concerns and challenges as it's difficult to predict how a new technology system will shape future work. Observing current behaviour on legacy systems provides just part of the picture.

Elekta Unity, the first high-field MR-linac, is an example of ground-breaking technology because it overcomes the technical barriers that have hindered the integration of precision radiation therapy by combining magnetic resonance (MR) imaging with a linear particle accelerator for highly targeted, real-time radiotherapy. Fast moving, electrically charged particles are strongly influenced by a powerful magnetic field, so keeping them on track while near an MRI seemed like an impossibility before research found breakthroughs. It's now a system that is being used by clinicians in healthcare institutions around the world.

The new MR-linac allows the exact location of tumours to be identified during treatment delivery. MR imaging provides radiotherapists with a much clearer description of the location of a tumour than is possible with more conventional computed tomography-based systems which use x-rays. What's more, MR imaging is particularly adept at differentiating soft tissues making it especially relevant to tumours in the abdomen; the location of 65% of tumours. This increased confidence around the location of a tumour allows cancer cases to be treated with radiotherapy that was previously not viable because of the location of nearby critical tissue. The greater confidence in the location of dose delivery also opens the possibility of treating with fewer instances of higher doses.

The right tools for the job

Human factors practitioners have the skill and toolsets to help frame the design and its base architecture at the earliest stages of development where the objective is also to inspire and inform the design. Most explorations of human work draw on the same core data collection approaches:

1. **Observations in a naturalistic setting** (the 'real world')
2. **Observations in a lab setting** (simulations or user trials)
3. **Interviews**
4. **Self-reporting**
5. **Literature reviews**

For revolutionary systems, observing and documenting current work (using descriptive models), or work as expected (using prescriptive models as described in standard operating procedures or SOPs), only provides part of the picture. More formative tools, such as cognitive work analysis, are required to describe how work could be conducted.

As such, there is much that can be learnt from using a range of different tools. When new tools are introduced to a discipline, there's often the tendency to compare them to more traditional approaches, highlighting the limitations and weaknesses of these established approaches. While this is an important part of discussing the value of the new, it can result in a complete rejection of the old – akin to 'throwing the baby out with the bathwater'. In practice, it's often advantageous to draw on the relative strengths of each of these method types.

In the case of Elekta Unity, a mixed methods approach was established that sought to learn from current work as prescribed using SOPs, work as disclosed via interviews, current work as done through observations, and future work as imagined using formative modelling, all at the earliest stages of the design process, seeking to maximise the value of the full toolkit.

This involved drawing from the same core sets of data collection approaches and analysing them with a diverse range of tools. The core data set was informed by studying several different areas: the current use of legacy equipment, Linacs using CT imaging across seven treatment centre visits spread across North America, South America and Western Europe; observations of over 360 patient treatment sessions; after-hours walk-throughs; over 50 stakeholder interviews; and extensive literature reviews.

The core methods used to process this data can be broadly segregated into descriptive and formative approaches.

The descriptive approach

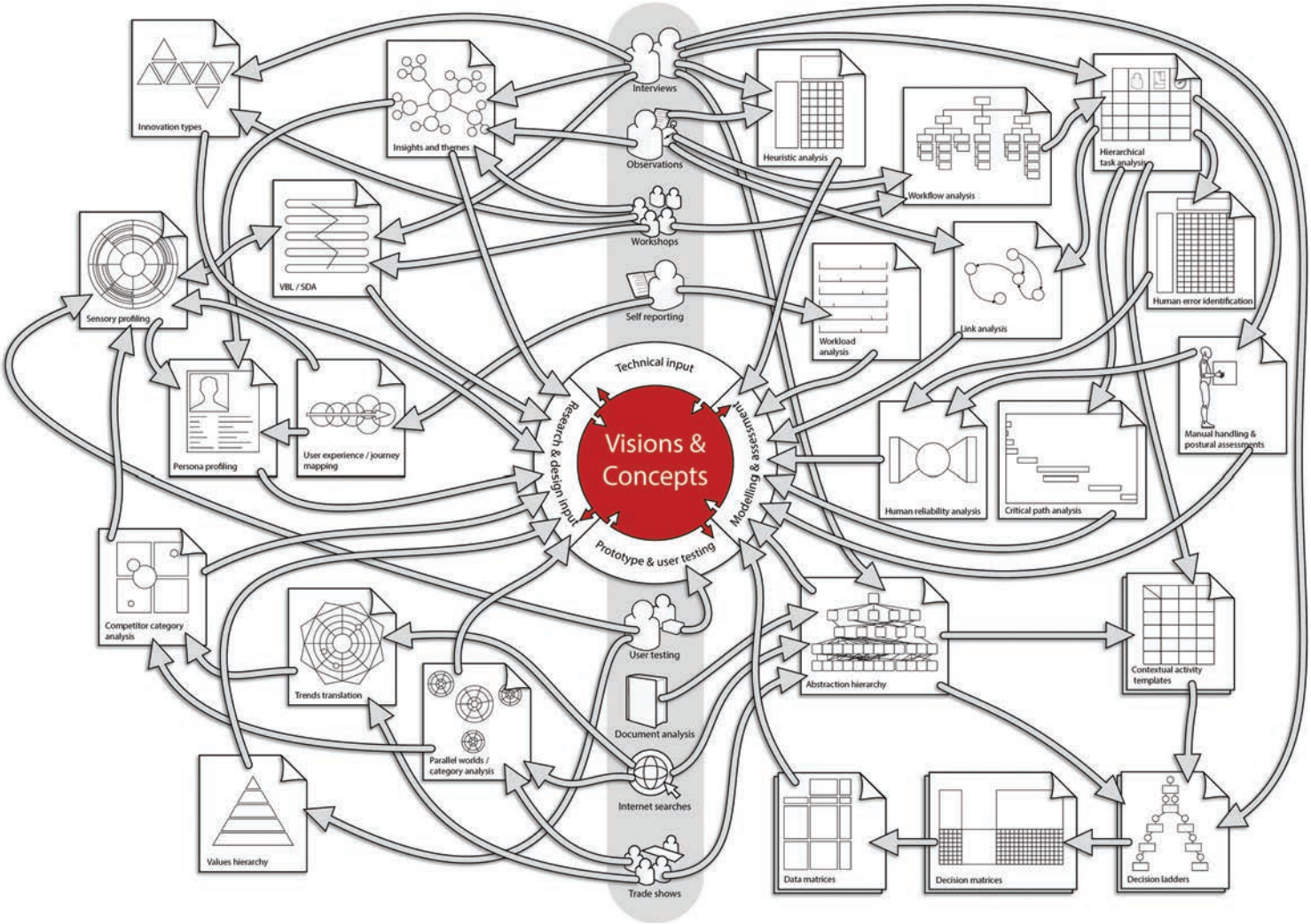
Radiotherapy is typically a highly structured process that follows a well-rehearsed workflow. As such, Hierarchical Task Analysis (HTA) was a fitting backbone for the descriptive analysis. In the first instance, we used HTA to explore the variability in workflows, or work as done, by exploring the observed differences between treatment locations such as lung, prostate or breast, and geographic location, as well as treatment centre types, such as a large teaching hospital with many Linacs and a large radiotherapy department to regional cancer treatment centres with a single Linac and a small team. It soon became apparent that the variability was relatively limited. Where it did exist, it tended to be at the detailed 'leaf-level' of the task model or in the detailed 'plans' of the HTA.

Given the limited variability and the relatively close match between work as prescribed and work as done, HTA proved to be a valuable approach. The main advantage of HTA was its large range of extensions, such as Critical Path Analysis and Link Analysis. The core model provided a common task description that could be explored in greater detail.

The temporal nature of the task was explored by assigning average base-level task times recorded from over 350 observations to each sub-task in the HTA. Critical Path Analysis was then used to identify areas in the task flow that offered the greatest potential for efficiency savings. Link analysis was used to time map the tasks in a spatial setting of a plan view of a typical treatment and control room. This revealed opportunities to optimise the layout of physical controls and objects that healthcare professionals and patients interact with, as well as the location of physical and digital information displays.

The HTA model also proved valuable in evaluating the safety of the system, both from a physical, manual handling, perspective, using a tool called REBA or Rapid Entire Body Assessment, and →

IMAGE: ELECTA UNITY



Visions and concepts research model

from a cognitive level predicting opportunities for 'error' using TRACEr or Technique for the Retrospective and predictive Analysis of Cognitive Error.

The formative approach

At a more formative level, tools from cognitive work analysis were used to explore how work could be conducted. Hierarchies were constructed to explore the relationships between the physical objects in the system such as new and existing technology, and the higher order systems values of efficacy, efficiency, safety, inclusiveness, satisfaction and flexibility. Decision ladders were used to describe how information across digital displays, documentation, staff interactions, the physical environment and the verbal and non-verbal patient cues were currently being used to guide treatment sessions and to explore how they could be used in the future. The flexibility, variability and resilience of the system were also explicitly explored.

Inspiring and informing design

The purpose of this detailed analysis was to inspire and inform the design of a vision for the future at the infancy of the project. This vision was created six years before the first patient was treated with the system; the intention was to form a basis for the detailed design that was technologically grounded and evidence-driven. Some of the notable features of the design, such as the low table top or 'couch' that the patient lies on, were informed by anthropometric datasets and manual handling assessments of those assisting and positioning patients. Engineered safeguards were inspired and informed by 'error' predictions and carefully considered against their impact on system resilience.

The approach also provided a detailed description of the information requirements of the system. This ensured that the right information was displayed, in the right place, at the right time, to the right people, in a suitable format that complements information drawn from human interactions and the physical environment.

The output was a three-minute video describing a vision for the patient experience for the future system, backed up by detailed reports. This formed the target for a full-scale development programme that resulted in the design of Elekta Unity, the world's first high-field imaging MR-linac, that was used to treat its first patient in September 2018, ushering in a new era in the battle against cancer.



Dan Jenkins leads the research team and **Malcolm Boyd** is a Senior Sector Manager at DCA Design international. See www.dca-design.com. **David Gilmore** is Director of User Experience at Elekta. The Elekta Unity project was awarded the 2018 HFES User Centred Design Award, a 2018 iF Design Award, and a 2018 Good Design Award. See www.elekta.com



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Optimising Human Potential

According to the International Air Transport Association, airline growth will be rapid in the coming years but tough recruitment policies mean the necessary experience will be hard to find. Lou Boulden talks to **Gemma Aiuto-Turner** about the operations sector, where a new apprenticeship scheme is helping to develop much-needed skills

Building skills in aviation operations

Whenever you take a flight with a commercial airline, you'll see or speak to check-in staff, gate crew, cabin crew, pilots and the ground crew. But there are many more people involved than that behind the scenes carrying out the work that gets your flight off the ground. A large proportion of this work in carried out in the Operations Control Centre (OCC).

What happens in the OCC?

One of my friends always greets me as though they are marshalling in an aircraft, and for years, I'm sure my mum thought I was an air traffic controller but working within the OCC is nothing like any of that. The OCC's main purpose is to ensure the flying programme continues as published, predicting and minimising any disruptions to passengers, crew, cargo and the aircraft.

What does the job involve?

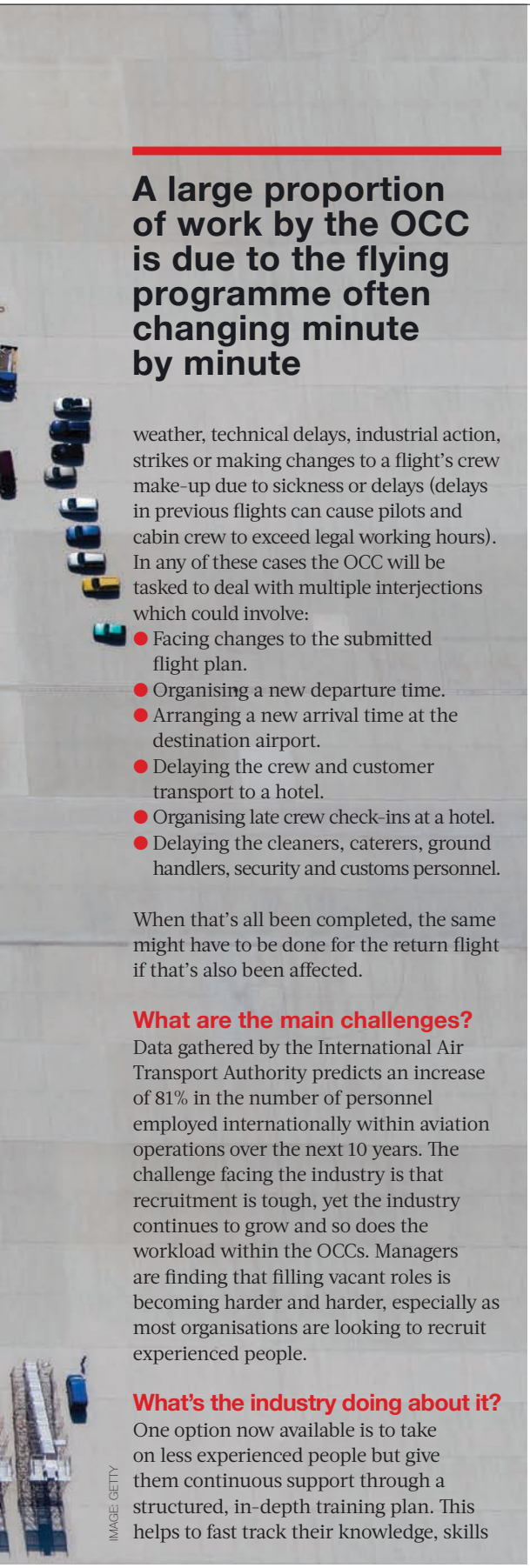
It's not a glamorous job, even within the biggest airlines this is no NASA; in some cases, the OCC is located in an industrial estate away from the airline's home base. The working environment looks like any other open-plan office with each worker having two or three computer screens. Operating 24 hours a day, 365 days a year, the OCC operates to shift patterns consisting of a mixture of 12-hour days and nights.

How did you get into this work?

My first exposure to an OCC started 16 years ago when I joined the Royal Air Force. Since then I've worked in an OCC environment for both private and commercial providers, working my way from an assistant to the duty operations manager, before transferring into a full-time training role for a major airline. Twelve months ago, an opportunity, too exciting to miss, arose for me to move to a training organisation to support the OCC function on a larger scale.

What does a typical day look like?

Like many aviation roles, every day is different. A large proportion of work completed by the OCC is carried out because the flying programme often changes minute by minute. Tasks could include re-organising flights due to



A large proportion of work by the OCC is due to the flying programme often changing minute by minute

weather, technical delays, industrial action, strikes or making changes to a flight's crew make-up due to sickness or delays (delays in previous flights can cause pilots and cabin crew to exceed legal working hours). In any of these cases the OCC will be tasked to deal with multiple interjections which could involve:

- Facing changes to the submitted flight plan.
- Organising a new departure time.
- Arranging a new arrival time at the destination airport.
- Delaying the crew and customer transport to a hotel.
- Organising late crew check-ins at a hotel.
- Delaying the cleaners, caterers, ground handlers, security and customs personnel.

When that's all been completed, the same might have to be done for the return flight if that's also been affected.

What are the main challenges?

Data gathered by the International Air Transport Authority predicts an increase of 81% in the number of personnel employed internationally within aviation operations over the next 10 years. The challenge facing the industry is that recruitment is tough, yet the industry continues to grow and so does the workload within the OCCs. Managers are finding that filling vacant roles is becoming harder and harder, especially as most organisations are looking to recruit experienced people.

What's the industry doing about it?

One option now available is to take on less experienced people but give them continuous support through a structured, in-depth training plan. This helps to fast track their knowledge, skills and behaviours through an aviation industry-designed and government-backed 18-month apprenticeship for operations employees.

IMAGE: GETTY

What's most important about the role?

One factor essential to all roles in the OCC is situational awareness, without a high degree of which, the team will be missing the moments when they had the potential to stop a problem from becoming a crisis. The ability to predict these situations is vital in running a successful OCC. There are a number of stages to the training. The initial stage of situational awareness ensures the apprentice can identify single events and their consequences from reading an airspace notification. The second stage focuses on identifying those events that could lead to potential problems such as when getting an airspace closure notification. The final stage consists of making fast decisions based on this experience.

What does the training involve?

During the apprenticeship several topics are covered, starting with human factors. Once the initial training module has been completed, the apprentice is asked to go back into their working environment to identify the factors that have been discussed so that they can put the theory learned into practice. In March 2018, West Atlantic UK were the first airline to be supported by the apprenticeship scheme and they are delighted with the results and are seeing the benefits each day. Daniel Coleman is one of their apprentices.

Gemma Aiuto-Turner is Head of Aviation Training at Crosby Management Training.

DANIEL COLEMAN, OPERATIONS OFFICER APPRENTICE, WEST ATLANTIC UK

What's your background?

Prior to my role at West Atlantic UK, I was working in road haulage. But from a young age it was always my ambition to work in aviation although I'd always been deterred from looking for a job in the sector as most of them needed at least a minimum of two years' operational experience. When I saw the Operations Officer Apprentice role advertised on West Atlantic's website, I was very interested as it offered an entry level introduction to the industry. I also knew that it would generate a lot of interest from other potential applicants.

How is the apprenticeship going?

I've been very impressed by how my apprenticeship has been managed both internally and externally. I have previous experience of an apprenticeship earlier in my career and the differences between that and my current training at West Atlantic are vast. The first two weeks were dedicated to training, covering aspects such as human factors, compliance, legislation, safety and security. I've been set regular assignments on interesting topics that have encouraged me to research and invest effort to complete my work. Soon, I'll move on to a new discipline where the training will be managed again.

How is it helping your career?

To gain a better grasp of the network and to witness the operation in effect, we've been given the opportunity to jump seat around the network. I flew to Paris and operated with the crew on the French postal service contract flying around southern France and Corsica. This was an invaluable experience and is actively encouraged by the company. I'm sure the current and ongoing training, support and experience I'm receiving is setting me up for a lifelong career in the industry and I look forward to completing my training.

Filtering out the facts

Often relying on gut instinct, people vary considerably in what they bring to the decision-making process. **Neil Buchanan** and **Arthur Stewart** discuss the use of naturalistic decision-making to increase safety awareness

"Something's not right" said the task leader, observing the farcical attempts of a group of blindfolded business executives to erect an A-frame tent on a cold February day in the Lake District. Only the leader could see or speak, and the 'workers' were required to follow her command. While the task was straightforward (assemble each pole set, clip together the frame, hook and peg the inner tent, drape and peg the flysheet), it was time-critical to earn their team points in a week-long challenge. The inability to visualise the components and their interaction undermined the workers' ability to fully understand and engage with the task, while the inability to speak negated sense-checking, affirmation and ultimately, focus.

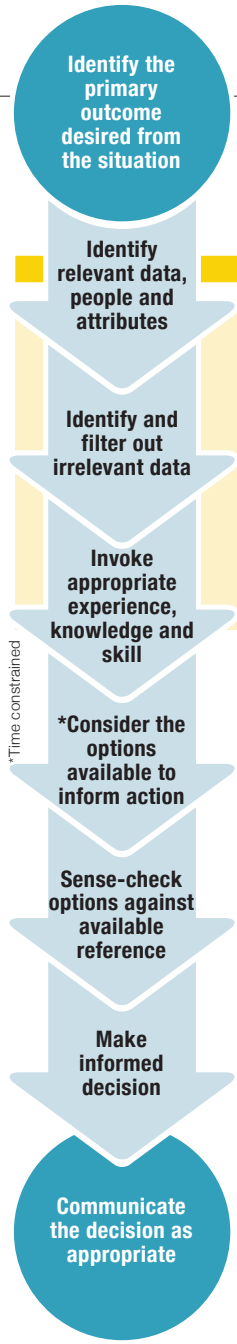
When the environment is altered, the role of communication assumes much greater importance in coordinating the effort to implement a decision. The participants, who were safety advisors and managers of a major utility company, learnt about the critical dependency on communication in implementing decisions requiring collective action. Subsequent video replay graphically revealed the gap between expectations (work as directed) and reality (work enacted). In other words, when all information is available, decision-making may be relatively straightforward, but when vital cues are missing, we may fail to sense that things aren't right, and decision-making becomes a whole lot more problematic.

Perceiving reality

Because we live in an ever-changing world, tasks are seldom simple. Monitoring and assessment of prevailing circumstances is referred to in some contexts as situation awareness. This is defined as perception of the elements in the environment, comprehension of their overall meaning, and projection of future status and it's essential to effective decision-making. Across various sectors including transport, energy, health and defence, many tasks routinely faced are not straightforward, and may be vague in definition, have ill-defined objectives, limited time, unstable conditions and potentially severe consequences.

Researchers have in the past sought to model these decision styles on a continuum between intuition and analysis, and where decision-makers would use using prior experience to rapidly categorise situations in a 'recognition-primed decision model'. This collective effort spawned the birth of the discipline of naturalistic decision-making in the late 1980s. It was given impetus following a tragic incident in July 1988 in which the USS cruiser Vincennes shot down Iran Air flight 655, killing 290 passengers and crew, having mistaken it for a hostile aggressor.

The gravitas of decision-making



DECISION-MAKING TOOLKIT

Unfolding scenarios mean there are some decisions which must be made with far more data and less clear information which define the task, affecting situational awareness and the decision itself. By applying the toolkit, we may equip ourselves to enter such complexity with a little more confidence.

importance becomes all too clear in the light of accident investigations and human tragedy. In an emergency, the operator must not only consider true information, but also incomplete, muddled, conflicting or misinformation. Decisions informed by situational awareness need to be responsive to information which may be unreliable, in an environment which is usually sub-optimal and subject to rapid change.

In our digital age in which information is so readily delineated into bullet points, soundbites or binary outcomes, we might usefully reflect that some of the technologies of the 'analogue age' were useful after all. For instance, a 1970s car dashboard's oil pressure gauge provided measurement, direction of travel and rate of change information. Nowadays, a warning light flags a fault, but while unlit provides no real-time feedback until the problem occurs.

Interacting components

In complex systems, the interaction of multiple components requires operators to have well-developed situation awareness informed by multiple data sources in order to make essential decisions which are often strategic and safety-critical. In the case of the Deepwater Horizon disaster, the drillers' situation awareness was influenced by flawed assumptions, and a combination of the resulting misinterpretation of pressure tests along with fatigue and other human factors. Ultimately, they misperceived the real danger, believing that everything was fine when the antecedents of a major disaster were present.

Risk perception and comprehension of cues can be clouded by extraneous factors relating to both the task and the environmental conditions. Individuals may also project their comprehension to others, giving an opportunity to them to affirm or negate it, prior to decisions being made. But individuals vary considerably in what they bring to the decision-making process, introducing bias. As well as knowledge, experience, training and ability, is the 'comfort factor' which relates to risk acceptance. While some of this may relate to personality traits, there's also the weighting of the known and the unknown.

This was elegantly illustrated by economist and anti-war activist Daniel Ellsberg whose paradox famously revealed much about instinctive risk perception and behaviours: Two closed containers each contain ten balls. Container one has five red and five black, and container two has an unknown and random distribution of each. A financial reward is offered for selecting a red ball, and a blindfolded participant selects which container to pick a ball from. Combining the equal distribution (container one) the random distribution (container two), the probability of picking a red ball is identical for each, but container one is overwhelmingly preferred by participants over container two. What this simple experiment tells us is that people tend to base decisions on gut instinct and the comfort afforded by known facts rather than higher mathematical brain functions or logic.

Time-critical decisions

Time-critical decisions may expose an over-reliance on technology or data, calling for mental agility and adaptability. Such attributes are pillars of resilience engineering but also apply to safety. Traditionally viewed as an absence of harm or loss, safety is now also seen as adaptive and the capability for performing work in a varying and unpredictable workplace environment.

Naturalistic decision-making and situation awareness are not only relevant for industry sectors, but also apply to non-professional scenarios such as playing a competitive team sport, discovering your wallet, phone or keys are missing, or being part of a crowd evacuating a shopping centre after an incident. For these and other comparable scenarios, a customised decision-making toolkit could be used for sequencing these and other similar decision situations.

Back in the Lake District, after eventually succeeding with the blindfold tent exercise, the business executives are now knee deep in a stream, intercepting sealed canisters floating down before they wash into Lake Windermere. Inside some, are scrabble letters. As each member longs for respite from the excruciating cold, the group is not trying to formulate a response, it's attempting to arrange six letters – R, R, E, F, Q and Y, in order to discern the task. Like all unprecedented events, it calls for thinking outside the box and, unknown to them at the time, naturalistic decision-making. Meanwhile another instructor is waiting to deliver the next clue – at the ferry queue. ●


Neil Buchanan is a Lecturer in Applied Sport and Exercise Science and **Arthur Stewart** is a Senior Researcher in Ergonomics and Health, both at Robert Gordon University in Aberdeen.

Further reading

Roberts, R, Flin, R & Cleland, J (2015). "Everything was fine": An analysis of the drill crew's situation awareness on Deepwater Horizon. *Journal of Loss Prevention in the Process Industries*, 38, 87-100.

IMAGE: SHUTTERSTOCK

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IMAGE: ISTOCK/SHUTTERSTOCK

Screen time escape

1 As our newsfeeds fill with the latest research that claims that rewarding children with screen time is as bad as giving them sugary treats, it seems medical professionals and the media are taking the impact of screen time seriously. And 'smartphone addiction' doesn't just apply to children and young people, with one in every five adults accessing the internet solely through their phone.

Excessive screen time can affect physical and mental health, our relationships and our productivity, as recent tragic cases have demonstrated. Researchers have conducted a study to identify antecedents of smartphone addition and its associated conflicts. The findings focused on data collected from adolescents, who are major targets for smartphone advertising and can be vulnerable to addictions. The findings established 'loneliness' and 'self-regulation' as the main antecedents for smartphone addiction along with family, personal conflicts and poor academic performance as the significant negative consequences of its excessive use.

Supporting this work, over half of teens surveyed in this study in the US said they spend too much time on smartphones; 36% of parents said the same.

Researchers hope that the study findings can help to create awareness and offer insights for developing effective interventions for addressing smartphone addiction amongst teens. The planners, regulatory and administrative authorities will use the study findings to formulate measures that would promote positive coping mechanisms to prevent smartphone addiction among adolescents.

Do you know how often you use your smartphone? For those with an iPhone, check out Apple's new feature, Screen Time, which tracks usage and sets parameters for how long you use certain apps.

S Mahapatra, (2019) Smartphone addiction and associated consequences: role of loneliness and self-regulation, Behaviour & Information Technology, *DOI 10.1080/0144929X.2018.1560499*

Seat squeeze

2 Thoughts at this time of year in the UK often turn to holidays and getting away to the sun. But airlines appear to be reducing seat width while individuals worldwide are getting larger. In fact, people taller than six feet can no longer fit in airline seats, a recent US lawsuit alleges. And while in the US a bill has now been passed to require minimum standards for airplane seat size and legroom, it still leaves very little wiggle room for passengers.

With flights becoming increasingly crowded, and with load factor (the ratio of the lift of an aircraft to its weight) at a record high, researchers recently aimed to demonstrate a method for examining the competing effects of secular trends in body size, seat size and configuration, and the increased load factor of airplanes. A case study demonstrates the method by exploring the effect of seat width on the accommodation of US civilians (based on seated hip breadth). It revealed that recent trends of decreasing seat widths and increasing load factors leads to higher 'disaccommodation'.

E L. Miller et al, (2019) The effects of seat width, load factor, and passenger demographics on airline passenger accommodation, Ergonomics, *DOI:10.1080/00140139.2018.1550209*

Sign design

3 Road signs are designed to communicate with road users, to control traffic and to improve road safety so comprehension of signs is crucial if they are to be effective. Road sign designs have three elements: shape, colour and central image. Although in most countries, each sign type has a distinct shape and colour, standards and regulations for traffic sign design varies across countries. How do these differences rate in terms of ergonomics?

More than 30 conventional signs and one to three alternatives for each conventional sign were evaluated for their compliance with three ergonomics guidelines for sign design: physical and conceptual compatibility, familiarity and standardisation. Twenty-seven ergonomics experts from ten countries evaluated the signs relative to their compliance with the ergonomics guidelines. For 19 of the 31 signs, an alternative design received a significantly higher rating in its ergonomics design than the conventional sign with the same meaning, showing that there is scope to improve road sign design.

T Ben-Bassat et al (2019) Expert Evaluation of Traffic Signs: Conventional vs. Alternative Designs, Ergonomics, *DOI: 10.1080/00140139.2019.1567829*

Sharing lessons in safety

A new report has highlighted the high patient risk associated with some medical devices used for patient care and treatment. The report, from the Healthcare Safety Investigation Branch, puts forward key recommendations to improve patient outcomes, focusing on how medical devices are designed, and better understanding of how clinicians interact with them when treating patients, as **Tina Worthy** explains

The formation of the Healthcare Safety Investigation Branch (HSIB) is a world-first and represents a landmark moment for the NHS in England. HSIB's purpose is to help improve safety in the healthcare system by developing recommendations and sharing lessons from investigations. HSIB's independent investigations don't apportion blame or liability but aim to improve patient safety as a priority.

As an example, HSIB's report 'Design and safe use of portable oxygen systems' published in November, arises from an investigation that was launched following the death of an 83-year-old man who failed to receive oxygen from a portable system whilst having CPR. The patient's breathing was supported using a bag-valve-mask, with a reservoir bag attached, connected to a portable oxygen supply with a standard valve. However, the reservoir bag was not inflating between breaths, indicating that the patient was not receiving supplementary oxygen, so the resuscitation team concluded that the oxygen cylinder was empty. It was replaced and the oxygen supply checked as being delivered to the patient. The following morning the medical gases porter went to replace the cylinder that was thought to be empty but on examination, the cylinder was found to be full.

The lack of oxygen is thought unlikely to have affected the outcome for this man, but the Trust informed the HSIB about the incident for consideration as a national investigation. After gathering additional information about the event and assessing the incident against the HSIB's investigation criteria, the decision was made to progress to a national investigation. It focused on reviewing how the design of portable oxygen systems is regulated by the Medicines and Healthcare products Regulatory Agency (MHRA) and reviewing the design of portable oxygen systems used in other industries to determine if there are appropriate lessons for healthcare.

The report highlights some key findings critical to future patient safety in recognising that oxygen is widely used throughout the NHS and finding clear evidence of ongoing risk. The investigation found that there were several design issues and flaws within current systems and products used within the NHS. For example, oxygen systems currently used across the NHS in England do not provide clear and timely feedback that oxygen is flowing to the patient. It was found that this was a contributing factor for clinicians who had misinterpreted that oxygen was flowing to a patient during treatment, when it was not, in fact, doing so.

There is potential to reduce error if human factors evaluation methods are incorporated into procurement methodology

The investigation went further, looking at the broader themes of design and regulation for medical devices in general, in particular looking at the human factors issues in people's interactions with systems and devices in both the pre and post-market regulatory stages. Evidence suggests that design changes, such as updating labelling and instructions for use, are most likely to be made following post-market incident investigations. However, these are weak solutions for preventing error but can be used to address an issue while long-term solutions are being sought.

Traditional NHS procurement processes thoroughly evaluate the utility and financial feasibility of products to be purchased. An important further finding, is that there is potential to reduce errors and improve effectiveness and user satisfaction if human factors evaluation methods are incorporated into procurement methodology.

Back in January 2018, NHS Improvement issued a patient safety alert on medical devices mentioning 400 incidents, including six deaths, over a three-year period that involved the incorrect operation of oxygen cylinder controls. This report reinforces that alert and a number of further recommendations have been issued by the HSIB.

Four recommendations are being made to the MHRA by HSIB:

- Review and update guidance for medical device manufacturers and Notified Bodies on how to correctly include how people interact with devices as part of their design process.
- Require all oxygen manufacturers to submit evidence of how they have considered how people use and interact with a device during pre-market assessment.
- Once in use, ensure the design of a device is considered as a possible contributory factor where an 'adverse event' has happened, and include this in the investigation.
- Discourage the use of weak design barriers, such as putting a label on the product, as a long-term solution to improve safety.

Keith Conradi, Chief Investigator at HSIB, said: "Patient safety is of the highest priority to the NHS and there should be no margin for error around the use of medical equipment and devices that are designed to save lives and support clinicians to deliver medical care. Our report has found that regulation and system design have more to do here. During our investigation we looked at other areas of industry to see what could be learned by the healthcare sector, and how serious incidents could be prevented by changing something at the early testing and approval stage for devices. Our recommendations and observations to the MHRA reflect this, with the overall aim of tackling the real patient safety risks associated with design and making life easier for staff working in busy environments."

As part of this investigation, HSIB worked with a range of health professionals, industry bodies and reviewed academic literature. Since the investigation started, the team have had interest in this report from colleagues across the world. The report is now available on the HSIB website and responses to the recommendations will be published.

Further reading

More details about HSIB can be found at www.hsib.org.uk
A full copy of the report can be downloaded at: https://bit.ly/2M56YkU

IMAGE: GETTY

Q&A

MEMBER PROFILE

An industrial placement can be invaluable as a starting point in a career in human factors. Lou Boulden talks to **Hannah Whitney**, a human factors research assistant at the Rail Safety & Standards Board, about the opportunities her industrial placement has given her

How did you get into human factors?

I'm currently a student at the University of Bath, completing a four-year undergraduate degree in psychology, with the third year being a 12-month industrial placement. When searching through the placements on offer, I was largely influenced by the work experience I'd completed the previous summer. I accompanied various members of the ergonomics team at Network Rail to interdisciplinary meetings and on-site visits which introduced me to human factors and immediately captured my interest. As I'd gained experience in workplace design, task analysis and workload assessments, I jumped at the opportunity to do my placement at the Rail Safety & Standards Board (RSSB). I've now been here for almost six months and have enjoyed every aspect of it. I hope this can be the start of a successful career in human factors for me.

What do you like most about your job?

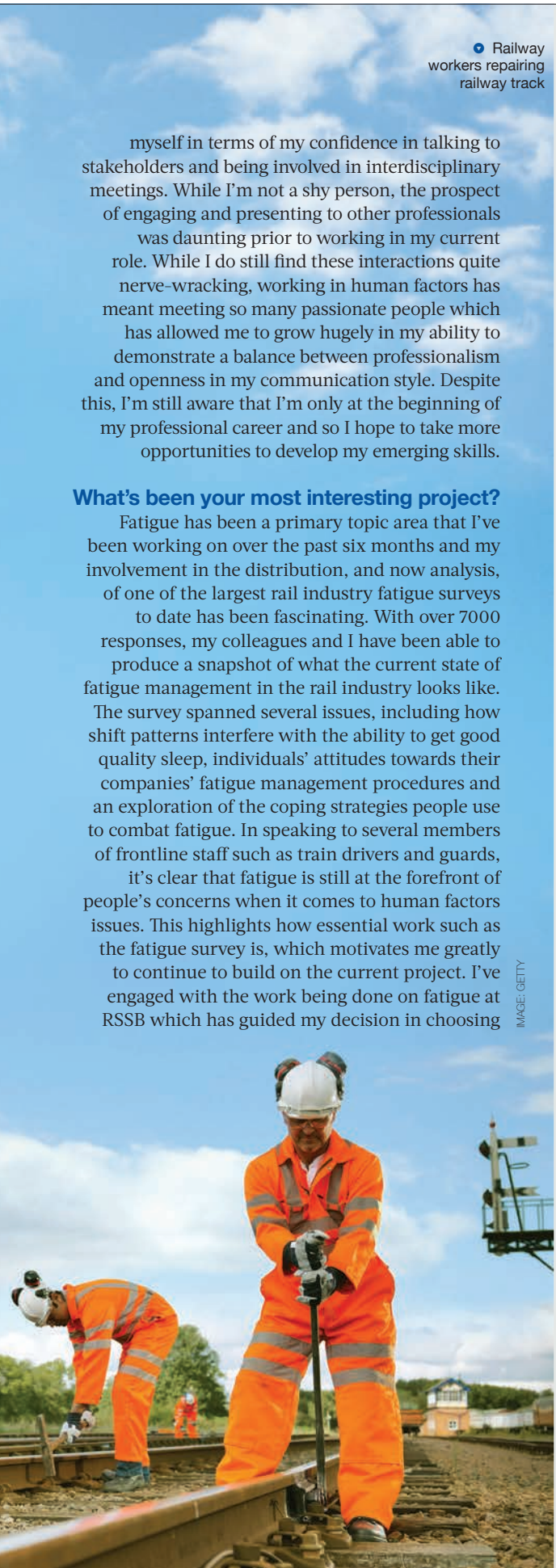
Working and engaging directly with frontline staff is an extremely rewarding aspect of my job as it emphasises the 'human' in human factors and allows me to speak openly with the key individuals we're doing work for. Such interactions are a reminder that the projects I'm working on have a real impact on the safety of individuals, their job satisfaction and ultimately their overall productivity and happiness at work. Additionally, being able to see the real-world effects of the work being done at RSSB every day is extremely motivating as it continues to highlight the importance of human factors, not only in the rail industry, but in any sector. No matter how simple or complex a system is, ultimately the role of individuals and where they fit within this system is vital to ensuring safety and efficiency.

What opportunities has it given you?

Perhaps the most valuable opportunity I've been given while working in human factors research is to work closely with individuals who have decades of experience and an abundance of knowledge which I'm able to learn from every day. As my colleagues come from a variety of academic and professional backgrounds ranging from engineering to psychology, I'm constantly learning new things and engaging in comprehensive discussions with them about human factors, work and life in general. These encounters allow my opinions not only to be heard but also to be constructively challenged which is something I find extremely rewarding and motivating.

How have you developed professionally?

Having never worked full-time for an organisation such as RSSB before, I've noticed great change within



Railway workers repairing railway track

IMAGE: GETTY

myself in terms of my confidence in talking to stakeholders and being involved in interdisciplinary meetings. While I'm not a shy person, the prospect of engaging and presenting to other professionals was daunting prior to working in my current role. While I do still find these interactions quite nerve-wracking, working in human factors has meant meeting so many passionate people which has allowed me to grow hugely in my ability to demonstrate a balance between professionalism and openness in my communication style. Despite this, I'm still aware that I'm only at the beginning of my professional career and so I hope to take more opportunities to develop my emerging skills.

What's been your most interesting project?

Fatigue has been a primary topic area that I've been working on over the past six months and my involvement in the distribution, and now analysis, of one of the largest rail industry fatigue surveys to date has been fascinating. With over 7000 responses, my colleagues and I have been able to produce a snapshot of what the current state of fatigue management in the rail industry looks like. The survey spanned several issues, including how shift patterns interfere with the ability to get good quality sleep, individuals' attitudes towards their companies' fatigue management procedures and an exploration of the coping strategies people use to combat fatigue. In speaking to several members of frontline staff such as train drivers and guards, it's clear that fatigue is still at the forefront of people's concerns when it comes to human factors issues. This highlights how essential work such as the fatigue survey is, which motivates me greatly to continue to build on the current project. I've engaged with the work being done on fatigue at RSSB which has guided my decision in choosing the topic of fatigue for my final year dissertation as it's clearly a primary issue, not only in the rail industry, but in all safety-critical industries.

Working directly with frontline staff really emphasises the 'human' in human factors

What does your typical week look like?

The majority of my time is spent in the office working on projects, with a large part of it being dedicated to statistical analysis at the moment. When on-site trips are required, I'm quick to show interest as getting out of the office and engaging with people across the industry reinvigorates my motivation for the work I'm doing. Also, if there are any training courses going on in the office such as the Non-Technical Skills training or the Human Factors Awareness Course, I'm always keen to sit in and observe to deepen my understanding across all areas of human factors and to see how it's applied in areas of work that I'm not directly involved in. While this brief description captures the work I'm currently doing, no two weeks are really the same as projects move along, develop and evolve, and so six months on since I started working in human factors, I'm still involved in new, exciting things and I'm constantly learning new skills.

Modelling ergonomics problems

The journal *Ergonomics* is calling for contributions to its Computational Modelling in Ergonomics special issue. Welcoming submissions from all aspects of the discipline including physical, physiological, psychophysiological, psychological, cognitive, social, organisational and systems ergonomics, the aim of this issue is three-fold: to provide a platform for communicating contemporary ergonomics research involving the use of computational modelling approaches; to showcase the capacity of these approaches to dynamically model ergonomics problems; and to inspire the ergonomics community to pursue further applications involving these approaches.

The deadline for receipt of papers is 28 February 2019, with a projected publication date of January 2020. Find out more at **https://bit.ly/2svqSfO**

Operational insights

Professional bodies, such as the CIEHF, provide support to their members and work to advance the discipline, but how does it all happen in reality? Tina Worthy, the CIEHF's Chief Operating Officer, explains a little about what her and her team do to try to achieve these things, with input from many volunteers

As a CIEHF member, you'll have had some interaction with us at some point. It might only have been through our website when you joined or when you paid your membership renewal, or perhaps you're one of our many generous volunteers who give their time to help with our activities and has more personal dealings us, here at the Institute.

First of all, the word 'Institute' might conjure up for you a grand stone building with steps up to an imposing entrance and portraits of past presidents in the vast hallway. It's not quite like that. Being a mere youngster, in scientific discipline terms, at only 70 years old, and of course, much smaller in member numbers (and therefore income) than other great Institutes, such as our engineering counterparts for example, we've had to adopt a much more flexible and agile approach to our operations. So, we have a small but light and airy office as a base, and we use commercial office space as and when we need to meet in other locations.

Working under the direction of the Chief Executive, we are an operational team of six who deal with different aspects of the business and my job is to manage it all and try to make it run as smoothly and efficiently as possible. So, what does that mean in practice?

Right now, the annual conference planning and organising is at full steam ahead. We've just administered the completion of final reviews on the 70 submissions we received back in November, and we'll soon be collating them into a digital book of proceedings. We've supported just over 50 reviewers along the way (each submission has three reviews), ensuring they complete their reviews on time, which allowed us to then assist the Programme Committee in compiling the programme. We're now marketing the content of that programme through soundbites, videos, articles and social media.

In conjunction with that, we're finalising work on our 70th anniversary activities, some of which will take place at the conference to give it a real sense of celebration. Other activities will be rolled out through the year. This is harder than it sounds. Each activity (and there are seven of them) requires careful thought as to how it will work in practice to the best effect and how we can enthuse our members to reach the level of engagement we're aiming for.

We're also currently managing our new CPD assessment process and trying to support our almost 600 Registered Members and Fellows in maintaining (or gaining for the first time) their Chartered status. We've gathered and managed a team of almost 40 assessors, many volunteering for the first time, who have been carrying out the actual assessments. We've been supporting them in getting to grips with the process and in providing quality feedback to members. This is scheduled to be completed by mid-March.

Near the end of January, we supported a Professional Affairs Board meeting, with eight of our elected members, where one of the agenda items was to finalise amendments to the rules by which we administer, process and assess all our membership applications and course accreditations. This was no small task. We have an Executive Committee meeting in the middle of February and a Council meeting at the beginning of March. We organise these meetings, and prepare the agenda and the majority of papers, including either writing or supporting proposals for various activities that either originate with us or with one or more of our members.

We're also currently investigating opportunities for new member benefits which means checking out demonstrations and proposals and negotiating contracts. At this time of year too, many payments come in for membership renewals and conference bookings. This income is reconciled each month and reported to our accountants.

I hope you found this look behind the scenes, at just some of the work we do, interesting. If you think you might like to volunteer or get involved in any of our activities, please let me know – email **tina@ergonomics.org.uk**

IMAGE: ISTOCK

Tina Worthy
Chief Operating Officer

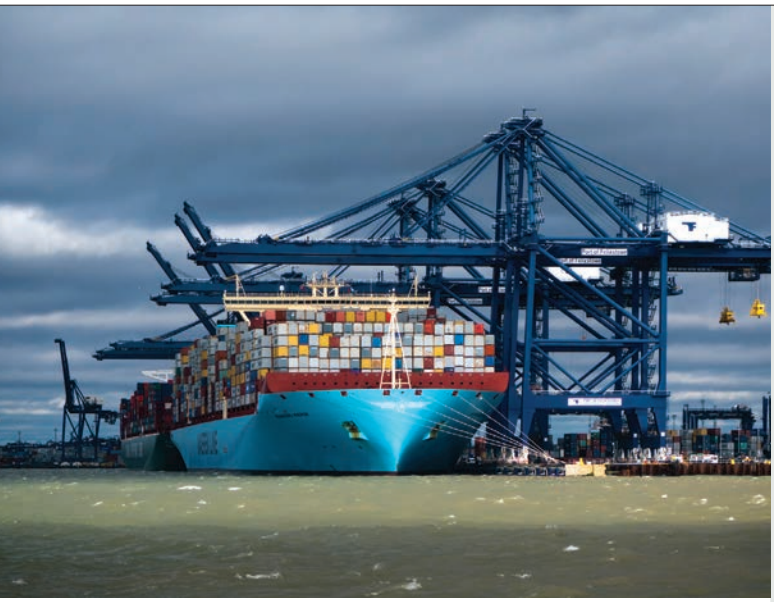
Sarah Tapley
Membership Manager

Sally Hawkes
Events Manager

Louise Boulden
Communications Manager

Ian Houseman
IT Manager

Amanda Towns
Business Support



A Maersk Line container ship is moored quayside at the port of Felixstowe, the busiest container port in the UK

REGIONAL NEWS

SOUTHERN

Supporting seafarers

"Setting people up to succeed", the theme echoed across the maritime community at the first CIEHF Southern Regional Group event of 2019, which took place in Fareham in January. Led by Marc Williams, Human Element Policy Manager at the Maritime & Coastguard Agency (MCA), 'Safer Lives, Safer Ships, Cleaner Seas' brought together human factors specialists with maritime experts from the MCA, Ministry of Defence, the Royal Navy and the Marine Accident Investigation Branch (MAIB).

Top of the agenda across all talks, was that of seafarer welfare. Seen as paramount for improvements in work structure and mitigation of fatigue, the group discussed research and work currently underway to better understand the health implications of long and regular watch-keeping patterns and the link with safety performance. Working potentially up to 91 hours per week in a six hours-on, six hours-off rotation, primarily driven by rising fuel prices and the need to cut costs, the group agreed that while not mandatory for the sector, human factors expertise is greatly needed.

While it was agreed that in past years, the shipping industry has focused more heavily on the technical performance of its fleets, with ship design at the forefront, there is great opportunity for human factors specialists to help leaders understand the vital role that human performance plays in the workforce.

Covering British shipping inspections, Pat Dolby, Head of Inspection Operations at MCA, flagged training as a key area where the sector needed support. With the MCA acting for the UK as both a Port and Flag State, Pat's team are responsible for inspecting British ships around the world and foreign ships in UK waters. Language barriers and inconsistent training, for example, for fire drills, were areas he feels human factors can potentially address.

Richard Vie, Past President of the Institute of Marine Engineering, Science and Technology, was keen to add to the training debate, explaining that as in many other industries, a blame culture has led to the industry citing 'human failures' as the core reason behind high fatal accident rates. "Is this the only response we have?" he asked. Richard believes the answer lies equally in ship design and highlighted this as a key area where human-centred design could be introduced earlier in the process. "It's common sense that human-centred design will improve business performance," he said.

Paul Bryson, Inspector of Marine Accidents at the MAIB, highlighted ship bridge design as an opportunity for human factors specialists, explaining that due to ships being produced in small numbers, standardised bridge design does not yet exist. Linking some recent incidents to potential obstruction of the seafarer's view from the bridge, he felt there was a tremendous amount of value that human factors specialists could bring to ensure design was intuitive and, eventually, standardised.

Richard Vie said that engagement and outreach at events such as this, and those run by the industry's societies and bodies, are crucial if we're to change the hearts and minds in the industry. He also suggested that human factors be added to marine engineering course content to help build awareness earlier in careers.

Summing up the event, it was agreed that relationships across the sector are complex, but this shouldn't be a reason not to try to change things and improve the sector's performance. "If you want an efficient, safely operated ship that protects the environment, with a motivated, happy crew with good shore support, then you have to give them the tools to do their job well and listen to what they're saying," Richard concluded.

Ship design is a key area where human-centred design could be introduced earlier in the process

Ending with presentations from maritime and aeronautical controllers from HM Coastguard, and a whistle-stop tour of the Operations Centre, which is responsible for coordinating the whole of the UK's search and rescue service out to the mid-Atlantic, everyone left inspired by the desire and enthusiasm for human factors to make real change across the sector.

IMAGE: ISTOCK

SOUTHERN

Investigations into healthcare

The latest CIEHF Southern Regional Group event, 'Safety in healthcare: human factors in action', will take place on the afternoon of Friday 22nd March in Winchester. A series of presentations will focus on healthcare and patient safety.

The Healthcare Safety Investigation Branch, an independent body to investigate accidents and incidents within the healthcare domain, will be providing an overview of their organisation and case studies to illustrate the breadth, depth and challenges that are faced. Dr Janet Anderson of Kings College London will talk about using resilient healthcare principles to inform the analysis of never events. There will be an open forum to discuss how effective interfacing with the HSIB can be achieved, and the CIEHF Human Factors White Paper on Healthcare will be presented.

This event will be of interest to all human factors and occupational medicine practitioners who are keen to share good practice and promote safety culture through the application of effective human factors.

Find out more at **www.events.ergonomics.org.uk**

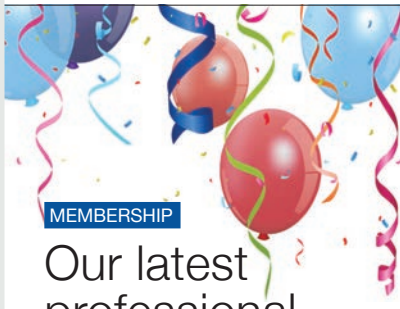
CIEHF events at a glance

For more details of all CIEHF events, see our website at **events.ergonomics.org.uk**

Eligible for CPD Lifelong Learning

EVENT	WHEN & WHERE	DETAILS
Ergonomics & Human Factors Careers Day	27 February 2019, Birmingham	The very best of careers guidance, options and opportunities, featuring talks about work in different sectors and a lively Jobs Fair.
Human Factors for Health & Social Care	4 March 2019, Birmingham	How patient safety, system performance and ways of working can be improved by integrating human factors into day to day healthcare.
Safety in healthcare: human factors in action	22 March 2019, Winchester	An overview of the work of the Healthcare Safety Investigation Branch, and a look at resilient healthcare principles to analyse events.
Doctoral Consortium	29 April 2019, Stratford-upon-Avon	A day for PhD students to present their ongoing research to their peers and to learn from each other, and from a PhD Masterclass.
Ergonomics & Human Factors 2019	29 April – 1 May 2019, Stratford-upon-Avon	CPD Masterclasses, keynotes, presentations, posters, discussions, drinks, BBQ, dinner, quiz and more to celebrate our 70th anniversary.

Please note that some events details may be subject to change after publication. Please check the events website for up-to-date information.



MEMBERSHIP

Our latest professional members

We congratulate the following members whose applications for professional membership of the CIEHF over the past few months have been successful. All have submitted comprehensive details about their qualifications, experience and achievements. Those listed also have Chartered status.

Registered Members

- Eadaoin Guilfoyle
- Emily Catlow
- Mike Shermon
- Stephanie Simpson
- Thomas Harvey

Fellows

- Michael Boardman

Organisations

- Congratulations to **K Sharp** who have recently been awarded Registered Consultancy status.

The K Sharp team is very proud to have become a CIEHF Registered Consultancy as it's a fantastic reflection on the standard of human factors that we provide. In addition, it gives great guidance to potential new partners and clients that we can be trusted to deliver excellent output.
Barry Kirby,
Managing Director, K Sharp

NATS

Optimising the human contribution in NATS

The NATS Human Factors team plays a key role in maximising the safe and efficient operation of more than 2.4million flights every year in UK airspace. The team includes ergonomists, psychologists and human factors specialists with a worldwide reputation for optimising human performance.

To find out more about the work we do, services we provide, or experience we might be interested in, please contact NATS Head of Human Factors neil.may@nats.co.uk or visit www.nats.aero and search human factors.

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70th ANNIVERSARY ISSUE

Bringing human factors to life

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How human factors ensures lessons learnt lead to better design






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CONTENTS

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NEWS AND CURRENT AFFAIRS

APPLIED ERGONOMICS AND HUMAN FACTORS

COVER IMAGE: ALAMY

RESEARCH MATTERS

CIEHF NEWS

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FROM THE PRESIDENT

The cycle of change

Neil Mansfield
CIEHF President

@profnjmansfield

With the Annual Conference and AGM approaching we are about to enter the next cycle of changes at Council and the Executive Committee, the two bodies that form the focus of Presidential responsibility. That means that this is the last time that I will write this column, as I will be replaced in a matter of weeks.

I have been pleased to see progress in many areas of CIEHF over the past 12 months, much of which has occurred behind the scenes but ensures we're in a very strong position moving forwards. This has included further action to put us in an even better financial position, and work to make our rules and processes far easier to understand and fit for the 21st century. For example, those eligible to vote will have received notifications of the new online election process for future officers of the Institute, and I anticipate that the number of votes cast will be far greater than in the past, enhancing the voice of the members.

We need to have a clear vision for where we will head in the future and to this end, we're currently working on a new strategy that will signpost the future direction of CIEHF and give focus on where we want to make an impact. The world of ergonomics and human factors has changed a lot during my career and the world in which we operate has also changed enormously. We must be ready to create fresh ideas, embrace new opportunities and look for improved ways of working, whilst retaining expertise in those areas in which we have our foundation. Through my term as President I have witnessed the enormous impact that we make across a wide range of sectors and I'm confident that CIEHF and its members will continue to improve people's lives long into the future.

I've witnessed the enormous impact we make across a wide range of sectors

FROM THE EDITOR

Seven dynamic decades

It's 70 years since the 'birth' of ergonomics; 1949 was the year the term was coined and the year in which our organisation took its first tentative steps. We're celebrating the occasion in a number of ways, one of which is a look in this issue on the application and impact of ergonomics and human factors over the decades.

We start with a timeline showing the changing focus of our discipline from industrial and consumer ergonomics in the 1960s and 70s to technology and global concerns in the last 20 to 30 years.

The origins of our discipline lie in the military and an article on defence through the years highlights some of the main contributions of human factors in this sector. The Second World War also sets the scene for making the link between the design of equipment and the risk of catastrophic error in an article about incident investigation.

Our cover story by Jon Berman looks at power generation and the critical role human factors has played in process control and human performance, highlighted by incidents from the late 1950s onwards.

The popular coupling of ergonomics and seating is made in our Day in the Life feature, but these are no ordinary seats, as Craig Hudson explains.

Cybersecurity is the topic of a discussion piece, starting with work on authentication in the mid-1990s, and we also take a look at aviation, pharmaceuticals, networking, a career in research and finally, we're taken on a worldwide trip by tandem.

Tina Worthy
editor@ergonomics.org.uk
@ciehf

70 YEARS OF ERGONOMICS 1949-2019

An ergonomics timeline

The enabling nature of our discipline, together with its adaptability, has ensured its continuing impact and growing influence, from its origins 70 years ago to the present day, as these highlights demonstrate

'40s

- Military research into WWII pilot fatigue assesses the effects of environmental stress on vigilance of radar operations.
- Combinations of control design, function and placement recognised as major contributors to pilot error.
- **1949** The word 'ergonomics is coined, and the Ergonomics Research Society (ERS) is formed.

'50s

- Anthropometric data is used in seating requirements and chair design.
- Crane cab design returns the focus to the operator, increasing the field of vision, dramatically improving safety.
- Accident patterns in the steel industry are analysed leading to accident avoidance and reduced absence.
- **1957** The first issue of the journal *Ergonomics* is published.
- **1958** The first ergonomics film is produced by the British Productivity Council called 'Fitting the Job to the Worker'.
- **1959** The International Ergonomics Association is formed. William Floyd becomes the first Professor of Ergonomics.

'60s

- A systems approach to design gains popularity in many domains such as safety and healthcare.
- Ergonomists are involved in the development of a hospital bed which later becomes a British Standard for the NHS.
- Ergonomics is applied to the development of the control console for the largest all-transistor computer in Europe.
- Ergonomics is applied to the development of domestic appliances including electric drills, electric carving knives, record players and hairdryers.
- The Post Office looks at short-term memory and recall in relation to postcodes and telephone numbers.
- Circadian rhythms and physiological changes are investigated in relation to shift work patterns and rotation and individual selection.
- The move to decimalisation of UK currency is considered with respect to coin design and usage.
- Studies consider the effect of in-car radio and other tasks on driving, and the how fatigue impairs skill during prolonged driving.
- Reaction times, speed and efficiency of older people are studied, and later their job satisfaction and problems adjusting to new working environments.
- A digital human modelling system SAMMIE, or System for Aiding Man Machine Interaction Evaluation, is developed at Nottingham University.
- **1960** The first ergonomics text book is published called 'Ergonomics: Fitting the Job to the Worker' by Hywel Murrell.
- **1960** The first Department of Ergonomics and Cybernetics is established at Loughborough College.
- **1968** Graduates emerge from the first undergraduate course in ergonomics at Loughborough.
- **1969** The first issue of the newsletter 'ERS News' (subsequently, '*The Ergonomist*') is published.

'70s

- Standalone military projects include work on radar and infrared displays.
- A systems approach in the military is applied to the design of ships' operations rooms, vehicle environments and fleet information systems.
- Trials of alternative layouts lead to the control room design for the ESSO refuelling depot at Heathrow Airport.
- The Flixborough chemical plant disaster changes emphasis to safety and the causes of accidents, which leads to the development of health and safety legislation.
- Legibility of displays, allocation of function and the decision-making of operators when interacting with large-scale, computer-generated data are explored.
- **1975** The International Organisation for Standardisation (ISO) sets up a Technical Committee on Ergonomics.
- **1977** The ERS is renamed The Ergonomics Society. '*ERS News*' becomes '*The Ergonomist*'.

'80s

- An Ergonomics Society Working Group is set up to feed into the public enquiry into the proposal to build Sizewell B.
- Ergonomists play a key role in the development of 'point and click' graphical interfaces such as the computer mouse.
- Early development of experimental immersive head-mounted display and interactive glove technologies takes place.

'90s

- The first affordable, PC-based surgical skills simulator is developed.
- The final part of a 17-part standard 'ISO 9241 Ergonomics requirements for office work with visual display terminals' is published.
- Ideas for the creation of the European Rail Traffic Management System begin to be discussed.
- European Directives for health and safety at work come into effect including those for Display Screen equipment, manual handling, and personal protective equipment.
- Terms such as joint cognitive systems, distributed cognition, situation awareness, mental workload and virtual reality became commonplace.

'00s

- Human-centred design is recognised as critical in maintenance of cybersecurity in organisations.
- Increasing emphasis is placed on patient safety and health and safety of healthcare professionals.
- Significant progress is made in consideration of complex systems including those surrounding the issue of sustainability.
- **2009** The Ergonomics Society is renamed the Institute of Ergonomics & Human Factors.

'10s

- Design solutions start to focus on the alleviation of job stress including flexible work schemes to achieve a better work/life balance.
- JSP 912 is published, mandating the integration of human factors in defence projects and the need for Suitably Qualified and Experienced Personnel to deliver it.
- Industry 4.0 emerges as a term to describe automation and data exchange in manufacturing technologies, including cyber-physical systems and the Internet of Things.
- A lexicon is created to describe and characterise the different levels of autonomy in vehicles.
- Research focuses on understanding complex, dynamic, socio-technical systems.
- **2014** The Institute is granted a Royal Charter in recognition of the unique contribution of ergonomics and human factors as a discipline and a profession, and of the standing of the Institute.

References Patrick Waterson & Ken Eason (2009) '1966 and all that': Trends and developments in UK ergonomics during the 1960s, Ergonomics, 52:11, 1323-1341, DOI: 10.1080/00140130903229561

Patrick Waterson (2011) World War II and other historical influences on the formation of the Ergonomics Research Society, Ergonomics, 54:12, 1111-1129, DOI: 10.1080/00140139.2011.622796

Using AI in patient care

It goes without saying that AI-powered systems need to work well with people, and nowhere is this more critical than in healthcare, as **Mark Sujan** and **Dominic Furniss** explain

The hype around Artificial Intelligence (AI) in healthcare is huge, on a political scale and in the public imagination. The UK Government has pledged to revolutionise the National Health Service (NHS) by developing leadership in AI research and adoption in the NHS. The Secretary of State for Health and Social Care, Matt Hancock, is a self-professed patient registered with Babylon Health's AI-driven online general practitioner (GP) system, *GP at hand*. AI in healthcare is set to be a multi-billion pound industry.

It's a common misperception that the use of AI would simply replace clinicians, creating virtual doctors, which trade a fallible human with a more reliable digital counterpart that has access to millions of data points. However, even with the *GP at hand* system, it's quite clear that AI is not intended as a substitute for human intelligence.

Looking back over lessons learned in human factors literature over the past 40 years, the introduction of new technology hardly ever just replaces people. More often, technology changes the way we work and interact with the technology. We can draw inspiration from seminal human factors work such as Bainbridge's 'Ironies of Automation' and Sarter & Woods' 'Automation Surprises' in the cockpit. These are important reminders that we need to put human factors back into healthcare AI, both at research and practical levels.

At Human Reliability, we've started work on a project around the safety of autonomous infusion devices. The work is funded by the Assuring Autonomy International Programme, which is a joint undertaking between Lloyds Register Foundation and the University of York. We're collaborating with clinical safety engineers at NHS Digital and clinicians from Royal Derby Hospital. We're exploring the critical barriers to safety assurance and regulation that need to be addressed in order to develop and use infusion devices that can learn from monitoring a patient's vital signs, and which can adjust or stop the drug infusion independently without intervention by a clinician.

IMAGE: ISTOCK

The benefits of the use of such AI-driven infusion devices are potentially enormous. Not only does it promise to reduce errors and the time nursing staff spend on manual checks, but it will also allow drug treatment that's tailored to the individual characteristics of the patient ('precision medicine'), rather than being based on guidelines that are designed for the 'average' patient.

We're taking a human factors approach to understand these opportunities and issues. We use Hierarchical Task Analysis and the Systematic Human Error Reduction and Prediction Approach (SHERPA) methodology to analyse clinical working practices, potential risks and performance influencing factors. We use scenarios of future AI use that allow us to reason with patients, clinicians and manufacturers about risks and benefits of using autonomous infusion devices.

Ergonomists have a key role to play at different stages of the human-centred automation development lifecycle. Early on, there is a need to consider the fit between new autonomous potentials, working practices, performance gains and risks. Mid-way, the coordination involved in these joint autonomous and human systems needs to be designed and evaluated. Finally, new ways of working between AI-driven systems and clinicians need to be managed. This includes giving advice on maintaining and developing competence, managing handover between the system and clinicians in abnormal scenarios, incident investigation and system upgrades. Ergonomists need to shape human-centred AI in healthcare.

Dr Mark Sujan is a senior consultant at Human Reliability Associates. He has more than 20 years of experience developing, applying and teaching human factors and safety engineering methods.

Dr Dominic Furniss is a consultant at Human Reliability Associates. His research explores how people, products, policies and processes interact to impact quality and safety.

Further reading

L Bainbridge (1983) Ironies of automation. *Automatica*, Vol 19, 6, pp775-779.

Automation Surprises by N Sarter et al in Handbook of Human Factors & Ergonomics, G Selvendy (ed).

See the project case study at www.humanreliability.com/casestudies/sam_project/.

MTM - EAWS

Ergonomic Assessment Work Sheet

The need to identify the degree of exposition to biomechanical load has led at the beginning of the new millennium to the development of specific ergonomic risk screening tools; the aim of these tools is to analyse the risk factors that may lead to overload the operator and eventually to occupational diseases. As always, the final goal is the redesign of the work system so that the any risk can be minimized and the performance eased.

The basis of every ergonomic risk screening tool is to estimate the correlation between the task ergonomic characteristics (force, frequency, postures, etc.) and the probability to cause an occupational disease. The main difficulty is to establish how the different factors interact and lead to work related troubles or diseases.

For a quantitative ergonomic risk evaluation of a specific working sequence, generally two evaluation levels are used:

- First level tools: risk screening tools which require a quick checklist.
- Second level tools: risk evaluation tools which require a detailed analysis with index calculations. They are applied where a possible risk has been already detected by a 1st level system and the “risk generator” is not yet well identified.

The correct use of EAWS will provide the following:

0 -25 Points	**Green**	Low risk: recommended; no action needed
> 25 - 50 Points	**Yellow**	Possible risk: not recommended; redesign if possible, otherwise take other measures to control risk
> 50 Points	**Red**	High risk: to be avoided; action to lower the risk is necessary

For more information visit www.ukmtm.co.uk
Our International Partners are the IMD (International MTM Directorate)
And are found at mtm-international.org

CHIEF EXECUTIVE'S PERSPECTIVE

Building a platform for the next five years

In this issue our overriding theme is rightly about looking back over 70 glorious years of the discipline. Many of you will have particular memories, but ever mindful that balance always needs to be struck, I would like to focus minds in the opposite direction: on the future. Good organisations continuously cast eyes ahead and, from time to time, pause to formalise and document what they see.

We began this process ourselves last June by inviting all members to any of five planned Regional Group events across the UK from Glasgow to Bristol to London to Coventry to Manchester, to contribute ideas about our future as a body and to feed those ideas into our next five-year strategic plan. Since then there have been further opportunities to contribute to that strategy as we move toward the culmination of the work in September of this year. Then, your Council will be asked to endorse the plan that will be presented to them.

By this time, our Strategy Working Group will have met a total of four times, with trustees having had the chance to meet the Group on two occasions in order to challenge, augment and revise the ideas being generated. All members have had opportunities to listen to two webinars about the progress made, and to lobby trustees about the plan. We have been fortunate to have been able to bring in, work alongside and to benefit from the advice of Steve Perkins as an independent facilitator in this process. He has provided an essential and detached eye and helped us, as a body, to think about how the world views us as a discipline, what our stakeholders value about us and where we can make the most impact in a rapidly shifting society with the resources available to us in terms of staff, partners, volunteers and finances.

It has been a real pleasure to work alongside volunteers Ian Rowe, Jim Taylour, Jean Page and Will Tutton who I invited last Autumn to form the Strategy Working Group. They have gelled as a group and have each brought differing insights into where and how we might make a difference as a discipline going forward. Alongside, trustees Bob Bridger and Becky Charles were invited to join the group to provide a regular and essential feedback loop to Council as the work has developed, aiming to ensure that there are no surprises when the final proposal is put in front of them.

So, is all done and dusted, or can you still contribute to what our future as a solvent, thriving, purposeful, contemporary Institute might look like? There is still time to have your say.

Come along to a session at our Ergonomics & Human Factors Conference at the end of April that will outline the vision, mission and values that the group believes will propel us forward. Learn about the four strategic themes that we believe will provide the essential framework into which members can contribute ideas and time in the period 2020–2025. And then contribute specific SMART project ideas that can fit under those four themes, that will inspire and engage fellow members to support the work of the Institute.

The Strategy Working Group will take these ideas away to a session later in May. In June they will meet with trustees to test our strategy and to make any adjustments before finalising a proposal to Council on 5 September.

I would like to thank all who have contributed to date to what has been a decidedly inclusive effort. I feel very comfortable that we have cast the net widely in a genuine attempt to make this *your* strategy, and a shared and inspiring one. As I step down at the close of my five-year term in September, I feel confident that my successor will be in a position to be able to grasp a well-defined roadmap and be assured of the support of an enthusiastic membership who have a stake in a shared strategy that will provide a great platform for the next five years.

Good organisations continuously cast eyes ahead and, from time to time, pause to formalise and document what they see

Steve Barraclough
Chief Executive of the CIEHF
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IMAGES: SHUTTERSTOCK

A DAY IN THE LIFE OF AN...

EJECTION SEAT SPECIALIST

Craig Hudson, Senior Human Factors Engineer at Martin-Baker Aircraft Company Ltd

Sir James Martin, an aircraft manufacturer, joined forces with Captain Valentine Baker to form the Martin-Baker Aircraft Company in 1934. Captain Baker's flying experience and skill was vitally important in the development and flight testing of the company's prototypes. But he was tragically killed during a test flight in 1942, at which point, James Martin dedicated the rest of his life, and the future of their company, towards pilot safety. Martin-Baker now stands as a world leader in ejection seat technology.

Martin-Baker's products are designed, manufactured and assembled at its HQ in Middlesex and the company is still run by Sir James Martin's descendants.

I'm part of the Human Engineering Department whose members have a diverse mixture of specialities and backgrounds. The team includes engineers with military and civilian pilot qualifications, a flight physiologist, textiles engineers, a survival systems specialist, anthropometrists and me. I bring a background in aircraft integration assessments and qualification, coupled with a deep working knowledge of Pilot Flight Equipment and Head Mounted Display integration. A working day for me is as varied as it's possible to get.

An ejection seat is the most complex chair anyone will ever get to sit on. For 99.9% of the time, it simply must be comfortable, adjustable, provide life-supporting oxygen and hold a pilot securely in place whilst allowing them to see out of the cockpit and access a myriad of displays and controls. But when needed, the ejection seat has to deliver a perfectly-timed sequence of mostly explosive-driven events which protects them from extreme g-forces and windblast, extracts them from the aircraft after the canopy has been jettisoned, or fragmented, or pierced by breakers on the top of the seat, and places them under a parachute with their survival aids attached ready for landing in the sea or on land.

The company's first 'in-service' lifesaving ejection was in 1949, when it took J O Lancaster around 35-seconds from pulling a handle to being safely in the parachute with a lot of manual stages in between. Seventy years later, the process has been systematically improved, so it can now take less than a second in certain circumstances, to be under a fully-inflated parachute. The whole process is automated, with complex electronics on the latest designs helping decision-making and allowing safe ejection throughout a wide range of conditions from zero speed and altitude, right up to over 600 knots at altitudes of tens of thousands of feet, when the seat also provides life-sustaining oxygen. The harnesses on the latest seats can even release the parachute automatically when landing in salt water meaning the only thing the pilot must do is climb into an attached, automatically inflated life-raft.

Our team is one of the company's most integrated groups as we're involved in almost every stage of the product lifecycle, from specification, concept, proof of concept testing, design and development through to qualification, delivery and training. We're then involved in legacy and through-life support, providing additional services such as upgrades or anthropometric range expansions. We also perform this role across all Martin-Baker ejection seat installations for air forces around the world.

At any one time, our department may be home to three or four types of ejection seat or crash protection/mission seats from non-fast jet aircraft. We also possess many essential facilities such as detailed aircraft-specific cockpit mock-ups, a seat inversion wheel for testing negative-g

We never expect aircrew to do something we wouldn't be prepared to do ourselves

The author performing dynamic parachute harness release trials on land

Martin-Baker ejection seat, and below, cockpit of MiG-15 fighter plane with ejection seat

restraint, and a hoist for parachute suspension and release assessments. The group is also responsible for designing and prototyping the human interface textiles on the seat, such as harness systems, cushions, arm and leg restraints and survival aids containers. One member of the team is responsible for the selection, packing and post-ejection deployment of survival aids. This is a complex task which can vary according to seat type, country of use and the environment they're to be used in, following which the end users must often be trained to do the packing and maintenance themselves.

The interactive assets we hold, combined with our team's deep working knowledge of the product make us a focal point for visiting manufacturers, air forces and other organisations (a CIEHF Regional Group visit took place here last year). We especially appreciate visits from anyone who has used our ejection seats 'in anger', and there have been almost 7600 lives saved to date, as we learn so much from them because their experiences are always vivid and unique. In return, they get to see and learn about the latest advancements in the technology that they openly acknowledge as having saved their lives. Very few industries have this level of interaction with the end users of their products and I find this one of the most rewarding aspects of my job.

One of my roles is to ensure our seats can accommodate people of as wide a range of shapes and sizes as possible, whilst placing them in a precisely located position from which they can operate the aircraft but at the same time guaranteeing them a safe path out of the aircraft during ejection. In order to achieve this, a typical development or qualification process for the seat involves a range of lab-based and external activities. All our team takes part in the activities as we never expect aircrew to have to do something we would not be prepared to do ourselves. This particularly applies to Post Ejection Survival Training/Testing (PEST) activities which is the most complex testing we can perform in person. Full system ejection testing, which was performed by a few seriously dedicated people in the past, is no longer allowed so must be performed using appropriately sized and dressed instrumented manikins.

The human assessments we perform are wide ranging, but most commonly involve: anthropometry, in order to understand crew population sizes; ingress and egress tests in normal, rapid and emergency situations; comfort assessment; cockpit mobility, vision and reach; cockpit design eye-point positioning to allow unobstructed instrumentation and external vision; ejection seat control placement and operating force assessments; seat inversion for restraint testing; ejection path clearance assessment in controlled slow, measured seat extractions; and parachute suspension and release simulation. Probably the most exciting activity we do is PEST, which amongst other things involves parachute harness release trials on land (dragging behind a vehicle) and at sea (dragging behind a boat), usually followed by life jacket flotation and dinghy boarding assessments (and a nice hot cup of tea!).

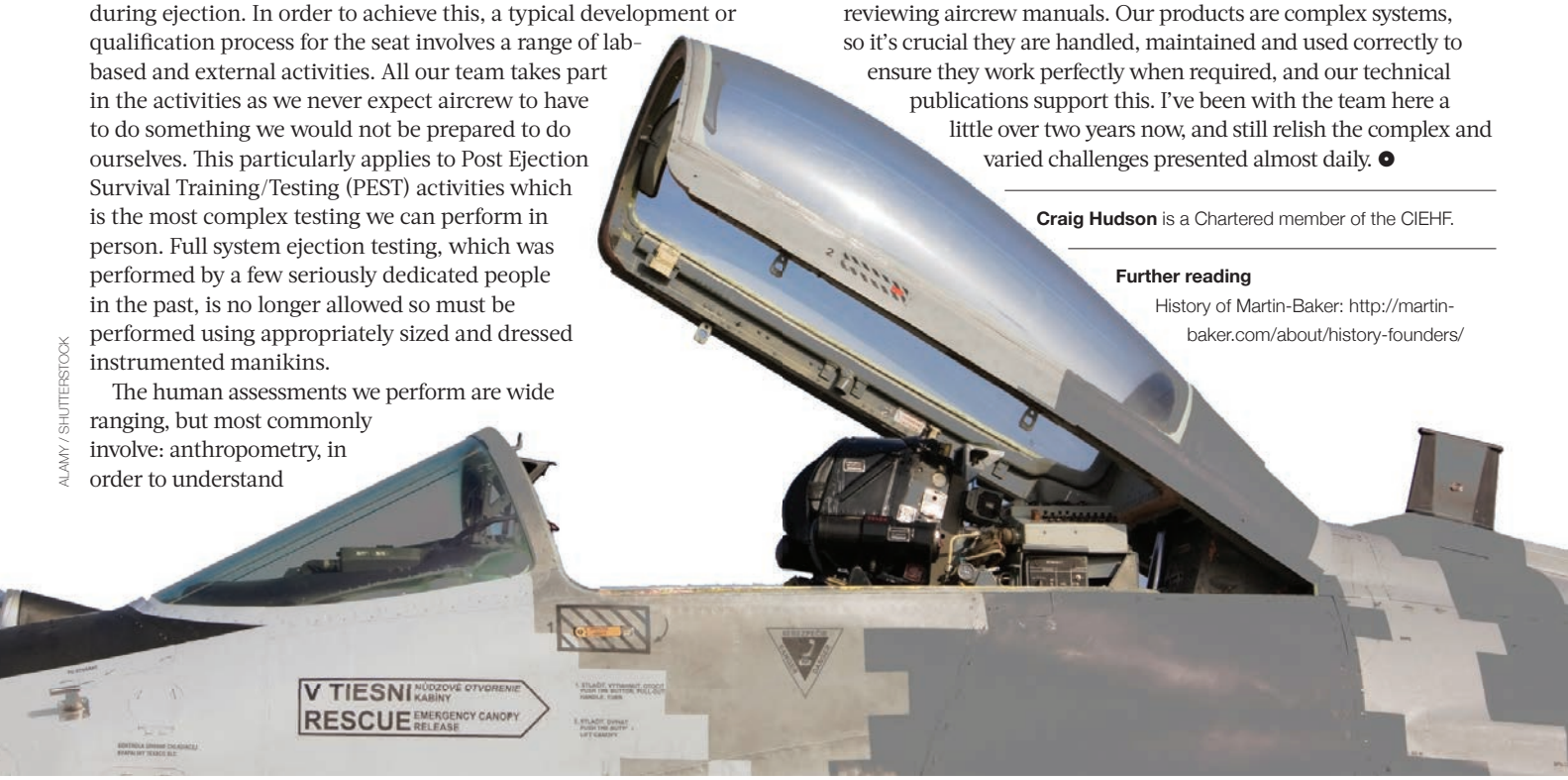
The team also regularly advises other departments such as the environmental and seat test teams with respect to the correct required Pilot Flight Equipment fitting and strapping-in techniques employed throughout a wide range of non-human testing activities. The company performs exhaustive iterative development, environmental and qualification testing of all individual sub-systems, firstly in isolation, followed by increasingly complex testing when combined with other stages. This culminates in complete end-to-end system tests using facilities such as an ejection tower, a net for catapult tests, a rocket sled test track for high speed tests, and uniquely, a pair of Meteor aircraft for high altitude, full sequence ejection tests.

Since joining MBA, I've become a restraint specialist, in particular, the design, testing and qualification of arm, leg and head restraint systems. I also support the production of technical publications by reviewing aircrew manuals. Our products are complex systems, so it's crucial they are handled, maintained and used correctly to ensure they work perfectly when required, and our technical publications support this. I've been with the team here a little over two years now, and still relish the complex and varied challenges presented almost daily.

Craig Hudson is a Chartered member of the CIEHF.

Further reading

History of Martin-Baker: http://martin-baker.com/about/history-founders/



ALAMY / SHUTTERSTOCK

Touring by tandem

Alison Moors, together with her husband, travelled across four continents by tandem on a year-long adventure, their good, bad and ugly encounters with human factors practice along the way, revealing huge differences in 'modern' life and work.

My daily bike commute in the UK has taught me that a good fit between body and bike is important. A poor riding position is inefficient and causes neck and back strains. While this may not matter too much on a daily commute, it adds to up to long-term trouble when cycling all day every day for a year, which is what myself and my husband were just about to do.

Having decided we were going to buy a new tandem for our journey, we set about sourcing the bike that would take us around the world in a year-long adventure. Off-the-peg tandems tend to assume that the taller person is going to ride 'pilot' at the front. This wasn't the case for us, as I was going to take up that position, with my taller husband at the back. We found a supplier who took time to understand our requirements, using specialised jigs to measure our anthropometry and build the bike to our individual body dimensions. It was a worthwhile investment, as were the well-designed handlebars that accommodated multiple riding positions. Other, non-standard requirements were important to us too, for example, being able to easily dismantle and rebuild the bike for the seven flights we were to take, sometimes rebuilding it on arrival at the airport so we could cycle out. We got to know our bike very well over the next twelve months and could now easily help with any design maintenance review.

Continuing the anthropometric theme, standing a foot above most people in South America meant we found our feet hung off the ends of beds and we longed for a shower that didn't involve a cramped ducking posture to get under. Extra height proved useful though when we were in an obscure village near Lake Titicaca that received an unexpected visit from the President of Peru. It meant we had a clear view of the welcome ceremony and he gave us a special wave and nod.

Inevitably, we saw some pretty hair-raising health and safety sights on our journey. Whilst in South America we saw men working at height with no personal protective equipment, harnesses or barriers, dangling weights over the side of buildings, and workers welding unprotected on the public pavements, to name just a few. We saw enormous differences in work practice for grass cutting. A large grass bank in Chile was being cut by several workers using hand-held strimmers, grass in Cuba was cut with just a large knife, and a hedge in Crete was cut by two people holding an electric lawnmower on its side! In contrast, in Oregon in the US, we watched gigantic combine harvesters controlled by one person and a global positioning system making short work of vast fields. The subsistence farming that harked back to a different era made for a better landscape and diversity of wildlife; the birdsong in Cuba for example, was beautiful and ever-present on the road and contrasted to the modern day, silent wheat fields of Oregon.

Limited access to modern equipment took a noticeable toll on health. We often saw people bent over carrying huge bundles on their backs. Although my Level One Spanglish got us around and through several Spanish-speaking countries, it wasn't enough to engage in deeper and more meaningful conversations. I couldn't ask why they didn't invest in basic equipment such as carts to move large or heavy bundles from the fields and it was disturbing to see the unladen older women walking hunched over, presumably due to the long hours of carrying heavy loads throughout their life.

Alison Moors and her husband riding tandem

One of our favourite places to cycle was Cuba, a beautiful country of varied landscapes, quiet roads and courteous drivers that would slow down and give us a wide berth and a big smile. I wondered whether their driving style was, in part, due to risk homeostasis: the tendency, when people subjectively perceive that the level of risk is low, to modify behaviour to increase their exposure to it. An everyday example is when drivers drive at higher speeds in a car that has better safety features (airbags, antilock brakes, etc). In industry this has implications for introducing safety initiatives. In Cuba, I wondered whether drivers have higher levels of perceived risk as the roads are multi-use with as many horses and carts as cars, most of which are 'vintage' through necessity rather than choice. We caught a bus that had no brakes and was stopped by moving down through the gears and we caught *collectivos* (like a taxi) that had speedometers that didn't work, permanently illuminated warning lights and a door that inconveniently swung open if you went around a corner too fast!

Although we felt way safer on Cuba's roads than in New Zealand or North America with their high traffic density, for car drivers the evidence suggests that safety features pay off; with over 133 fatalities per 100,000 vehicles per year in Cuba compared to five in the UK. Of course, driving style may just be an integral part of Cuban life which moves at a more leisurely pace than ours. Along the roadsides in Chile we encountered elaborate makeshift shrines composed of the remains of a mangled car or bike following a fatal accident. You might think that this would encourage safer driving behaviours, but it just leads to drivers kissing the dangling dashboard holy talisman, mumbling a quick prayer and then beetling along 'protected' by divine forces rather than any improved safety features or behaviours.

We came to appreciate the excellent wayfinding signage here in the UK, for example, our railway stations and hospitals follow human factors guidelines to make wayfinding easy. This was brought home to me when my husband was taken ill with meningitis and had a five-day stay in a Cuban hospital. The medical care was excellent but the infrastructure was ramshackle. In a dimly-lit corridor at 4am, trying to find a way out, I walked one identical un-signposted corridor after another. Our local hospital has consistent and standardised wayfinding with colour-coded blocks, legible directional signage, helpful overviews that locate where you are in the whole hospital and clearly lit exit signs. It took me 40 minutes to find a way out of the Cuban hospital. What would happen if people had to leave in an emergency? Luckily, I'd had the presence of mind to take a photograph of my husband's ward so I could ask directions back to it the following day when I inevitably got lost within a minute of my return.

We encountered many cultural differences too but one thing that remained consistent throughout, was people's surprise that a woman was riding 'pilot' at the front of the tandem. We'd had frequent shouts of "He's not pedalling, you know" and occasional genuine jaw-droppers like "Why do you let her drive?"; this was met with a cool eyebrow raise from us both. Realistically, a riding position that allows posture changes and plays to the strengths of both cyclists in terms of trust, nerves of steel, decision-making and muscle strength is going to be the winner – and sometimes that means the woman goes up front!

We had an amazing adventure, we saw sights and had experiences that really made us reflect on life. We didn't record our mileage, but we did spend a rainy afternoon calculating the New Zealand leg of our adventure, which amounted to over 3000km and a total altitude climb of three times the height of Everest. Would we do it again? – definitely, but for now, back to the daily commute.

In Cuba, courteous drivers would slow down and give us a wide berth and a big smile

Alison Moors is a Director of Human Impact Solutions Ltd

Tandem cycle itinerary

- Belper in Derbyshire to Manchester airport
- New Zealand - North and South Islands - most northerly to most southerly point
- Chile - from Patagonia to the Atacama desert
- Bolivia - Uyuni and La Paz to Lake Titicaca
- Peru - Lake Titicaca to Maccha Pichu
- Cuba
- US Pacific West Coast from San Francisco Northbound
- British Columbia (Canada) round the islands of Vancouver and back to Vancouver City
- Greece, Crete and across the Peloponnese
- Sicily, around Palermo
- Manchester airport to Belper

Matching capability to demand

Delivering the capability to meet changing defence requirements has always been a challenge, not least from integration of new technologies. Here we take a look at the role of ergonomists as they worked to meet these challenges whilst ensuring maximum safety for the people involved

The term 'ergonomics' was coined at a meeting at The Admiralty in London in 1949 forging the link between the discipline and defence. The journey has been long and hard since then but has resulted in recognition of the importance and contribution of human factors at the highest level, as the following insights, some of them very personal, demonstrate. But let's start at the beginning.

Recognition

The Second World War gave great impetus to the study of human performance because the extreme demands that were placed upon responsible personnel led to difficulties in the control and operation of radar, anti-aircraft tracking systems, high speed aircraft and other intricate military equipment.

Technical developments had reached the stage at which the capacities of the operator rather than the potential of the equipment was setting limits to the performance of people and machines working together.

There was a growing need for example, for more effective design of operations plotting rooms, for the development of suitable clothing for extreme weather conditions, and for the establishment of design criteria to satisfy the human requirements of tank drivers for protection, visibility and efficiency.

So if further progress was to be made it was necessary for human limitations to be studied and for equipment to be designed that took these into account.

In the 1950s, technological developments in industry often associated with the concept of automation had, with increasing frequency, resulted in the construction of machines which threatened to make excessive demands on their human operators. Some of these turned out to be too complex for people to control effectively, or so rapid that to keep pace with them they exceeded normal endurance limits.

In consequence, ergonomists were more frequently called on to make their findings available as a guide to design engineers. In this way 'human engineering', or ergonomics, first came to prominence.

Extracted and adapted from Ergonomics: the Scientific Approach to Making Work Human, reprinted from the International Labour Review, Vol LXXXIII, No 1, 1961, and from Ergonomics at 60 – a celebration, published by The Ergonomics Society in 2009.

Target acquisition

The Human Factors Department of BAE Systems' Advanced Technology Centre (ATC) originated in the mid-1960s, as part of the British Aircraft Corporation's (BAC) Guided Weapons (GW) Division. The main focus of the Department's research in those early years was in supporting BAC's development of guided weapon systems. As a consequence of these origins, the department developed strengths in two critical research fields: human visual performance and manual control skills. These capabilities were developed as a result of a GW operator's requirements to visually acquire a target and then track it using a joystick.

During the period 1970 to 2000, a small team of vision scientists developed a suite of models, known collectively as ORACLE™. These models enable the prediction of human visual performance with a wide range of sensors and displays, in combination and in isolation. In many respects the ORACLE™ suite of models represents one of the most significant successes of the ATC's Human Factors Department.

Extracted and adapted from 'Advanced Technology Centre's human factors specialists play vital role in defence' by Laird Evans in Ergonomics at 60 – a celebration, published by The Ergonomics Society in 2009.

Communication

In the early 1970s I joined the Army Personnel Research Establishment as an eager young psychology graduate. I had been appointed at no less than £1331 per annum to one of the then seemingly innumerable defence establishments, only to be immediately seconded to another, the Military Vehicles Engineering Establishment. It was an era of hierarchical staff structures, where every form you

IMAGES: SHUTTERSTOCK / GETTY

filled in asked for your rank or grade, and where messengers brought round the post. There were paper memos and carbon paper, very few computers, no emails and masses of files in that centre of the universe otherwise known as 'The Registry'.

In my own specialist area, ground-to-ground target acquisition research, the lack of substantial computerised simulation capability meant that we went out onto military ranges with real target vehicles, tanks, personnel carriers and so on. Every year seemed to bring a significant human factors exercise investigating tank crew workload.

Almost every summer brought a major, highly labour intensive, field trial on Salisbury Plain with a veritable army of target vehicles, land rovers, lab caravans and Portaloos. Because there were no such things as mobile phones, we usually went equipped on these field trials with vast numbers of military radios, walkie-talkies and sometimes even megaphones!

If I compare then and now [2003] the principal changes have probably been the availability of widespread, instant communications, and the availability to all of small, portable, and extremely powerful computing and data processing facilities. The complex models, such as Integrated Performance Modelling Environment, and rapid prototyping facilities for displays and equipment interfaces, developed by QinetiQ's Centre for Human Sciences, far surpass anything that could have been considered in the late 1960s and early 70s. Finally, it is now much easier for anyone to have ready access via the Internet to national and international collections of human factors data and standards.

Extracted and adapted from 'The way we were... in defence vehicle ergonomics' by the late Roger Harvey published in The Ergonomist 400, Oct 2003.

Integration

In the mid-1980s there were endless experiments, studies and trials taking place in purpose-built laboratories in the extensive library (there was no internet of course) and in the field with in-service and prototype equipment. Some notable examples of studies include: those that investigated the causes of and protection against noise-induced hearing loss;

Prince Henry, Duke of Gloucester visiting Royal Observer Corps in Coventry 1946

longitudinal studies looking at personnel selection, training and retention; extensive anthropometry surveys; physiological studies investigating human responses to and protection from cold, heat, fatigue, manual handling and other stressors; and applied psychology studies investigating weapon aiming, data presentation and image analysis, command and control, and electronic mapping systems long before the ubiquity of Google Maps and SatNav.

We investigated tank commanders' vision systems, manning requirements and tank crew endurance. The UK's Challenger 2 main battle tank incorporates many of the findings from these studies.

The principal changes have probably been the availability of widespread, instant communications

The Ministry of Defence (MoD) recognised that a failure to consider the people component of capability could result in increased accidents and incidents, greater training costs, reduced performance and mission effectiveness, breaches in duty of care, a scarcity of appropriately skilled personnel and substantial increases in design costs. The emphasis was on developing processes and standards to enable the customer to be better informed and to facilitate industry, including human factors, much earlier and proactively in the design cycle.

In 2010, a policy known as JSP 912 was published, defining Human Factors Integration (HFI) as the MoD's systematic process for identifying, tracking and resolving human-related considerations ensuring a balanced development of both technologies and human aspects of capability. And, for the first time, it mandated the integration of human factors in defence projects and stated the need for Suitably Qualified and Experienced Personnel to deliver it.

To support the development of the HFI processes and the underpinning knowledge base, in line with the changing defence strategy and economic shift, defence human sciences research contracts were issued in a competitive manner. This opened what had once been a firmly shut door to the commercial market place including the various defence manufacturing companies, research consortia and to numerous human factors consultancies.

Extracted and adapted from 'Developments in Defence' by Martin Thody in The Ergonomist 565, May-Jun 2018

Future intelligence

A final word from Bob Bridger, who has extensive experience in the defence sector; from 1999 to 2017, he was head of the Human Factors Department at the Royal Navy's Institute of Naval Medicine where he applied human factors across domains in the Navy and in defence procurement.

"In my view, the most significant contribution human factors has made to advances in defence was the development of JSP 912. Human factors experts were involved in drafting this policy, which is significant in many ways, not only because it integrates human factors into systems engineering, but it also brings together human factors specialists working with the customer and with suppliers.

There are so many new technologies that need integrating with users to deliver maximum capability, such as robots, autonomous vehicles, Artificial Intelligence in the ops room and exoskeletons in the field. It's vital that human factors continues to play a major role." ●

Further reading

Human Factors Integration in defence systems (JSP 912): http://bit.ly/defenceJSP912

From early studies into authentication to investigations into human vulnerabilities exploited by spear phishing, human factors plays a central role in the cybersecurity of complex systems. **Chris Johnson** and **Rob Becker** share their thoughts and give us insights into the efforts being made against cyber-crime

Staying one step ahead

Headlining the news just recently: "Hackers are passing around a mega-leak of 2.2 billion records", it can be tricky to view cybersecurity as the source of hope it is, and not something to be feared. Estimated to be a $1.5 trillion industry, with some countries now basing their economy around it, cyber-criminals are using new technology that makes data breach attacks easier and more accessible. Human factors specialists look at how the user interacts with the digital world and use this understanding to reduce the impact and likelihood of digital security breaches.

Chris believes that over the last 50 years, human factors specialists have worked hard to become accepted within the engineering of safety-critical applications and their

IMAGE: GETTY

contributions have laid the framework for advances in cybersecurity. No-one now questions the central role that human factors plays in the cybersecurity of complex systems. The greatest single advance has been to shift the focus away from the narrow technical obsession with encryption and protocols to look at the role that human behaviour plays, both in creating vulnerabilities and in establishing a culture that strengthens the integrity and resilience of critical systems.

In a ranking of business risks facing enterprises across the globe, cybersecurity came out as a top threat in Allianz Global Corporate & Specialty's recently released 'Risk Barometer'. Countering this threat, as Chris says, "relies on many different stakeholders working together to increase the resilience of complex systems against a growing range of threats, many of which are specifically intended to exploit human vulnerabilities as part of the attack."

Rob believes our discipline's contribution is yet to come, and that we are only just beginning to comprehend where areas of information security and human factors intersect, and where our discipline can begin to focus its efforts. "That being said," says Rob, "I think there has been tremendous progress made in Cyber Vulnerability Investigations, and digital security experts are beginning to take notice of user behaviours and how these can predict the use and abuse of digital systems."

With regards to significant contributions to cybersecurity, Rob thinks that unifying human factors with other user-centred disciplines, such as user research, business analysis and user experience will also help drive human factors doctrine into the foundations of secure system design.

So who made the initial impact into cybersecurity from a human factors standpoint? The first major work that influenced Chris' thinking was conducted by Angela Sasse's group at UCL. She pioneered early studies into authentication, taking an empirical approach derived from previous work within human computer interaction. Investigating the causes and effects of usability issues with security mechanisms in 1996, she also studied specific mechanisms such as passwords, biometrics and access control. Her research group has developed human-centred frameworks that explain the role of security, privacy, identity and trust in human interactions with technology. Chris commends her for "absolutely rejecting the focus on techniques that were poorly matched to the cognitive and perceptual characteristics of the end-user population. The integration of features such as two-factor authentication using mobile devices in a way that does not significantly interrupt primary tasks, but which does noticably improve access control, is a legacy of her work."

Taking a nostalgic look back, what has human factors contributed to that stands out? Rob says hands down, it's the spam filter. Just this February, Gmail announced that it is now blocking 100 million extra spam messages every day with artificial intelligence using its machine learning platform, TensorFlow. An early human factors consideration in cyber may not have been beneficial though. The rise of phishing emails and messages worked by exploiting human personality and social characteristics, known as social engineering. Social engineering in cyber-crime has evolved from the classic 'Nigerian Prince' scam to sophisticated spear phishing attacks which use your personal information, such as intelligence gleaned from social media, to try and engender trust. Today, basic design features such as a spam filter are helping to defend people from particularly malicious attacks.

The cyber world can seem cryptic but it supports the systems that sustain our society and way of life

Chris agrees that human factors from both an offensive and defensive perspective cannot be under-estimated. "Targeted attacks on individuals is reaching new levels of sophistication and is informed by behavioural science. In order to counter these threats, we need to find better ways to educate the potential victims so that they are aware of and can be resilient to the threats."

But how important is human factors in cybersecurity's future development? Rob thinks that in a world that's now hugely underpinned by digital systems, neglecting human-centred design is costly from both a business and safety perspective. "Companies spend millions on making their digital systems airtight against outsider threats, but this becomes a wasted investment if we fail to account for human fallibility on the inside" he says. "A sensitive email with the wrong person copied in could result in a catastrophic data leak. This kind of non-malicious behavioural slip can wreak havoc when the conditions are right."

Connecting controlled hardware to a secure computer network can cause chaos for sensitive or safety-critical systems too. Rob references the 2003 Slammer Worm incident at the Davis-Besse power plant in the US, where an infected laptop downed nuclear monitoring systems for over five hours. "Human factors can help develop both physical design solutions or secure-by-design, and 'soft' solutions, such as training programmes or behavioural nudge theories," he says.

The cyber world can seem cryptic to many, but it also supports the systems that sustain our society and way of life. Rob says: "Being unafraid to dive into the world of cyber could unearth a veritable gold mine of human factors work; I believe we are only just scratching the surface."

Chris Johnson is Professor and Head of Computing Science at the University of Glasgow. His research focuses on the cybersecurity of safety-related systems. He has held fellowships from the US Air Force and NASA and he helps run the forensic and penetration testing labs for the UK Civil Nuclear Licence Holders. **Rob Becker** is a Human Factors Engineer at BAE Systems, where he works on cybersecurity as well as other aerospace human factors design and research projects.

The role of human factors in supporting safe and reliable power generation should not be underestimated, not only for the physical aspects of control room and interface design but also in furthering our understanding of the influence of organisational factors on human performance, as **Jon Berman** explains.

Keeping the lights on

We expect the lights to come on when we flick the switch. Indeed, life as we know it would cease to exist if we couldn't recharge our mobile phones! We take for granted the availability of electricity, but behind the scenes, human factors has played a central role in achieving this, setting aside its contribution to encouraging energy conservation and efficient use.

I was fortunate to join the industry just three months before an event that precipitated some of the most significant contributions that human factors has made to safe power generation. These came in the aftermath of the nuclear power plant accident at Chernobyl in 1986. Prior to the ill-fated experiment that took place in Reactor 4 late one April night, the nuclear industry seemed to have the mindset that if you took intelligent operators, trained them well, and gave them good procedures, what could go wrong? Chernobyl demonstrated that the answer is: "Quite a lot".

Human factors was at the forefront of developing our understanding of the importance of organisational factors and how the culture within the organisation can, and will, influence human performance. Human factors was instrumental in recognising the significance of the socio-technical system, and in the development of tools to help understand and manage the factors that will affect human performance and reliability. And that contribution goes beyond the energy sector; the thinking has spread to all the high-hazard industries and beyond.

But human factors had been active in supporting safe delivery of power for many years before Chernobyl. At Three Mile Island in 1979, the last of an inter-related series of events was a simple mechanical failure (a valve stuck open)

View over London skyline at dusk

that was not recognised by the control room operators, in part due to ambiguous displays. It allowed large amounts of nuclear reactor coolant to escape, which was the principal mechanical cause of the primary coolant system depressurisation and partial core disintegration that followed. This was an avoidable accident that not only led to huge financial loss, but also caused immeasurable anxiety and panic within the local population and damaged confidence in the industry.

Following this accident, the industry was forced to examine the adequacy of the design of control rooms and interfaces, with the result that significant improvements were made in understanding complex decision-making and the presentation of high-quality information.

And going further back to 1957, a fire at Windscale occurred, in part, because of inappropriate decisions. This was the UK's most serious nuclear power incident and occurred when a routine heating of the number one reactor's graphite control blocks got out of control, causing adjacent uranium cartridges to rupture. The released uranium began to oxidise, releasing radioactivity and causing a fire that burned for 16 hours before it was put out. The fire left about 10 tonnes of radioactive fuel melted in the reactor core. The fire also caused the release of sizable amounts of radioactivity into the atmosphere. Consequently, the government banned, for several weeks, the sale of milk produced in a 200 square mile area around the reactor site.

Whilst a lack of knowledge and understanding played a role at Windscale, subsequent recognition of the complexity of the process led to ever-greater efforts to understand human performance and behaviour. As always, it's what we learn from past accidents and mistakes that allows us to achieve continuously increasing levels of safety and reliability – and human factors is at the forefront of driving such improvements.

Despite more complex and reliable automation and engineered safeguards, people will remain integral to the performance of high-reliability systems, and power generation, with its potential for significant failures, is such a system. Human factors can generate reliability in complex systems, and power generation needs to be reliable, and safe.

The nuclear industry is developing advanced human-machine interfaces and improved methods for the assessment of human reliability, but I'm particularly excited by current developments around resilience and Safety-II: understanding what underpins sustained successful organisational performance rather than concentrating on failures, and recognising that we need to understand and enhance 'work as done' rather than focusing on 'work as imagined'.

Human factors is increasingly engaging with the world of leadership and management thinking. We're developing tools that help us better exploit the strengths of human performance whilst mitigating the limitations, and helping us to understand what drives behaviours and decisions. We're also getting better at understanding how we can be more sensitive to weak signals; those precursor indicators that the system is not behaving in the way we originally intended.

Human factors was instrumental in recognising the significance of the socio-technical system

We're getting better at designing socio-technical systems that can accommodate deviations, rather than producing systems with more layers of 'defence' that risk becoming ever-more brittle. With its ability both to consider human performance in the context of the broader socio-technical system, and to take account of all the factors that affect performance, human factors is ideally and perhaps uniquely placed to drive progress in these areas of work. Developing flexible and resilient systems is particularly important in the nuclear sector, not only to support operating stations but also to ensure that decommissioning of older plant is undertaken safely.

Human factors continues to drive improvements in our understanding of how to create and sustain high reliability and high performing organisations.

Jon Berman has recently stepped back from being a Director of Greenstreet Berman, the consultancy he helped set up over 20 years ago, although he remains part of the team. His career started in aviation before moving to power generation and then human factors consultancy. He's a Fellow and a Past President of CIEHF.

Making sense: how accidents really happen

Nobody sets out to have an accident and accidents are rarely caused by an individual. We take a look at the contribution of human factors in helping us to understand why people's actions made sense to them at the time and how a system can create the conditions for an accident to occur

Human factors as a discipline and profession has highlighted how aspects of people, the work and the environment are systematically connected to how people perform. It shines a light on interactions between people and all other elements of systems, as opposed to simply stating the 'cause' of an incident to be attributable to 'human error'. This is safety-critical expert Steve Shorrock's view, shared by accident investigators Paul Bryson and Mark Young.

We asked all three for their views on how human factors has contributed to the development and advances in incident investigation over the years.

What's the most significant contribution human factors has made to incident investigation?

Steve thinks that human factors highlights the human contribution to system performance, not just rare accidents. "This adds important perspective," he says, "putting a brake on interventions that could create more problems than they solve."

Paul agrees, adding that by investigating the human, it's given investigators an opportunity to explain why an accident occurred and what circumstances existed to allow the accident to occur rather than the more traditional method of finding what was broken and who was to blame.

Mark says that it's hard to look past James Reason's Swiss cheese model in answering this question: "Although contemporary thinking also centres around the work of Sidney Dekker and Erik Hollnagel, we must acknowledge that Reason gave us the platform on which to build industrial awareness of human factors. So much so in fact, that almost everywhere I go in industry, whether delivering training or investigating accidents, people have heard of the Swiss cheese model."

Mark believes that the model's success in widespread understanding is down to its simplicity, driving home the message that front-line 'human errors' are the result of a chain of organisational factors. He says: "For this alone, it's served to deflect attention from 'one person making one mistake' towards a more holistic view of accident causation. However, this same simplicity can also draw criticism, as it invites linear, cause-and-effect thinking which has less import in a world of complex systems. Nevertheless, I think it's fair to say that over the last 20 years or so since the model was popularised, the application of human factors to incident investigation has mushroomed. Whilst we still have work to do, I'm heartened that there are now many qualified HF specialists working in investigation bodies around the world."

Of this, Steve says: "Human factors specialists tend to think in a different way, have different competencies, and add different perspectives to investigators from other professional backgrounds. Human factors specialists help us to understand the nature of human performance and how it interacts with the design of tasks, equipment and working environments. They also emphasise how we can't just train and supervise human performance or add layers of controls hoping to nail down every aspect of human performance; we have to design for human performance while investing in the requisite competency and expertise, providing appropriate authority and room to adapt and adjust as needed, to maintain effective operations."

What first highlighted human factors as a way to identify the true causes of incidents?

Both Steve and Mark noted the same significant contribution during World War II. Crash landings were a problem for the Boeing B-17 'Flying Fortress'; even though the planes were functioning as designed and the pilots were highly trained, they made basic errors. Alphonse Chapanis, the Army Air Force Aero Medical Lab's first psychologist, noticed that the flaps and landing gear had identical switches that were co-located and were operated in sequence. In the high-workload period of landing, pilots frequently retracted the gear instead of the flaps, but this hardly ever occurred to pilots of other aircraft types. Chapanis fixed a small rubber wheel to the landing gear lever and a small wedge-shape to the flap lever. This kind of 'pilot error' almost completely disappeared.

Steve says: "A few years later in 1947, experimental psychologists Paul Fitts and Richard Jones analysed accounts of 460 errors made in operating aircraft controls, through interviews and written reports. They noted that a great many accidents resulted directly from the manner in which equipment was designed and where it was placed in the cockpit. What had been called 'pilot error' was actually a mismatch between characteristics of the designed world and characteristics of human beings, and between work-as-imagined and work-as-done."

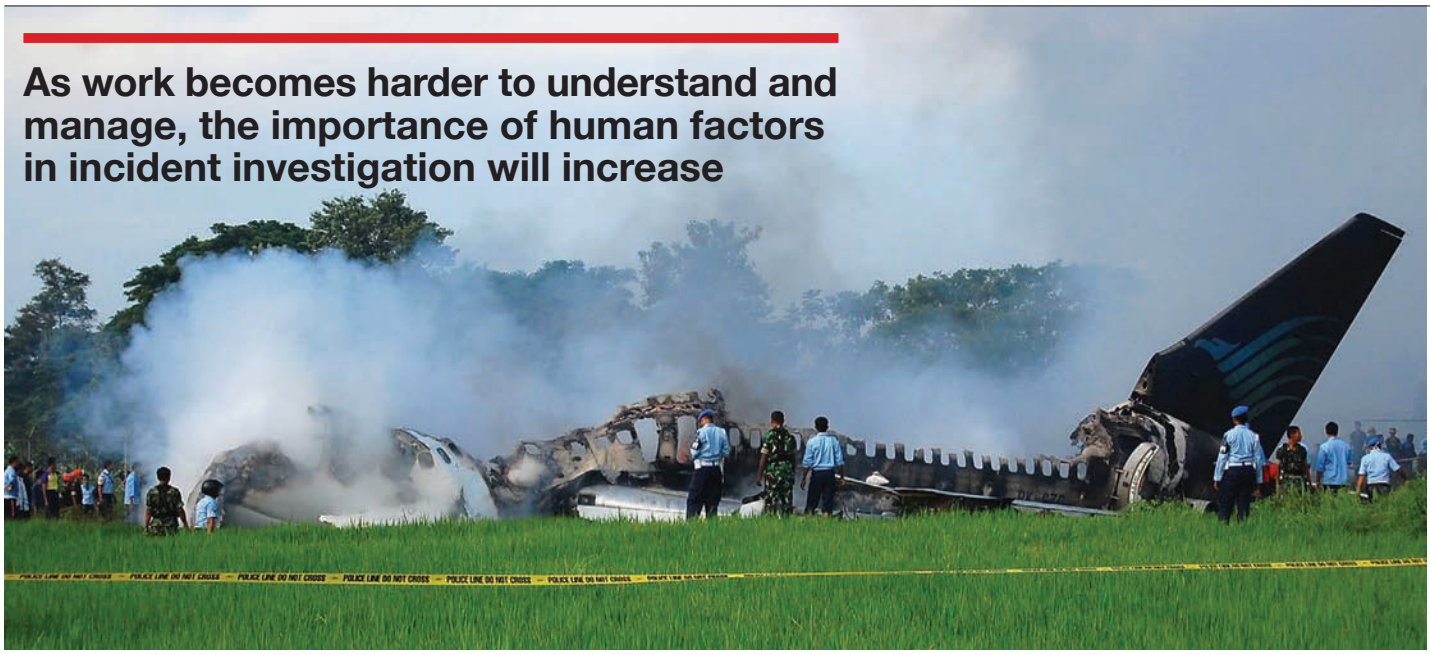
Looking specifically at the maritime sector, the contribution of human factors to accident investigation has been a bit of a slow burner, says Paul. "Fatigue has been a focus for several decades, but it's only recently that more attention has been paid to other key areas such as human-centred design. This has largely been in response to the increasing levels of automation with innovations such as automatic radar plotting aids, satellite navigation, automatic identification systems, and the shift from paper charts to digital displays, which have changed how ships are navigated."

Attention has been deflected from 'one person making one mistake' towards a more holistic view of accident causation

Mark references several disasters in the 1980s that, because of the detailed inquiries into them, have since been studied in great depth by human factors researchers. He says: "The explosion of the *Challenger* space shuttle in 1986 was the subject of a detailed treatise about the factors leading up to the decision to launch. In the same year, the Chernobyl nuclear disaster became the subject of a paper by James Reason. →

IMAGES: ISTOCK

As work becomes harder to understand and manage, the importance of human factors in incident investigation will increase



Finally, the investigation into the Kegworth air crash in 1989 was noteworthy for its contribution from human factors in understanding issues associated with the cockpit displays as well as cooperation between flight and cabin crews. These case studies certainly played a big part in my formative years in human factors, and still do today for many others."

Investigators look at the still smouldering wreckage of a Garuda airlines Boeing 737-400 which burst into flames as it landed at Yogyakarta international airport, Indonesia.

What role will human factors play in the future development of incident investigation?

"As complexity increases, as goal conflicts stack up, as people and technology become more tightly entwined, and as work becomes harder to understand and manage, the importance of human factors in incident investigation practice will increase" says Steve. "Accidents will require more competency in human factors, not only to understand how they happen, but to design interventions to improve system safety."

Talking specifically about commercial aviation, where accidents are thankfully extremely rare, Steve is keen to say that investigators could usefully turn their skills toward everyday work as a means of improving system safety without needing an accident as a reason to do so. "Human factors is almost uniquely positioned to help turn the focus on everyday work, since 'systems ergonomics', as described by John Wilson, has always had everyday work as its main focus" he says. "Safety-II is, in a sense, systems ergonomics and systems thinking applied to safety. The basic tenets are not new, but the domain of application (safety management) is not accustomed to thinking in this way. Human factors can help with an understanding of how things normally work, as a basis for understanding how things occasionally fail. This can help to ensure that recommendations for rare events do not make everyday work even harder, and perhaps more risky."

The Marine Accident Investigation Branch has recognised the importance of human factors in its investigations for many years. Paul says: "Determining local rationality and the influences of system interactions is fundamental to an accident investigator's understanding of why an accident occurred and what could be done to prevent recurrence. This is far more difficult to achieve than the more traditional approach of comparing 'work as imagined' with 'work as done' and identifying human errors. As the marine industry heads towards semi and fully autonomous ships, investigation of the role of the human (and the machine) in socio-technical systems will inevitably increase further."

Mark thinks that while we still have work to do, and nowadays the focus is very much on the role of people in complex systems, there still seems to be some perception in the outside world that 'human factors' is just about individual factors, such as the cognitive or perceptual limitations that caused a person to act in a given way. He says: "Whilst such evidence is, of course, still valuable, within the human factors discipline, attention has shifted towards interactions in larger systems comprising human and non-human (or technological) agents. These interactions are less tangible and less amenable to practicable recommendations but are no less important in understanding what happened. Methods such as AcciMap, developed by Rasmussen, offer a way for investigators to analyse multiple causal factors in a non-linear manner."

The trick for the future, says Mark, is in many ways, the same old story for human factors: ensure that it's integrated throughout incident investigations. "We risk treading on the toes of system safety engineers in this, since many of the complex systems issues we're now grappling with, also lie in their territory. But if we play to our strengths, that fundamentally human factors is about human behaviour in the context of these systems, we can and should continue to make vital contributions to the investigation of accidents and incidents."



Steve Shorrock is a Chartered Ergonomist and Human Factors Specialist, and a Chartered Psychologist, with a background in practice and research in safety-critical industries. **Paul Bryson** is an Inspector of Marine Accidents at the Marine Accident Investigation Branch (MAIB). **Mark Young** is an Inspector of Railway Accidents at the Rail Accident Investigation Branch (RAIB).

Focus on pharmaceuticals

Large scale changes are affecting the pharmaceutical industry driven, in part, by emerging technologies and healthcare concerns about effective medicine use and value. Research and work highlighted by **Dominic Furniss** and **David Embrey** demonstrate the contribution of human factors in this area

The application of human factors in the pharmaceutical industry goes beyond the design of devices and analysis of care, areas which have received research and regulator attention, to the wider system through which pharmaceuticals are delivered. This includes all aspects of the life-cycle from the laboratory bench, to trials, to manufacture, to pharmaceutical care and onwards to surveillance of real-world use and outcomes.

Many research projects see human factors practitioners working with pharmacists to explore diverse issues. Examples of these include:

- Exploration of how carers coped with administering artificial nutrition and medication via a tube in a patient's nose or through their stomach. Most patients were fine, but some complained of poor support, poor training, issues with device design and medications not licenced to be given in liquid form.
- Studying intravenous infusion administration in hospitals where there was a high rate of deviations from policy. Most of these did not lead to any harm, indeed some deviations even improved safety, which questions traditional notions of 'error'.
- Investigating how patients use handheld information about their medications to cope with a fragmented healthcare system.
- Investigating how different forms of automation and autonomous systems can help or hinder intravenous infusion administration in the Intensive Care Unit.

In industry, one example of how human factors practitioners can help improve human performance issues that all sizes and types of pharma companies face is through the use of tools for human error risk management. One such tool, called Systematic Human Error Reduction in Process Analysis or SHERPA, elicits the undocumented knowledge and experience of operating personnel to develop procedures that are compatible with the realities of day-to-day operations. This can greatly reduce noncompliance issues.

SHERPA also takes a proactive approach to managing potential failures, and the identification of the performance influencing factors that drive these failures. As an example, it was used in the development of a new pharma manufacturing facility to provide 'risk aware' operating procedures and competency management systems and has produced major benefits in terms of reduced errors and reductions in training times. Following further successful tests at other sites, SHERPA is now being considered for deployment across the whole organisation to enhance good manufacturing practice.

Attention to human factors blended with systems thinking can deliver real benefits to how medicines are made, prescribed and administered throughout the system from factory through to the hospital and the home. Those of us on the pharma side are learning more and more about human factors all the time. Those of us with a background in human factors are learning more about how the pharma industry works, and the many different facets that impact the quality and safety of medicines production and management that affects us all. Real impact will come in the collaborations that will take place between the two.

Attention to human factors blended with systems thinking can deliver real benefits

One way this is being facilitated is through the CIEHF's Sector Group on Pharmaceutical Ergonomics & Human Factors. Its membership includes individuals with an interest in Pharma human factors across academia, the NHS, the pharmaceutical industry and regulatory authorities. One of the group's key objectives this year is to hold an event in October, which will look at the risks of medication errors associated with labelling issues by taking a systems perspective. The objectives will be:

- To create greater understanding of how processes can be designed to manage safety issues arising from packaging similarities.
- To widen the range of engagement of stakeholders to provide meaningful collaboration and cooperation.
- To develop a consensus to a systematic approach to labelling and how best to involve all key stakeholders.

More information about this event can be found at events.ergonomics.org.uk. If you're interested in joining the Pharma Sector Group, please see more information on the main CIEHF website at www.ergonomics.org.uk > Get involved > Sector Groups & SIGs. ●

David Embrey is the founder of Human Reliability Associates and **Dominic Furniss** is a Senior Human Factors Consultant at the same company and also helps manage the CIEHF Pharma Sector Group, together with Brian Edwards, Colin Knight and Gary Guan. Colin and Gary contributed to this article with information about the work of the Group.

IMAGE: SHUTTERSTOCK

The changing face of research

From the early days of exploration into human capability to studies on interface design, a career spanning a time of incredible advances in technology has been particularly rewarding, as **Jan Noyes** explains

I'm from the West Country; I was born in North Devon and 'reared' as the locals would say, in Cornwall from the age of three. The reason I mention this is because Cornwall is a long way from most of the UK. So, one Friday afternoon in October under pressure from my secondary school, I completed a UCAS application at great speed and put down five universities. One of them was Loughborough; I didn't have a clue where it was but soon worked out you couldn't travel there from home and back in a day. So I stayed overnight in Royce Hall and was entertained by partying final-year students, one of whom had a sports car, and from then on, Loughborough it was! The decision was further helped by the large number of students who lived in halls, so arranging accommodation from 300 miles away was not an issue.

I loved my undergraduate years. Loughborough had amazing laboratory facilities; Jim Horne and his sleep lab, Peter Stone and his lighting lab, Ernest Hamley and his environmental chamber, Peter Jones and the anatomical lab with no outside windows, to name but a few. Other lecturers included Nick Norgan, Course Director; John Atha, my Hall Tutor; Sue Harker and Ken Eason who taught the psychology; Rob Hooper the physiology; Murray Sinclair, Bob Harding and Jack Sandover, the technical stuff. I was always intrigued by the name 'Department of Ergonomics and Cybernetics' which was engraved on a lot of the equipment.

A Science Research Council-funded PhD on keyboard ergonomics followed, supervised by Brian Shackel, and I was fortunate enough to enjoy the benefits of being part of the Human Sciences and Advanced Technology Research Group (HUSAT) with Leela Damodaran, Tom Stewart, Brian Pearce, David Davies and many others. At that time, HUSAT was flourishing and a post-doc position followed.

Then, 33 years ago, I walked through the doors of the Department of Psychology at the University of Bristol, located in Berkeley Square. Interestingly, this department had been very active in applied psychology human factors work post-World War II. For example, Charles Drew carried out some exquisite experiments on the effects

Some of the highlights of a career in research

IMAGES: ALAMY / SHUTTERSSTOCK

of alcohol on driving-type skills which led to the subsequent development of the breathalyser. In 1951, the department was formed from dividing the Department of Philosophy and Psychology into two, and comprised four lecturing staff, one of whom, Frank George, left to become Professor of Cybernetics at Brunel University. The remains of the 'Cambridge Cockpit', developed by Frederic Bartlett and Kenneth Craik to test pilot fatigue, allegedly still lies somewhere in Berkeley Square.

My first research post at Bristol was working on an Alvey-funded project on the human factors of speech recognition with Clive Frankish, Dylan Jones of Cardiff University and Alison Starr of Smiths Industries. The Alvey Programme was a 1980s British Government-sponsored research programme in information technology. Further projects followed concerned with the development of an advanced warning and diagnostic system for civil aircraft, pen-based recognition technologies funded by Hewlett-Packard, and the development of an energy management system. I was also doing quite a lot of teaching to final year engineering students and others, so a significant turning point for me was gaining a tenured lectureship in 1992. At that point, I had three small children and no ambition to climb the academic ladder.

One of the joys of an academic post is freedom; freedom to organise your day and to research what interests you. I loved the idea of starting with a blank piece of paper and building a research project. Pitting my brain against hard problems combined with the creative element, I found extraordinarily satisfying. And as my previous Vice-Chancellor once said: "You won't find a more incentivised group than academics". When you're in this zone, the hours and minutes slip by and I've often continued writing into the early hours of the morning, unaware of the time.

There were many highlights in my research career. One was being awarded the Institute's Otto Edholm Medal for contributions to applied research in ergonomics (after which my family loved to say, "Do you want a medal for that?" to which I could reply, "I already have one!"). Another highlight was the work with British Airways and the many familiarisation flights sitting on the flight deck, something that's probably not allowed today. One of these trips involved bringing a brand new, passengerless 747 Jumbo back from Boeing Airfield in Seattle, with a light aircraft and rusty Mustang car in the hold. Another highlight was being in an armoured fighting vehicle simulator on the Swedish plains whilst at the Defence Research Agency in Linköping.

Working with industry has always been a thrill and provided me with experiences which money can't buy. I'm lucky to have worked with NASA, the US Army, GCHQ, the Civil Aviation Authority, the railways, Nuclear Electric, Rolls-Royce, Westland Helicopters, to name a few.

Working with industry has provided me with experiences which money can't buy

One of my first industry visits was to *The Mirror* newspapers in Fleet Street whilst a PhD student. In the late 1970s, newspaper production was moving from so-called 'hot metal' to computers. So, the hot, dirty, noisy industrial environment was being traded for an office complete with fitted carpets and rubber plants, and the workers, and unions, were not happy. My job was to collect environmental data for the old and new workplaces. Whilst doing this, I shared a lift with Marjorie Proops, a well-known 'Agony Aunt' at that time. One of my final industry visits was last summer, whilst working on a qualitative study on interface designs with Nick Colford and the human factors team at Renishaw plc.

The challenges for me as an academic were to attain research funding and to publish, preferably in refereed journal papers, and to deliver teaching to a very high standard. And yes, I did decide to climb the academic ladder, and began by looking at my CV and working out where the gaps were. In my case, this was conference papers, so I focused on conferences and have enjoyed many visits to countries around the world. Around ten years later, I had moved from Lecturer to Senior Lecturer to Reader to Professor, and I now have Emeritus status for life.

More importantly, my work was not about me. It was about the many undergraduates, postgraduates, PhDs, post-docs and colleagues whom I was fortunate to meet along the way. Even now, I get the odd email about some anecdote or something I said many years ago and how it changed or helped that person. Usually I have little memory of this, but it's a wonderful feeling to know that someone has taken the time to tell you.

Retirement was a hard choice. Why would you stop doing something you loved? But the clock was ticking and 43 years of being busy had slipped by. As my late father once said, "I don't mind being 74, but I didn't half get here quick!"

Jan Noyes is Emeritus Professor of Human Factors Psychology at the University of Bristol.

Control of take-off and landing at airports no longer relies on high vantage points and a pair of binoculars. Digital technology and a deep understanding of human capability and performance has allowed the idea of remote towers to become a reality, as Jersey Air Traffic Control's **Peter Moore** explains

Seeing is believing

The first aeroplane to land on Jersey touched down on the beach on the Channel Island's south coast in August 1912. Following growing demand for air travel, Jersey Airport was officially opened in March 1937 and included a central tower. In the 1970s, new building work included the opening of a new air traffic control radar room and control tower as well as a meteorological station.

Human factors in this sector was developing rapidly during this time, and insights into the capabilities of controllers, their workload and their cognitive processing ability combined with advances in technology were bringing about huge changes in the way controllers worked. New air traffic control centres were built with human factors at the heart of their design and airport control towers were integrated into the systems. The current air traffic control building and tower in Jersey became fully functional in November 2010.

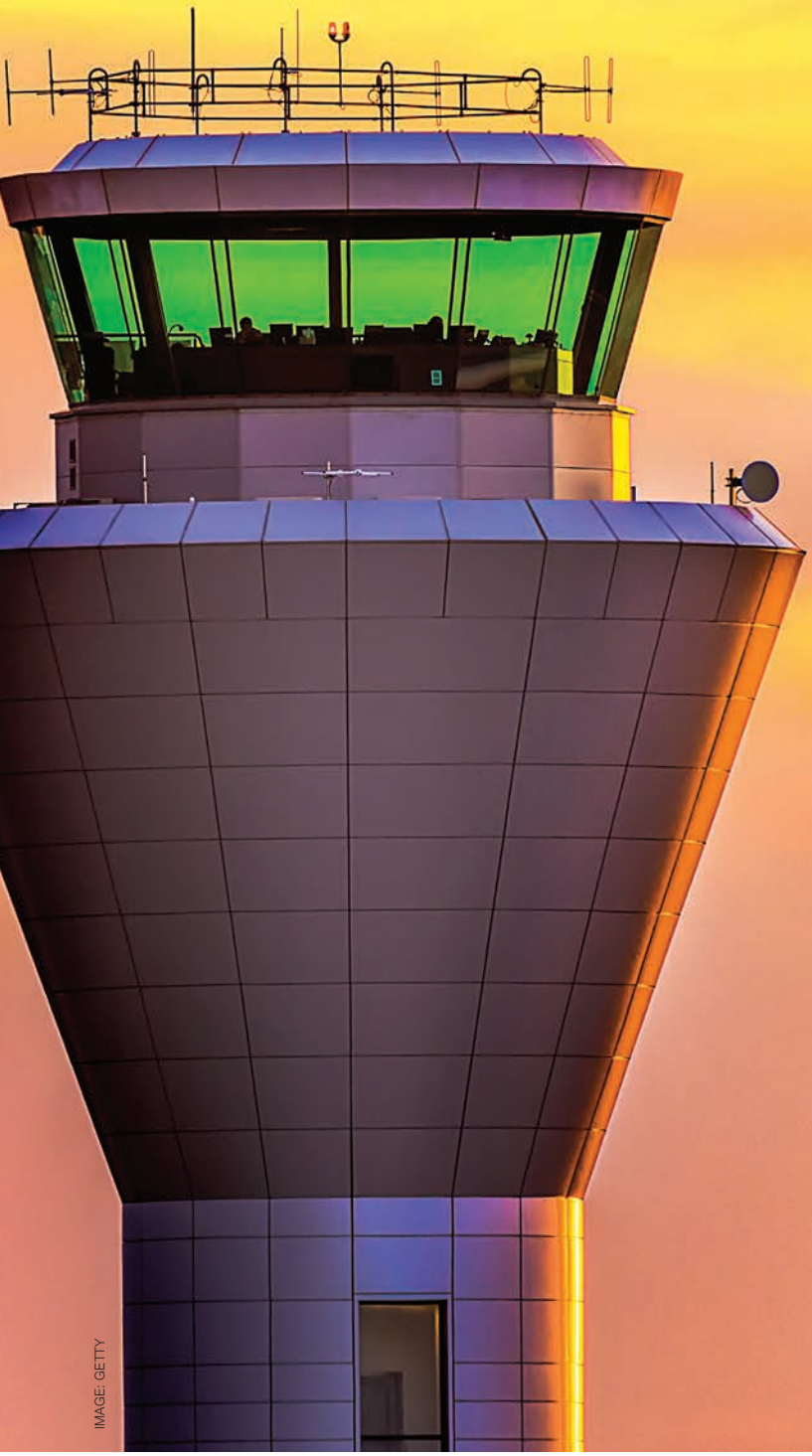
Controlling aeroplanes from an airport tower has for decades been a hands-on job, with controllers relying on excellent vision, powerful binoculars and high vantage points to assist them in their role of guiding planes to land and to take-off. But advanced technology and the development of remote towers means that controllers of the future can carry out the role from afar, using high-definition computer screens and cameras. Ports of Jersey (an integration of Jersey Airport and Jersey Harbours) has recently made a considerable investment in developing one of the UK's first remote towers, with the facility based just a few hundred metres from the airport's 39 metre tower.

In this case, the remote tower is designed to act as a contingency for Jersey Airport in the event of equipment failure or an evacuation of the existing site, hence its proximity to it. The technology and equipment used in the conventional tower was replicated in the remote tower so that controllers would be in familiar surroundings. As such, the only real difference for controllers was the view. From the outset, for the project to be a success it had to ensure that it was at least as safe as the existing tower, and that controllers were happy that their current view, which allows them to see landmarks such as lighthouses as far as 46km away, could be digitally recreated.

This was achieved via 11 fixed cameras giving a 240-degree panoramic picture and two pan-tilt-zoom cameras. They produce a faithful recreation of the view from the tower, a digital image stitched together across three screens in the remote tower allowing different camera views to be displayed on a single screen which continuously blend light levels, contrast and focus to give one seamless panoramic picture.

It's not a replicated view exactly, but a different, optimally enhanced view. For example, not only do they have digital zoom on the 'out the window' view, they also have two pan-tilt-zoom cameras that not only let you focus on areas of the aerodrome, but also track aircraft using a target label. That kind of technology, together with the ability to add infrared cameras giving night vision and the ability to see aircraft in bad visibility, means that controllers have an enhanced view that's better than the original.

Before choosing the screens that would be used for the remote tower, a study was carried out by Ports of Jersey to investigate human-computer interaction with the 'out the window' view. The services of human factors experts at Cranfield University were



Air Traffic Control Tower in Jersey

engaged to help with the study. A group of 15 air traffic controllers took part in the experiment, which involved wearing eye-tracking devices while responding to instructions to track various objects on screen. This captured objective eye movement metrics that measured controllers' response times while searching for targets.

The most surprising result of the study was the eventual recommended screen size. While everyone originally thought that ultimately bigger would be better, the test results showed that although subjective preference was for larger screens, smaller screens were better objectively. Two sets of screens were used to run tests to identify targets. The results of the eye tracking were conclusive; controllers found the targets quickest and their fixation was more focused on smaller, 43-inch screens.

The optimum distance for the screens from the controller's position were also considered to ensure that they had the best possible 'view' of the airfield. The screens were all put in the controller's field of vision, despite it being a 240-degree vista. The result was that the controllers didn't have to turn their heads as much and it made their response times quicker.

Changing perceptions about a remote tower was perhaps the biggest adjustment for Jersey's controllers. They originally thought they would be sitting in the middle of a 3D replica tower, because that's what old simulators were like, it's what they were used to and had trained on in the past. But the picture stitching works so successfully, an acceptable view of the runway and surrounding areas can be achieved on the screens in front of the controllers, without the need for them to turn their heads. The feedback from the controllers indicates that they are very happy with the set up and they find it intuitive and easy to use.

Smaller screens meant that controllers were quicker at finding targets

As part of the study, other tests were conducted. One test measured human performance and perceived workload in the remote tower versus the conventional tower, a system usability scale showed a 77% 'good' or 'excellent' rating, and a test compared heart rates during live traffic control and at rest. All studies gave very favourable results and were submitted as evidence for European Aviation Safety Agency (EASA) certification.

Jersey Air Traffic Control also carried out a simulated tower evacuation as part of its requirements laid out by EASA. The evacuation exercise involved a series of simulated laser attacks on the original tower and saw controllers transported by the Airport Fire Service to the remote tower, where they seamlessly picked up control of the existing traffic.

While there are many potential opportunities for the remote tower, such as offering training or even operational facilities to other airports, its primary function is to serve as a backup for Jersey Airport if the controllers are forced to evacuate their existing building because of an emergency or equipment failure. In that respect, it's been a huge success. Their rigorous 'live training' of controllers to operate in the remote facility has shown that it's a viable alternative and a valid contingency, something that we hope gives reassurance to Jersey's 100,000-strong population, that their main route in and out of the island could remain operational at all times.

Peter Moore is an Air Traffic Controller at Jersey Airport.

IMAGE: GETTY

Workplace Wellness Unpacked

Ergonomics for the 21st Century

KEY INSIGHTS

Wellbeing and work culture tools to help organisations thrive

Jim Taylour, Orangebox UK

Why surpassing traditional 'user experience' and delivering 'learning experience' is important for a successful multi-generational workplace.
Why making our workplaces socially, mentally and physically fit for purpose can support work culture more effectively than just attempting to make them 'cool'.

Wellness matters unpacked – your road map to greater project outcomes

James Pack, Sentinel RPI

Why our focus should be upon outcomes, leaving industry to develop innovative solutions.
How an integrated response and early engagement leads to wellness becoming a team sport.

Healthy buildings, happy people: an introduction to the WELL Building Standard

Victoria Lockhart, International WELL Building Institute

Why building design and operation is relevant to the public health agenda.
How our environment can be optimised to positively influence our health and wellbeing.

Chartered Institute of Ergonomics & Human Factors

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JOURNAL EXTRACTS

Continuing our look back, we highlight some of the research published in the first issues of our major ergonomics journals

Shifting times

1 With autonomous vehicles now being tested on our roads, the main concern seems to be what to do with our time whilst the car drives itself to our destination. But back in 1957, the operation and control of vehicles was a much more fundamental issue, as described in one research paper on vehicle design which outlines the poor fit between drivers and trucks.

By the late 1950s, the author noted: "A great deal of human sizing data has been obtained for pilots in connection with cockpit design, but little specific information is available on driver populations." So he set about conducting a sizeable study in the US which revealed that in one model of truck taller drivers couldn't operate the foot brake when the gear lever was in the left position, so in this case, it was impossible for tall drivers to put their foot on the brake pedal without first shifting gears.

He also noted: "In several models, only 5% of the drivers could comfortably reach and operate the hand brake. In others, only 60% could be accommodated for knee height between the pedals and the steering wheel."

The author also describes another worrying design feature: "Many errors have been observed in the location and design of electrical switches, especially for headlamps, fog lamps, and marker lights. In one model the dimmer switch was found to be located directly beneath the foot pedals…"

The author's work was published in 1957 in the very first issue of *Ergonomics*. It also included papers on noise, lighting, operator training, physical work and contributors to fatigue and stress, all of which continue to be topics of research today.

Ross A McFarland (1957), Human limitations and vehicle design, Ergonomics*, 1:1. DOI: 10.1080/00140135708964567*

IMAGES: ISTOCK

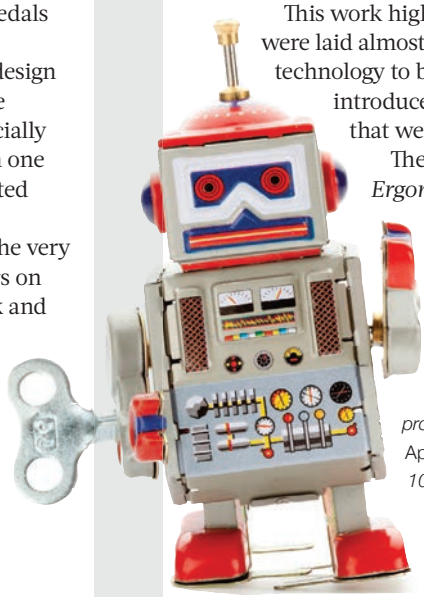
Social acceptance

2 Major change can be difficult and needs careful management, but one area is particularly emotive, that of robotics and automation. "Robots are taking over our jobs!" is a headline we've all had screamed at us but it's usually not the loss, it's the nature of work that changes to accommodate this technology. But none of this is new.

Published in the first volume of *Applied Ergonomics* in 1970, a research paper about minimising human problems when introducing automation noted: "an essential need is to involve all levels of the new system's users, from management to operators, at the earliest opportunity," with the fear of redundancy high on the list of issues to deal with.

The paper highlights the social aspects of automation, giving recognition and an insight into industrial interactions of the time: "Obtaining information from all levels in the organisation presents quite a problem in human relations. Senior people must be convinced of the necessity for discussions at lower levels without casting doubts on the management's own knowledge and ability. On the other hand, it is often difficult to extract information from people on the shop floor who are sometimes not very articulate, not always aware why they do things and usually a little suspicious of people prying into their world."

The author also understands the need for relevant information to be delivered at the right time if an automated system is to be successfully introduced, noting that: "…operators have to make decisions and operate controls without sufficient data being available at the working location. Frequently, the data that is collected and displayed is not in the form most suitable for controlling the process or detecting its mal-operation."



This work highlights the foundations that were laid almost 50 years ago, that enable technology to be successfully designed, introduced and accepted today in ways that were unthinkable at the time.

The first volume of *Applied Ergonomics* also includes research papers on multi-axis vibration, testing of consumer products and the influence of building design on behaviour.

F G Helps (1970), Minimising human problems when introducing automation, Applied Ergonomics*, Vol 1, issue 3. DOI: 10.1016/0003-6870(70)90001-3*

Q&A

MEMBER PROFILE

As Head of Human Factors and Aviation Psychology at a major European airline, **Siân Blanchard** shares insights into a career that has spanned defence, finance, rail and aviation

How did it all begin for you?

My first serious taste of human factors was during my undergraduate studies in human psychology in the late 1990s. The discipline really came to life for me during my industrial placement year providing human factors support to the Centre for Human Sciences team at the Ministry of Defence. Suddenly, I started to see how my studies could be applied to help support military personnel working in fast-paced, stressful and often high consequence environments. This was a turning point for me and it's when I knew that I wanted to pursue human factors as a career.

What have been your greatest experiences so far?

One of the most exciting things about a career in human factors is the opportunity to work with people who do amazing things, for example, fast-jet and airline pilots, finance traders, high-speed train drivers, accident investigators and aircraft system engineers. My career has given me exposure to defence, finance, rail and commercial aviation sectors where I've worked on some fascinating projects. When I worked in defence, I observed and interviewed fast-jet pilots on large-scale simulation and experimentation exercises in the UK and US in a joint distributed environment. I provided human factors technical advice on the competencies needed to operate future unmanned air systems technologies and conducted detailed analysis of human-machine interfaces, collecting and evaluating operator feedback through written assessments and interviews with aircrew. I even got to work on behavioural modelling for military gaming applications with the army.

I also had a great experience in rail, working with some interesting people including train drivers, signallers and track workers. I represented the UK rail industry in the development of technical interoperability standards in the European Union. I worked with a strong human factors team to develop industry guidance and best practice on human factors, incident and accident investigation, training and competency assessment, safety culture, selection and recruitment, and health risk assessments. During this time, I also trained as a coaching psychologist and created an in-house business coaching service supporting people with transitions into new roles, promotions and preparing for retirement. The experience gained in these ten years prepared me for the most challenging and exciting role in my career: being head of human factors at a major European airline.

Tell us more about your role in a commercial airline

As the Head of Human Factors and Aviation Psychology at easyJet, I wear many hats, from setting the strategic direction in health and human performance and devising initiatives to support the psychological wellbeing of pilots, to co-founding safety culture initiatives, to conducting incident and accident investigations. I lead a talented, multi-disciplinary team of people with expertise in human factors, aeromedicine, and occupational health and safety. Together, we innovate and lead initiatives to manage people risk and enhance health and operational performance across the airline. It's been a joy to work in a multi-disciplinary team with other professionals. The creative process is so much more dynamic and exciting, with people who think

IMAGE: ALAMY

Aircraft on arrival with ground service staff

differently and who have had different experiences. We've also been able to take on a much broader scope to produce policies and procedures on health and safety topics including a cabin fumes care pathway, communicable disease management, psychoactive testing, mental wellbeing and just culture.

What are some of the highlights of working for an airline?

There's a theme here: working with interesting people! Often, it's assumed I work only with pilots, and whilst they are an important community, there are so many more people I get to work with, including engineers, mechanics, cabin crew, ground handlers, de-icers, airport emergency managers, operation controllers, incident and accident investigators, and air traffic controllers.

Another highlight has been developing a pragmatic risk management approach to the new European Aviation Safety Agency rules on pilot mental fitness, following the tragic Germanwings flight 9525 accident. The approach we developed looks beyond a narrow compliance perspective and outlines how the initiatives of peer support, psychological assessment and psychoactive testing can be integrated into the wider health and safety management system to create opportunities for improved safety performance, health and people engagement.

I also really enjoy working with other aviation organisations from the airports, air traffic management and ground handling to work together to create an aviation industry award-winning safety culture programme. It's so exciting to hear

A big part of being a human factors practitioner is about having humanity

people's narratives about how they work, how they create safety and the challenges in the system that they overcome.

What lessons have you learnt as a practitioner?

I've learned invaluable lessons over the past 15 years from other experienced human factors professionals and psychologists and their insight into human work. Although, perhaps one of the lessons that has resonated with me the most, is from a pilot who is also an incident investigator, with whom I've conducted many investigations in the airline. We mentored each other, him teaching me about technical flight systems and flight operations procedures, and me teaching him about human factors and different investigation methods.

He once told me: "The day I stop feeling empathy is the day I stop investigating". That sentiment has stayed with me ever since and I'm reminded of it every time I approach a new investigation.

I think a big part of being a human factors practitioner is about having humanity.

Too often, we can recognise that investigation reports in the public domain in healthcare, transportation, etc, talk about the 'root cause' as though one factor can explain everything. Often, the culprit is identified as 'human error' which serves to blame and limit learning. Of course, it's important to understand human limitations but often this is just scratching the surface of something that's a lot more complex and fails to recognise that people create safety. Taking a systems-based approach allows greater insight into the strengths and vulnerabilities of the system and how we can influence this as human factors practitioners.

What's next for you?

I'm taking a leap into the unchartered territory of being a freelancer from April 2019! I'm keen to continue to work with organisations to enhance safety performance and wellbeing. I'm particularly interested in the practical application of the principles of positive psychology, that is, working with people to harness the strengths that enable them to thrive.

Siân Blanchard is an aviation psychologist and human factors consultant and has been with easyJet for five years. Siân will be practising as an independent consultant from April 2019 and is contactable on LinkedIn.

Making meaningful connections

Networking doesn't have to feel daunting for people who may be a bit shy or are just developing the skills, says **Karin Boers** as she talks to Louise Boulden and shares her experiences and tips for making the most of presenting at industry conferences

How does presenting help with networking?

Presenting at conferences allows you to network with relatively minimal effort because some of the hard work has already been done for you. Basically, you have a captive audience and your presentation gives you the opportunity to transform that captive audience into a captivated audience.

I presented a research paper at the 53rd Annual Conference of the Human Factors and Ergonomics Society of Australia (HFESA) in Perth last November. It was one of the most memorable conferences I've attended

and how I came to be there is a story of opportunity and part of my larger networking plans.

What took you to Australia?

My PhD research is about decision-making and communication related to occupational safety and health in the complex sociotechnical systems of large infrastructure construction projects. An article I had published in the May-Jun 2018 issue of *The Ergonomist* describes the first study I completed which was focused on a transformational approach to occupational safety and health on the Thames Tideway Tunnel construction project. I wanted to expand on my research and an amazing opportunity arose to work with distinguished Professor Helen Lingard at RMIT University in Melbourne, Australia. I proposed doing a comparative study between the UK and Australia's major infrastructure construction sectors to discover the differences and similarities, thereby facilitating learning for both parts of the world.

As a PhD student, I was encouraged by my supervisors to try to present papers at one national and, if possible, one international conference. This means preparing and presenting your work or research in front of an audience and usually also includes time for the audience to ask the speaker questions. Since I was going to be in Melbourne at the time of the HFESA conference it seemed the opportunity was too good to miss. It also gave me a chance to learn about sources of funding and I successfully applied for the John R Wilson Student Travel Bursary from the CIEHF to support my return travel from Melbourne to Perth.

Did the conference in Perth help your research?

Yes, it did. Human factors in construction is a growing field and by attending the conference in Perth I learned that the scope for applying ergonomics principles in this sector is much larger than I had previously considered. For instance, the systems thinking approach that I'm using in my research can also be used when defining a safe system of work and preventing injuries and ill health such as those caused by slips and trips, manual handling and workplace fatigue. The most fascinating perspectives I found that have opened new ways of thinking for me was by attending presentations from the manufacturing, rail and maritime industries. Understanding how researchers and practitioners in these sectors incorporate ergonomics in their work allows me to learn and apply these lessons in my own research.

Besides meeting a lot of interesting and like-minded researchers and practitioners, I also contacted several people that I ended up interviewing for my comparative research study after I had returned to Melbourne. So my data collection was significantly improved because of the contacts I'd made in Perth. Additionally, there are now several people that I'll stay in touch with to share ideas and knowledge.

What advice do you have for students just starting to share their work?

As a student, it's easy to think no-one will take you seriously at a conference, but this couldn't be further from the truth. In fact, papers presented by students are received with great anticipation because their research tends to address current industry and practitioner concerns as well as newly identified areas of interest.

If you're quite shy like me, how do you just go and talk to people you've never met? The participants at a conference will likely approach you and ask about your presentation so you may not need to take all the initiative. However, it's good to get into the habit of chatting to people you haven't met before and you can start by approaching other speakers and telling them about your interest in their research. Most people enjoy talking to others about their work and will be flattered and open to a discussion if you tell them how their work relates to yours or how interesting you found their findings.

Do you have any other networking tips?

Conferences are also a great way to keep in touch with the contacts you have made previously. Since you're working in the same field there will always be topics for conversation which makes it easy to get reacquainted with people you've met before and that will lead to conversations with new people.

There are usually quite good social activities as well at conferences so you can chat to other participants in a different kind of setting that can be a lot of fun. For instance, going on a tour of the Margaret River wine region started all sorts of interesting conversations!

Have business cards with you so you can give them to contacts you make. This makes it quick and easy to share your contact details with people who may want to discuss your work or shared topic interests in more detail. Or of course, these days you can make use of the many available business card scanning apps on your phone.

I found the experience of presenting at the HFESA conference invaluable and I'd encourage you to apply for the CIEHF travel bursary if you need it.

Start by approaching speakers and telling them about your interest in their research

Karin Boers is a PhD student in the Human Factors in Complex Systems Research Group at Loughborough University's Design School.

IMAGE: ISTOCK

MIDLANDS

Healthcare human factors explained

The CIEHF joined together with the University Hospitals Birmingham Human Factors Faculty to hold a Regional Group event on 4 March discussing the CIEHF's White Paper 'Human Factors for Health and Social Care'.

Over 90 people from a variety of healthcare organisations attended, including local clinical commissioning groups, and there was great representation from both clinical and non-clinical staff from NHS Trusts around the region. The event showcased the White Paper which was presented by Fran Ives, Ergonomics & Human Factors Adviser at University Hospitals Birmingham. This was followed by regional examples illustrating how human factors has been applied to healthcare, improving system performance and patient safety in maternity services, paediatrics, emergency departments and incident investigation.

Jane Higgs, Ergonomics & Human Factors Adviser from West Midlands Patient Safety Collaborative, illustrated how the recently launched Healthcare Safety Investigation Branch applies human factors to their safety investigations. Fran and Jane's combined expertise speaking at this event reflects the depth of human factors understanding now developing within healthcare in the Midlands region.

Representatives from local Trusts showcased their human factors work including Steven Tipper, Human Factors Programme Manager of UHCW NHS Trust, who discussed examples including the optimum environment for a neonatal unit. Dr Mary Salama, Consultant Paediatrician, and Karl Emms, Lead Nurse for Patient Safety from Birmingham Children's Hospital, talked about the revision of their Paediatric Early Warning System.

Debbie Jackson, Practice Development Nurse at University Hospitals Birmingham NHS Foundation Trust, discussed patient flow within the Emergency Department and the benefits of collaborative working between nursing and human factors specialties.

Finally, Dr Natalie Woodhead, Dr Hesham Abdalla and Caroline Mansell, leads for the 'Giving Birth in Walsall' project at Walsall Healthcare NHS Trust, shared their human factors work to improve team working, culture and safety for patients giving birth in the hospital.

The attendees had a range of human factors knowledge with some being very new to the discipline. The event provided an introduction and practical examples to enable them to understand its relevance to their own work areas and the benefits it can bring to both staff and patients. Seeing such enthusiasm and support for the event was fantastic and is an indication of the growing awareness and understanding of the discipline within healthcare.

Fran Ives, Jane Higgs and Pete Isherwood

CIEHF events at a glance

Eligible for CPD Lifelong Learning

For more details of all CIEHF events, see our website at **events.ergonomics.org.uk**

EVENT	WHEN & WHERE	DETAILS
Human Factors Conference 2019	Thu & Fri, 16-17 May 2019, Manchester	An inter-agency event between three high-risk industries: airport operations, fire service and healthcare. *Supported event*.
Safer Healthcare by Design	Wed, 12 June 2019, London	For healthcare procurement, designers, human factors practitioners and clinicians interested in design for patient safety. *Supported event, organised by CHFG*.
Workplace Wellness Unpacked	Thu, 13 June 2019, London	Illustrating why wellness is a team sport, its relevance to the public health agenda and how well-designed buildings can lead to happier people.
Medical Packaging and Labelling	Wed, 23 October 2019, Birmingham	Your chance to work collectively to understand and make recommendations for the future labelling and packaging of medicines and medical products.

Please note that some events details may be subject to change after publication. Please check the events website for up-to-date information.

IMAGE: ISTOCK

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The course agenda showcases topical case studies and offers best practices in improving the performance of safety-related systems and safety assessment and assurance, so that companies may stay both safe and compliant.

"The course provided an excellent overview of the required standards"

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EXTREME MACHINES

Creating a safe and efficient, self-supporting, undersea working and living space

9 October 2019 • Design Council, London

Join us at this one-day workshop where we will discuss the importance of designing for the widest range of human capabilities at a sensory, cognitive, and physical level. Historical and more contemporary examples will be used to explore a philosophy of inclusive design that can be integrated into the design process, not just for those with permanent disabilities (such as being profoundly deaf) but also when there are situational limitations on capabilities (such as choosing to watch a video without audio in an open-plan office).

Inclusive design is often confused with simply designing for people with disabilities but it is much more than this: quite simply, it's about designing for people – regardless of who they are. It's a philosophy that encourages us to consider how size, shape, age, gender, sexuality, ethnicity, education levels, income, spoken languages, culture & customs, and even diets shape the way we interact with the world and the products and services that inhabit it. More importantly, it's about designing products and services in light of this understanding.

Designing for People

How inclusive design can be used to create better products and services

The ethical case for inclusive design is easy to understand. Most of us want to live in a world where we all have an equal chance of engaging with society, participating in different activities, living independently. But it's a philosophy that also makes great business sense, and one that is embraced by some of the world's leading companies to develop a larger customer base, improve customer satisfaction, reduced returns and servicing, increased brand reputation, and improved staff morale.

At this event a wide range of tools and techniques for physical and digital design will be discussed to ensure that informed trade-offs can be made throughout the design process.

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(25% discount for CIEHF members)

Chartered Institute of Ergonomics & Human Factors

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CONTENTS

The magazine of The Chartered Institute of Ergonomics & Human Factors

NEWS AND CURRENT AFFAIRS

APPLIED ERGONOMICS AND HUMAN FACTORS

COVER IMAGE: ALAMY

RESEARCH MATTERS

CIEHF NEWS

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60 years of Ergonomics at Loughborough Design School

Twenty nineteen is not only a milestone for The Chartered Institute of Ergonomics and Human Factors (CIEHF) in celebrating its 70th anniversary, it is also a significant milestone for Loughborough Design School as we celebrate 60 years of Ergonomics at Loughborough University.

Ergonomics may be a relatively young discipline and profession, but Loughborough has played an important role in it's rise over the years. The first professorship of Ergonomics in the UK was founded at Loughborough University, with Professor Will Floyd in 1959, along with the establishment of what was then called the Department of Ergonomics and Cybernetics and formed the basis from which Loughborough Design School as it exists today evolved.

As part of our celebrations to mark the 60th Anniversary of Ergonomics at Loughborough we spoke to Roger Haslam, Professor of Ergonomics at Loughborough Design School and the current Editor-in-Chief of the international journal Ergonomics who asserts that today, Ergonomics and Human Factors activity is very much "Alive and Kicking at Loughborough University".

"In terms of education, our masters programme in Ergonomics and Human Factors is flourishing at the moment with really good class sizes and also really high calibre of students coming to study with us. In recent years we've had hospital consultants enrolling on the course along with people from various other healthcare professions, industrial designers, architects, engineers and psychologists and it is these students who are going to be part of the future lifeblood of the ergonomics profession in the UK in the years going forward".

The situation today is equally very positive with regards to research with Roger adding that "We have got real strengths in the area of environmental ergonomics with the Environmental Ergonomics Research Centre being a world leading laboratory and a major influence in its field. We also have real strengths in areas such as safety as well as patient safety and patient care which are major contemporary concerns now.

Roger was also keen to emphasise that critical to the ergonomics education and research activity at Loughborough, 60 years on, are the staff and the facilities that the Design School today is home to.

"The Design School has got the most cohesive, friendly, supportive group of colleagues that I've experienced. Amongst those staff we've got some real stars, both established academics and also up and coming people. I love coming in the building and just the buzz that you get as you walk through with the students working on their projects in the open spaces through to the staff area, which is just a really nice place to be".

Read the full interview at:
Lboro.ac.uk/lds

Loughborough University

FROM THE PRESIDENT

Who do they think we are?

Bob Bridger
CIEHF President

president@ergonomics.org.uk

I left this year's CIEHF annual conference with new ideas about the future of work, the future of human factors /ergonomics and how we can guide the Institute forward. Human factors and ergonomics is never applied on its own but it sits in a 'bigger box'; working with others in a multi-disciplinary team. Team working is good, but it seems to me that the box we're in and the work we're doing determine the way others see us.

Recently, we had a conversation with the British Occupational Hygiene Society about closer links. Partnering with bodies surrounding our space to develop an appetite for human factors and finding new ways of collaborating is to be welcomed. But what's interesting about this is what it says about the perceptions of others about CIEHF.

At the conference, Lauren Morgan gave a keynote address on healthcare, offering us the General Medical Council's definition of human factors: 'Human factors is a social science that focuses on maximising understanding of the behaviour of people, their interactions with one another and their environment, with the aim of optimising performance.'

In contrast, the future of work featured strongly in the conference, with the fourth industrial revolution: digitisation and automation of manufacturing and of the value chain; automated production and virtual reality as enablers in manufacturing, with the Internet of Things linking everything up. Future factory workers wearing exoskeletons working in augmented realities, and virtual operators will constitute the human element. Wearable technology will keep us all healthy and personal assistants will keep us company and keep us informed.

I left the conference wondering how many of our members see themselves as social scientists or as allied occupational hygiene professionals. Not many, I guess and even fewer in the future. Improving stakeholder perceptions of our discipline is something we'll need to include in our new strategic plan.

Human factors and ergonomics is never applied on its own but it sits in a 'bigger box'

FROM THE EDITOR

Complexity in its most extreme forms

This issue starts with a look at the safety-critical work of military helicopter maintenance engineers as explained by Kevin Hayes. Still in defence, our cover article by Anna Welch focuses on the many challenges in designing submarines, possibly one of the most complex systems in existence.

You could argue that the natural world is an extremely complex system of another sort (but which manages very well without us). Miles Richardson writes about his work with the National Trust to encourage people to connect more with nature in simple ways to improve wellbeing.

Ian Rowe explains the approach he's taken in light rail for organisations to learn from incidents rather than apportioning blame to an individual, while Paul Salmon shares ideas about new designs for rail level crossings to reduce the number of incidents.

Paul is one of the CIEHF's award winners this year, along with Lizzie Rawlinson and Tassilo Bouwman, who have also written about their work in this issue. All our winners are listed, along with our new Council and PAB members, our President Elect and our new President, Bob Bridger, who introduces himself with a Q&A. All were celebrated at our recent Ergonomics & Human Factors Conference, the main takeaways from which are included in a report by Lou Boulden.

Finally, Bob Smillie gives us a detailed perspective on ergonomics from the USA.

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A DAY IN THE LIFE OF AN...

ARMY AIRCRAFT ENGINEER

Kevin Hayes, Warrant Officer Class 2 in the British Army

For the last 18 years, I've been serving in the British Army as an aircraft engineer with the Royal Electrical and Mechanical Engineers. As a soldier, my area of expertise is with the different aircraft types that fall into the Land Warfare domain, mostly helicopters and Unmanned Aerial Vehicles.

Currently based out of Royal Air Force Odiham in Hampshire, I'm part of a mixed Army/RAF headquarters that oversees the deployment of multiple helicopter types to meet the priorities of UK defence both at home and overseas.

There are over 200 aircraft engineers that work under me in the organisation and up to half of these may be deployed abroad on exercise or operations at any one time. It's my job to ensure that these engineers can maintain the aircraft to a very high regulatory standard anywhere in the world, often in arduous environments, normally with limited resource, be it time, manpower, tools or spares, and under intense operational pressure. The potential for human error in these circumstances can be high and the consequences could not only result in a risk to life but could also have large reputational implications for national defence.

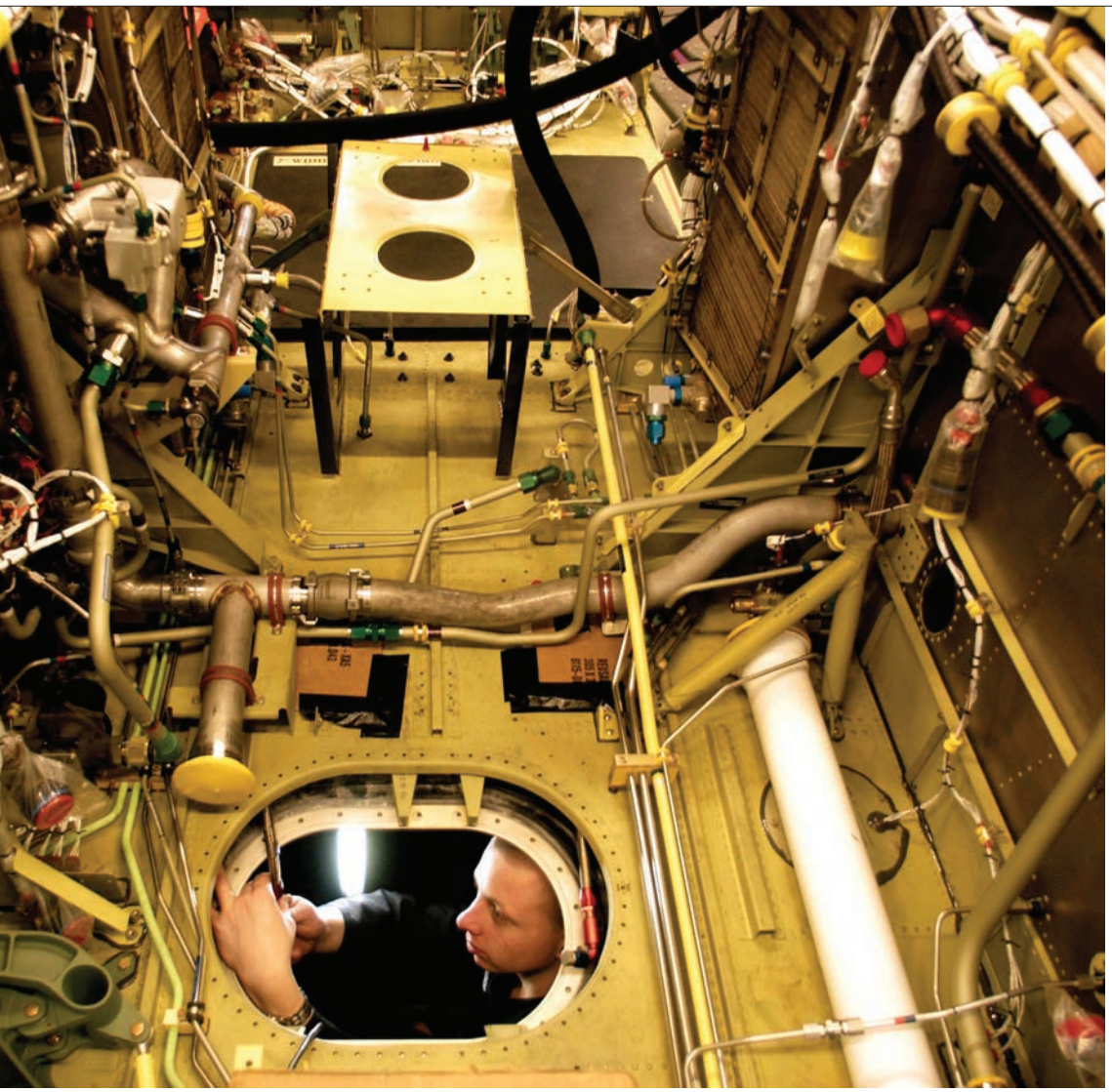
Thanks to significant buy-in by the civil aviation sector, the circumstances that negatively impact on human performance in an aircraft maintenance environment are among some of the most studied areas of human factors. Despite this, commercial companies working out of dedicated facilities in airports around the world must continually work hard to mitigate against the consequences of human error in their organisation.

Maintenance in military aviation takes these same issues and adds several extreme variables not found in civil aviation. By way of example, imagine that a company operating and maintaining a small fleet of helicopters was told that they had to disassemble their aircraft and pack them into the back of a C-17 cargo plane and fly them half way around the world. Since the helicopters need rebuilding at the other end, all the requisite tooling, spares and manpower will need to go on the same flight. If anything is forgotten it will take several weeks to arrive.

Now imagine that the arrival destination is nothing more than an open stretch of desert, with only a couple of tents for shade, or maybe it's on a frozen lake inside the Arctic circle in the middle of winter. Add to this the impact of telling the already fatigued maintenance team that they have only 48 hours to rebuild the aircraft ready for flight otherwise there is a very real possibility that lives will be lost. This isn't just a once in a lifetime hypothetical scenario, helicopters have frequently been deployed globally in this manner to great effect, such as during the 2017 humanitarian relief mission to the Caribbean in the wake of Hurricane Irma (Operation Ruman) or when a rescue mission was launched to Sierra Leone in 2000 to rescue six hostages during the civil war (Operation Barras). Since such events are by their very nature unplanned, there is also a requirement to carry out several practice exercises a year in various locations around the globe to prepare for different environments and contingencies.

It's my job to ensure engineers can maintain aircraft in arduous environments with limited resources

Operating a complex socio-technical system within a high tempo climate and with so many variables, means that there is a significant risk of an aircraft engineer making a potentially



A fitter working on a military helicopter

IMAGE: ALAMY

disastrous error. As an engineering officer, it's my job to be an expert on all elements of the maintenance process, to identify any weaknesses in the system and implement steps to mitigate against an error occurring. The term that we use for this is 'Technical Leadership', that is, being both a technical expert and being a military leader of people. The responsibility to those that you command within the military has no parallel in civilian industry, it goes far beyond a duty of care at work and permeates into a moral responsibility to them and their families both in their professional and personal life, often for years at a time.

Such responsibility is a necessary component to build trust with those you command; they need to know that ultimately you have their welfare at heart and would not actively seek to cause them harm. Without this trust there could be no morale or unit cohesion; key factors in mission success. As with any complex system, it's often a sophisticated balancing act trying to optimise the organisational output (mission success) against the needs of the individual. Unfortunately, this isn't always possible and sometimes risks to individuals need to be accepted in order to achieve the overall objective. Such decisions are not taken lightly and there is a robust Duty Holder system in place to ensure that the risk is held at an appropriate level in the organisation and that there is an accountable audit trail of decisions made.

Feedback from the organisational system comes from a wide variety of sources. For technical areas this tends to be in the form of quantitative data gathered from Quality Audits and the measuring of various engineering metrics. More qualitative information comes from formal and informal attitudes surveys and through the submission of near-miss reports and occurrence reports. Then using a continuous improvement methodology, issues are triaged and dealt with as expediently as possible with an attempt being made to reduce any residual or long-term risks to as low as reasonably practicable.

My route into ergonomics, as with many people, came about as part of a wider personal and professional journey. A formative experience of mine occurred in 2004 when, as a junior soldier, a Lynx Helicopter that I had serviced, crashed in the Czech Republic killing all six people on board. This wouldn't be the last time that I would lose colleagues to a fatal aircraft crash, but it was the first time that I became exposed to the systems properties of an accident and the tragic nature of how such events are invariably the result of a series of missed opportunities that could have altered the outcome.

As I've progressed through the ranks and assumed greater responsibility of command, this understanding has shifted away from a purely technical stance, to one that firmly places people within the system. I believe that such an ergonomic approach has great utility to engineers in Army Aviation and I actively promote its use across my organisation. Despite all the technical jargon and formal language that we use when discussing ergonomics or engineering, what's key for me is that, ultimately, we're discussing real people in real situations who are depending on us as professionals to keep them safe.

Kevin Hayes is a Warrant Officer Class 2 (Artificer Quarter Master Sergeant) in the British Army and has served operationally both in Iraq and Afghanistan. He is currently a student member of the CIEHF and is studying for an MSc in Ergonomics and Organisational Behaviour with the University of Derby.

Ergonomics has a long history in the USA and attracts many people into a great career across all sectors. **Bob Smillie** shares insights into the demonstrable successes, together with the progressive role professional bodies have played in the discipline's growth.

Ergonomics perspective from the USA

The USA has seen the formation of a number of professional organisations that offer support for the discipline and its practitioners, of which there are many. Application of ergonomics and human factors in the United States has led to many successful products and outcomes, including the following:

- Federal Aviation Administration human factors personnel participated in the design and evaluation of a standardised training programme for pilots flying Mitsubishi MU-2 turboprop aeroplanes that subsequently reduced the accident rate by 80%.
- Monterey County in California launched a new ergonomics programme designed to prevent or mitigate the negative impacts of work-related musculoskeletal risks and repetitive motion injury that's saved an average of $16.56 in workers' compensation and lost work time costs for every $1 invested over a three-year period. This led to more than $8.3 million dollars of savings in projected claims costs.
- Based on human factors expertise and research, the National Highway Traffic Safety Administration found that the centre high-mounted brake light now required on all cars and light trucks reduces rear-end crash injury and deaths by an average of 7% per year.

The Mitsubishi MU-2 turboprop flying above the Bixby Bridge in Monterey, California.

- Utilising further human factors expertise and research, the Federal Highway Administration found that implementing high-intensity activated crosswalks (like the UK's pelican crossings) reduced total crashes by 29% and pedestrian-vehicle crashes by 69%. Because the pedestrian hybrid beacons remain dark until activated, they can help increase driver attention to pedestrians crossing the roadway and can reduce rear-end collisions.
- Honeywell developed and implemented a company-wide ergonomics programme that led to $2 million in cost savings including zero repetitive strain, musculoskeletal injuries and a 24% improvement in worker productivity.
- At the George Wahlen Veterans Administration Medical Center, human factors engineers reduced central-line blood stream infections (CLABSIs), which have a 20% mortality rate, by creating a kit based on human factors design principles. This resulted in a reduction in incidents from 0.9 per month to zero. From an economic perspective, of all the healthcare-associated infections, CLABSIs are the costliest accounting for approximately $46,000 per case.

The world's largest scientific association

Set up in 1957, the Human Factors and Ergonomics Society (HFES) is the world's largest scientific association for human factors and ergonomics professionals. HFES serves the needs of members and the public by promoting and advancing the discovery and exchange of knowledge concerning the characteristics of human beings that are applicable to the design of systems, products, tools and environments of all kinds. The Society's 4500 members work in educational institutions, companies, government and military research centres, and independent consultancies in 58 countries. About 15% of members are students. HFES publishes the journal *Human Factors* and the *Journal of Cognitive Engineering and Decision Making*. It also publishes *Ergonomics in Design*, a magazine describing applications of human factors research.

A recent HFES highlight is a new anthropometric spreadsheet, known as the Virtual Fit Tool, developed to greatly simplify analysis for designers or others interested in knowing what percent of the North American users will be accommodated by a given set of measurements. The HFES Government Relations Committee published a policy statement on airline seating, and astronaut Nancy Currie-Gregg delivered a highly attended webinar entitled "Reflections on the Risk of Human Space Exploration – Lessons Learned from Past Failures". And right now, the HFES is in the process of revising BSR/HFES 100 Standard, Human Factors Engineering of Computer Workstations, a standard to provide specific guidance for the design and installation of computer workstations including displays, input devices and furniture that will accommodate a wide variety of users.

Certification of practitioners

Since being incorporated as an independent not-for-profit organisation in 1990, the Board of Certification in Professional Ergonomics (BCPE) has certified more than 1450 practitioners of ergonomics and user experience who demonstrate expertise and comprehensive understanding of the discipline. The BCPE has one application process that has specific education, work experience and work products requirements, and all applicants take an examination covering the core competency categories of analysis, design, validation and implementation.

Currently, BCPE is establishing a set of ambassadors for students and faculty near relevant ergonomics academic programmes throughout the country and internationally. This increased connectivity will serve as a mentoring and contact platform for potential future applicants. Ambassadors will share with potential applicants the reasons why they became certified and how the certification has benefited them professionally.

Leadership and growth

Set up in 2004, The not-for-profit Foundation for Professional Ergonomics (FPE) is dedicated to advancing professionalism in ergonomics through educational activities and awards. Its mission is to provide leadership in evolving and growing the ergonomics profession, bridge gaps between research, education and practice, and promote professionalism in ergonomics practice, all for the benefit of the public. Each year, FPE awards the Dieter W Jahns Student Practitioner Award and the Ergonomics Practitioner of the Year Award. The 2017 Practitioner of the Year award winners were the CIEHF's own Tom Stewart and Peter Buckle.

Supporting innovation and best practice

Supporting the sharing of innovation and best practice, the first Applied Ergonomics Conference (AEC) took place in 1998, providing a conference for practitioners of occupational ergonomics to learn from other practitioners. The US Occupational Safety and Health Administration (OSHA) was developing an ergonomics standard and companies were trying to understand how to integrate ergonomics into their organisational →

IMAGE: SHUTTERSTOCK

'Don't walk' pedestrian traffic light in New York City

structure and culture. In 1999, OSHA provided support to the conference to establish the Ergo Cup® competition to recognise employee participation in the development of ergonomics solutions.

In 2019, there were 49 teams representing organisations from around the world in the competition. Five Ergo Cups® were awarded in 2019 covering a wide range of innovations. Over the years, the competition has evolved but at its core the guiding philosophy remains the same: to recognise outstanding results from innovative ergonomics solutions and education in the workplace.

Support for individuals

The Applied Ergonomics Society (AES) is a worldwide resource for the ergonomics profession dedicated solely to the support of the profession and individuals involved with improving workplace performance, quality, sustainability and employee availability. It grew out of the annual AEC with a mission to provide knowledge, training and networking opportunities to enhance the skills and effectiveness of the ergonomics professional.

AES is a society within the Institute of Industrial and Systems Engineering, an international, non-profit association that provides leadership for the application, education, training, research and development of industrial engineers, ergonomics professionals, healthcare providers and related professionals. The main objectives and areas of research centre around understanding and finding interventions for work-related musculoskeletal disorders.

For more than two decades, professionals have relied on the National Ergonomics Conference and Exposition (ErgoExpo) to learn how to build an effective ergonomics programme or maximise an existing one, on any budget in any industry. The conference is aimed at practitioners with a focus on practice rather than research. ErgoExpo is the largest US conference for ergonomics practitioners, typically with up to 1000 attendees.

Psychology input

Another group to note that's been around for a few decades is Division 21 of the American Psychological Association: Applied Experimental and Engineering Psychology. It promotes the development and application of psychological principles, knowledge and research to improve technology, consumer products, energy systems, communication and information, transportation, decision making, work settings and living environments. As publishers of the *Journal of Experimental Psychology*: Applied, Division 21 members are research scientists and practitioners who study human interaction or involvement across a vast variety of sectors.

The Division promotes the discipline's role in the system design process to ensure that human psychological, physiological and performance characteristics are addressed. Questions of interest include: Will a design exceed the operator's capacity to respond or to process information? Is there a better way to design a system that capitalises on human strengths and compensates for human shortcomings? What are the optimal training methods and procedures for systems and people? Where did the system break down and how can it be fixed? What kinds of human errors were exhibited and how can these be eliminated in the future?

A company-wide ergonomics programme led to $2 million in cost savings, including zero repetitive strain and musculoskeletal injuries

Support from government

The Department of Defense Human Factors Engineering Technical Advisory Group (DOD HFE TAG) meets annually to focus on ergonomics and human factors, enhancing the coordination among Government agencies involved in human factors technology research, development and application. Composed of technical representatives from the Department of Defense, NASA, the Federal Aviation Administration and the Department of Homeland Security, the Group drives research and development responsibility in human factors and related disciplines. Official representatives of technical societies or industry associations with a stated interest in human factors also form part of the Group. Because of the diversity of the subject matter covered by our discipline, the scope of the technical areas addressed by the HFE TAG is broad but it deals with the concepts, data, methodologies and procedures which are relevant to the development, operation and maintenance of hardware and software systems.

As in the UK, the passion, dedication and drive of our professional bodies to open the USA's and wider world's eyes to the life-changing impact of our discipline is vital. And to ensure these bodies constantly evolve to meet the needs of today's practitioners, it's crucial that we support them.

Robert J Smillie is a retired senior expert consultant to the US Navy's Space and Naval Warfare Systems Command (SPAWAR) Office of the Chief Engineer. Shortly after receiving his PhD in human factors/ psychology from North Carolina State University in 1977, Bob went to work for the US Navy in San Diego and worked there for over 30 years. He's a Certified Professional Ergonomist, Fellow of the CIEHF, and a member of the Human Factors & Ergonomics Society.

IMAGE: SHUTTERSTOCK

CHIEF EXECUTIVE'S PERSPECTIVE

Technology at its best

In mid-May, your Institute hosted and co-chaired an international webinar featuring seven speakers and six presentations about the rapidly evolving world of medical device design. It centred on how human factors professionals can work together with and alongside engineers and designers to create powerful, usable technology that can save and improve lives. This is a very tangible expression of the power of human factors and the immediacy of the impact the discipline can make. Radio-guided surgery, as an example, is a growing field that can allow surgeons, acting locally to the patient, to identify and remove cancerous cells. Human factors expertise can inform the design and assess and improve the usability of such devices. One presentation specifically described the process and challenges during the development of a laparoscopic gamma probe for radio-guided surgery in prostate cancer.

Here, writ large throughout the six-hour session were at least six compelling reasons why a career in human factors can be so fulfilling. Our audience came from citizens of the USA and from the UK, drawn together in one place, but in many different time zones, solely by technology. One presenter was in Seattle, another, due to a packed schedule, was in Accra in Ghana and yet another was in California, the rest in the UK. Over 200 people registered for the event, organised jointly by CIEHF and by our colleagues in the Human Factors & Ergonomics Society of the United States (HFES). Just shy of 120 turned up to listen to all or part of the event, with many raising questions to the speakers in back-to-back sessions. The event was co-chaired by myself and Anthony Andre, a past President of HFES. No-one had to travel. No-one had to leave work early or stay late. No-one had to stay for the whole thing, although many certainly did. Here was technology at its best, the internet bringing together experts and non-experts with a common interest to learn together about understanding, fashioning, designing and implementing things that can improve life. And, even better, if you missed it then a recording of each of the six sessions is available through links on our website.

Several aspects struck me about what we did. It took time to plan, to test and to organise. It otherwise cost very little to stage. It drew two cultures together, members in two major national bodies of human factors specialists separated only by a large ocean, to think about how human factors can make life better, not solely on its own, but in tandem with other approaches and experts. Painstaking research, development and then application brought to a conclusion. A very good story.

My belief is that we need to further invest in pragmatic co-operation with other bodies of human factors specialists

The implications for CIEHF are many. We could readily (and to good effect) co-operate with other powerful member bodies like HFES to put on events that help members share, learn and compile CPD. We attract public interest by doing so, and we can use such events to publicise what we do and the value of what CIEHF does. We could gain income by doing so in future. This event was complimentary to members of both bodies, yet several non-members also joined by buying a ticket. This kind of approach helps illustrate the value of membership and builds an intrinsic and clear incentive for people to join us. It can also connect members together in future project work leading to commercial opportunities and career possibilities.

Events like this have very low fixed costs. If we laid on a free face-to-face event for which 200 people registered and at which 120 showed up, then we face a considerable risk. Our regional events illustrate this well, and demand is hard to judge ahead of the event unless a booking fee is levied.

My belief is that we need to further invest in pragmatic co-operation with other bodies of human factors specialists, just like us. The international bodies that do aim to bring our discipline together are well-meaning but impoverished in the resources available to do this. I sense there is an opportunity for CIEHF to take a lead, and in doing so cement our position as a modern, contemporary body that, by Royal Charter, is obligated to make life better by using our unique discipline.

Steve Barraclough
Chief Executive of the CIEHF
s.barraclough@ergonomics.org.uk

IMAGES: ISTOCK

Ex-Ministry of Defence specialist, author, and now the Institute's new President, **Bob Bridger** gives Lou Boulden insights into his past career and plans for his year ahead

From mining to maritime

Where did it all start for you?

I'd been working as a psychologist in the late 1970s and soon realised that it wasn't for me. Ergonomics seemed like great career option to utilise my studies. In 1981 I gained an MSc in ergonomics from University College London. It was at UCL that I first became enthusiastic about writing. The unit had, what was called in those days, a 'micro-computer' with a word processor installed on which I wrote my dissertation. As a left-hander, it was a relief to be freed from the discomfort and awkwardness of handwriting. I could focus on what I wanted to say rather than how to write it down so that others would be able to read it.

What was your first ergonomics job?

After graduating, I worked for two years for the Chamber of Mines Research Organisation in Johannesburg, South Africa. I worked on the mechanisation of deep-level gold mining and carried out a variety of studies. My biggest project was a study to compare the noise and performance of pneumatic and hydraulic rockdrills both in free field, surface tests and underground. Then I moved to the University of Cape Town (UCT) Medical School to take over from Mike Cooke (ex-Loughborough University lecturer) who had launched an MSc in ergonomics in the Department of Biomedical Engineering. I spent 15 years at UCT, taught most areas of the subject, was awarded my PhD, supervised some PhD students and co-founded the Ergonomics Society of South Africa, which is still going strong today.

I also collaborated with the physiotherapy department at UCT and we published a fair body of work on sitting and standing at work, which was a hot topic at the time and is making a comeback today (although, as is described in my forthcoming book, sitting is not the new smoking!). I also published the first edition of my textbook, *Introduction to Ergonomics*, which was even translated into Chinese.

One of the biggest misconceptions about human factors is that it's like a branch of psychology

How did you move into defence?

During my last year in South Africa, I moved house. My children had just started school and we wanted to live closer for convenience. Soon afterwards, the South African economy nose-dived due to contagion from the 1997-98 East Asian financial crisis. The local currency lost 30% of its value almost overnight and the interest rate on my new mortgage skyrocketed to 25%! I'd been considering relocating the family to the UK for some time but these changes provided an added incentive. After applying for a few jobs in academia that weren't right, I saw a job at Institute of Naval Medicine (INM) in Alverstoke advertised in *The Ergonomist* and applied. The Royal Navy threw me a life belt and four months later we were back in the UK.

What did you do at the INM?

I took over the role of Head of Human Factors at the INM with a staff of six. We conducted a wide range of projects lasting from a day or two to five years. The longest research project was a cohort study of occupational stress which was developed from cross-sectional work completed for a professional doctorate by our occupational psychologist Georgina Slaven. We also conducted studies on a wide range of other topics such as fatigue, the effects of ship motion on postural stability and work ability in ageing seafarers.

Apart from research, we established a service to support accident investigations and provided training in human factors in safety to Naval officers. I had the privilege of leading the human factors team that supported a service inquiry into an incident involving one of our nuclear submarines. I also served on a Fleet Commander's Investigation panel as well as supporting other investigations and delivering training.

IMAGE: ALAMY

River Class Royal Navy Offshore Patrol Vessel HMS Tyne takes pride of place on the River Dart for Dartmouth Regatta

Any particular highlights?

A highlight of my career at the MOD was serving for 13 years as a member of the Royal Navy Scientific Advisory Committee under Dr Shaun Kilminster. Our task was to conduct scientific and ethical review of research protocols submitted to the Ministry of Defence Ethics Committee. Review is an adversarial process and can be scary at times, as I learned from writing and submitting protocols myself. However, after reviewing over 500 protocols from MOD personnel and outside contractors in areas ranging from occupational biomechanics and work physiology, through epidemiology, cognitive psychology and counselling, I think I've got the hang of it!

What are you doing now?

I'm still active in safety and safety investigations and am currently working as an independent consultant to the health service. I'm also finalising the manuscript of my new guidebook on active work in the modern office. I've produced three more editions of my textbook in my spare time. The fourth edition, *Introduction to Human Factors and Ergonomics* was published in 2017. I changed the title to include 'human factors' because I see that as the direction of travel for the name of our discipline, at least that's how our services are increasingly described by our customers and, in the English speaking world, that's how many of the new departments and jobs are described.

What have you learnt from your career?

Many things. At INM I learnt how to be a manager in a general sense, how to run a department and how to manage full-time staff. I undertook training as an expert witness and acted for the Treasury Solicitors on several occasions.

One big thing I took away from this was an understanding of research governance including ethics and quality assurance and that there are fundamental requirements for good science that cross all our cognate disciplines. There is a set of tough questions that a scientific reviewer can ask a researcher irrespective of whether the research is on biomechanics, work physiology, cognitive psychology and so on.

I've also found that one of the biggest misconceptions about human factors is that it's about people, almost like a branch of psychology. This misconception is common amongst accident investigators and there's often some work to do at the beginning of an investigation to stop them thinking about why operators make errors and to start thinking about how the rest of the system prompted the error and failed to block its effects.

What are your priorities for your Presidential term?

First and foremost, I'm keen to work with the Chief Executive to deliver CIEHF's new strategic plan. My priority is to deliver value to members and to attract fresh talent. I firmly believe that CIEHF punches above its weight and is the only game in town for anyone interested in any area of human factors. For many professionals out there, CIEHF is an 'unknown unknown'. How can we change that? Well, we've got some ideas and we've got some other professional groups in our sights and we will be reaching out to them in the coming years. As some PR consultants advised us recently, "make your friends before you need them". ●

Bob Bridger is an independent consultant in human factors.

Ergonomics & Human Factors 2020

27 – 29 April 2020 • Stratford-upon-Avon

Chartered Institute of Ergonomics & Human Factors

Our flagship event showcasing the latest in research and application across all sectors

The conference will start with a day of Masterclasses on a variety of topics, and the interactive Doctoral Consortium where students can present their ongoing research.

This will be followed by two days of keynotes and a parallel programme of presentations, posters, workshops and discussions by leading professionals.

Submissions

Open from 1 September to 1 November 2019

Why submit?

Some comments from the last conference:

> "Good balance of content, with plenty of conversation time
>
> There was a varied mix of interesting presentations and discussions
>
> A well balanced selection of speakers from a wide cross section of industries
>
> Lots of space and time to mingle with others and discuss topics
>
> The increased emphasis on workshops and participative sessions was good"

Social events...

will include an informal BBQ, and the annual dinner with awards ceremony

LEARN. MEET. DISCUSS. BE INSPIRED.

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Medical Packaging and Labelling

23 October 2019 • Birmingham

Unsafe pharmaceutical packaging, and look-alike labelling, have both been identified as major contributing factors to medication errors. Feedback about reports of medication errors show that a systems-wide approach to how the label is developed, used and amended is needed. Human factors can address many of the issues.

This one day event will provide a unique opportunity for key stakeholders representing academia, healthcare, the pharmaceutical industry, and patient communities, to work together to identify the key issues and to make recommendations. The aim is to identify a group who will go on to work collectively to implement the recommendations that come out of this event.

Programme highlights

Keynote: Labelling challenges from a clinical perspective, Professor Jamie Coleman, University of Birmingham

This presentation will focus on the issues of look-alike labelling and the potential for medication errors associated with labelling and packaging. We will also hear perspectives from patients who have difficulties with labelling.

Taster workshop: A human factors approach to tackling labelling issues.

Syndicate workshops:

- Implementing a systems based approach to delivering education around labelling in clinical practice.
- Using a systems based approach to achieve an industry wide consensus for consistency on type font, size and label colours for both generic and proprietary medicines.
- How would a systems based approach to the layout of packaging information on medicines help to mitigate erroneous use of medicines by patients?

Book now and be part of a group examining the next steps needed to ensure future optimal labelling of medicines and healthcare products

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Over the last twenty years, there's been a resurgence in tram travel, its growth partly due to its green credentials and customer comfort. **Ian Rowe**, an expert in tram simulation systems, discusses the cultural aspects of this increasingly high-tech sector

Driving out blame culture

Most UK tram system operators are planning, or have recently undergone, significant expansion as part of urban masterplan development. While trams are often considered as 'buses on steel wheels', there are many important differences. At around 40 tons in weight without passengers, it's not possible for trams to take avoiding actions such as swerving, and at maximum speeds of around 50 miles per hour they take considerably longer to stop than other road vehicles. Tram systems include both street and segregated sections and have similarities with heavy rail.

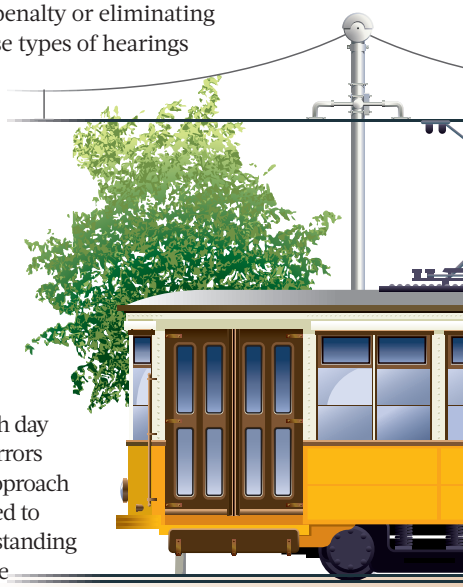
Much has been written about developing a 'just culture' as a healthy, progressive and safe way forward for organisations. Even though most light rail organisations would say they operate in a fair and just manner, my experience around the world would suggest that not all of them meet this goal. One story to illustrate this concerns Line Controllers. They make important decisions many times a day that affect safety for passengers, road users and pedestrians. They monitor and control the tram system, authorise tram movements and communicate safety-critical information to drivers.

During early 2018, a Line Controller authorised an un-signalled vehicle movement. All standard communications protocols were used but the Line Controller omitted to check that the tram driver had understood the instruction properly. As a result, the driver moved his vehicle into the path of another moving tram. Luckily, as these systems use a 'line of sight' principle, both drivers detected the problem and avoided a collision. Nobody was hurt but a normal incident procedure was triggered.

Routine drug and alcohol testing is carried out for all those involved in such incidents, so both drivers and the Line Controller were stood down pending the investigation outcome. The Line Controller was found to be technically at fault and he was suspended pending a further hearing where his fate would be decided. In line with normal procedure, this was a disciplinary hearing and a date and time was set. At this point, having been involved with some change management in this organisation, I was asked to review the case.

The purpose of the hearing was to determine how and why the error was made before deciding on the resultant actions. I noted that one of the outcomes from this type of hearing was normally an action aimed at the individual that ranged from re-training for minor errors through to warnings, or even dismissal, for more serious incidents.

I realised that this process would likely drive confrontational behaviour as it was normal practice for the individual to be accompanied and supported by a Trade Union representative who would attempt to argue the case for their colleague with the goal of reducing the severity of the penalty or eliminating it completely. From experience, these types of hearings would involve much reference to 'proper procedure' with many hearings thrown out on a technicality such as the hearing being called after an obligatory 30-day limit. The usual outcome of this approach is that the person involved would be disciplined for their error and it would then be back to business as usual for the organisation.



It's widely acknowledged that generally people don't go to work each day with the intention of either making errors or of being negligent. However, the approach adopted by the tram operator appeared to assume that this was the case. Understanding the error type is key to the appropriate

People waiting at a tram stop

response in this situation in an organisation with a just culture:

- **Violation errors**, where an individual knows that they are not following procedure or due process, are normally associated with punitive measures against the individual. But even this type of error may be systemic and commonplace with underlying causes that are not controllable by the individual. When violation errors are linked with laziness or sloppiness however, some type of punitive measure may be justly applicable.
- **Slip or lapse errors**, where individuals intend to do the right thing but omit a step of the process or perform the step incorrectly, should be investigated to identify any underlying cause that could be addressed in order to reduce the likelihood of a repeat. In this case, applying punitive measures to an individual is inappropriate and signifies a tendency towards a blame culture.
- **Mistake errors**, where individuals intend to do the right thing but are mistaken in their understanding of the situation and apply incorrect or inappropriate procedures or actions, should also be investigated to understand if the training given is adequate or if the procedure is robust and suitable under all circumstances. In this case, applying punitive measures to an individual is also inappropriate and would signify that a blame culture exists.

In this instance, the Line Controller had followed the procedure but omitted the final step so this could be classified as a slip or lapse error. The approach taken to address this was, however, more suited to a violation error.

Prior to the hearing, I entered a discussion with the management and persuaded them to trial a new approach. The result was convincing. The hearing was renamed an 'incident review' and included a review panel with representatives from different disciplines. The objective of the review was to obtain a thorough understanding of the incident with no preconception about the performance of the individual involved. By engaging with the socio-technical system model, they had a greater understanding of the performance of the total system incorporating people, process and technology within the specific environment. This immediately removed the threat to the individual involved and opened the minds of those conducting the review. The person involved did not seek Trade Union representation and became an open contributor to the review.

Whilst this review did level some criticism at the individual, it also identified a total of seven additional issues that contributed to the incident. Everyone involved agreed that this new process was more constructive than the previous approach and acknowledged that, as an organisation, valuable lessons were learnt that would otherwise have been lost. Rather than focusing the training on the individual involved, additional training was designed and delivered

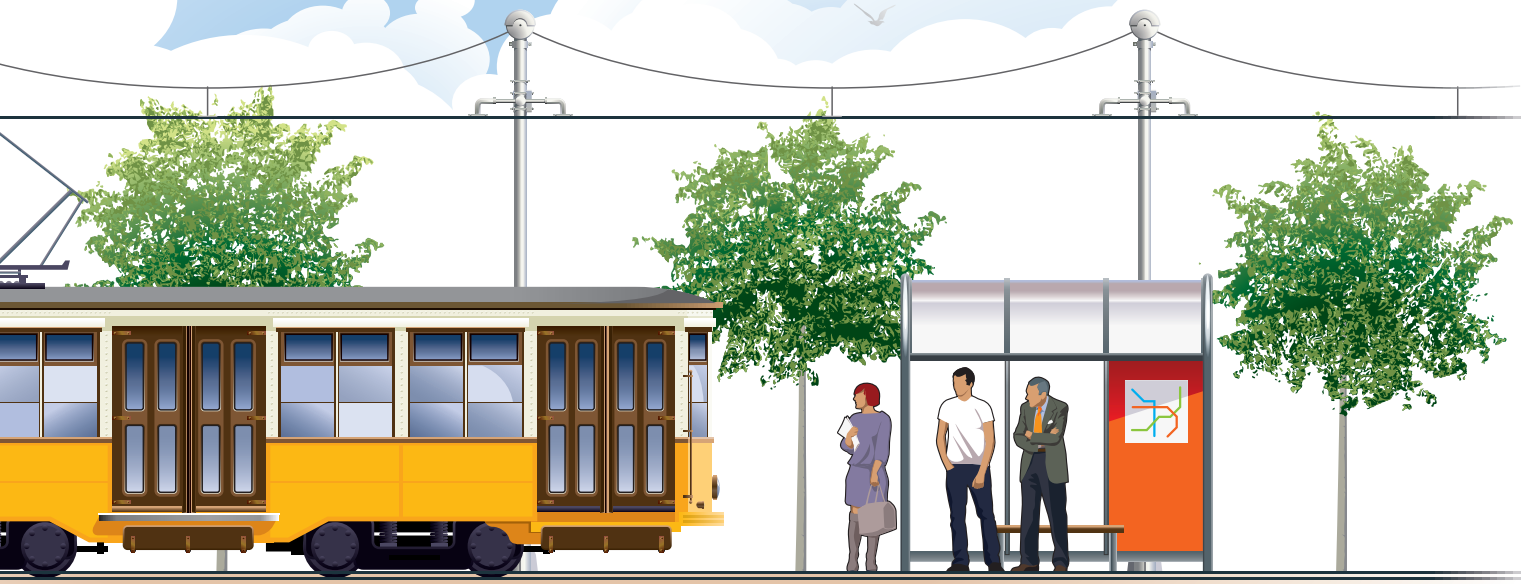
Valuable lessons were learnt that would otherwise have been lost

to all Line Controllers and drivers to reduce the risk of others making the same error. The lessons learnt from the incident were able to be communicated to the broader operational audience. The organisation involved have now changed their process to include an incident review and only to follow this with a disciplinary hearing if the review concluded that individuals involved had purposely or wittingly violated procedure.

Learning from incidents and near-misses is critical in improving safety. In order to truly learn, organisations need to thoroughly review their incident investigation and response procedures and ask the question: "Does the way we do things, that is, does our culture curtail or even prevent the opportunity to learn from what's happened?"

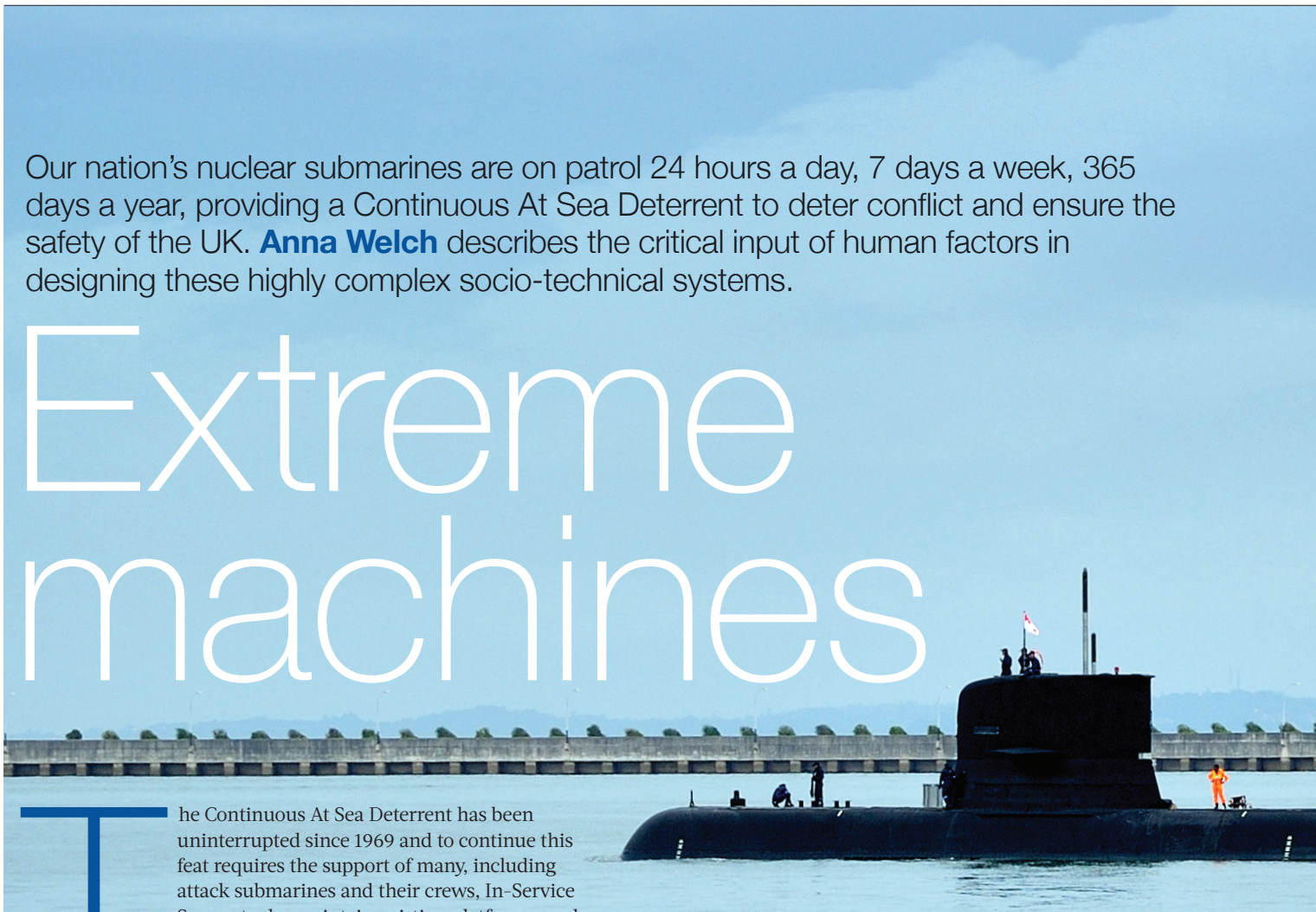
Ian Rowe is director of the design and operations management consultancy, Ian Rowe Associates. His multi-skilled team of experts developed Tram-Pro™, a tram simulator for drivers, trainers, managers and controllers, which received industry-wide recognition at the 2013 Global Light Rail Awards.

IMAGE: GETTY



Our nation's nuclear submarines are on patrol 24 hours a day, 7 days a week, 365 days a year, providing a Continuous At Sea Deterrent to deter conflict and ensure the safety of the UK. **Anna Welch** describes the critical input of human factors in designing these highly complex socio-technical systems.

Extreme machines



The Continuous At Sea Deterrent has been uninterrupted since 1969 and to continue this feat requires the support of many, including attack submarines and their crews, In-Service Support who maintain existing platforms, and the people striving to design and build our future submarine platforms. Our Royal Navy crews board these vessels for lengthy patrol durations until the next submarine and her crew is available to relieve them.

Supporting this endeavour, our team of over 40 human factors specialists and training needs analysts work to ensure that submarine operators are at the heart of future design. Our group of highly skilled individuals, with diverse industrial and academic backgrounds, has a strong team dynamic, take great pride in our product and have a responsibility to ensure a safe, operable, accessible and habitable environment for those who occupy it. Our work offers an opportunity to gain experience across the full breadth of human factors competencies, continuously developing both our individual skills and the team's capability.

A complex socio-technical system

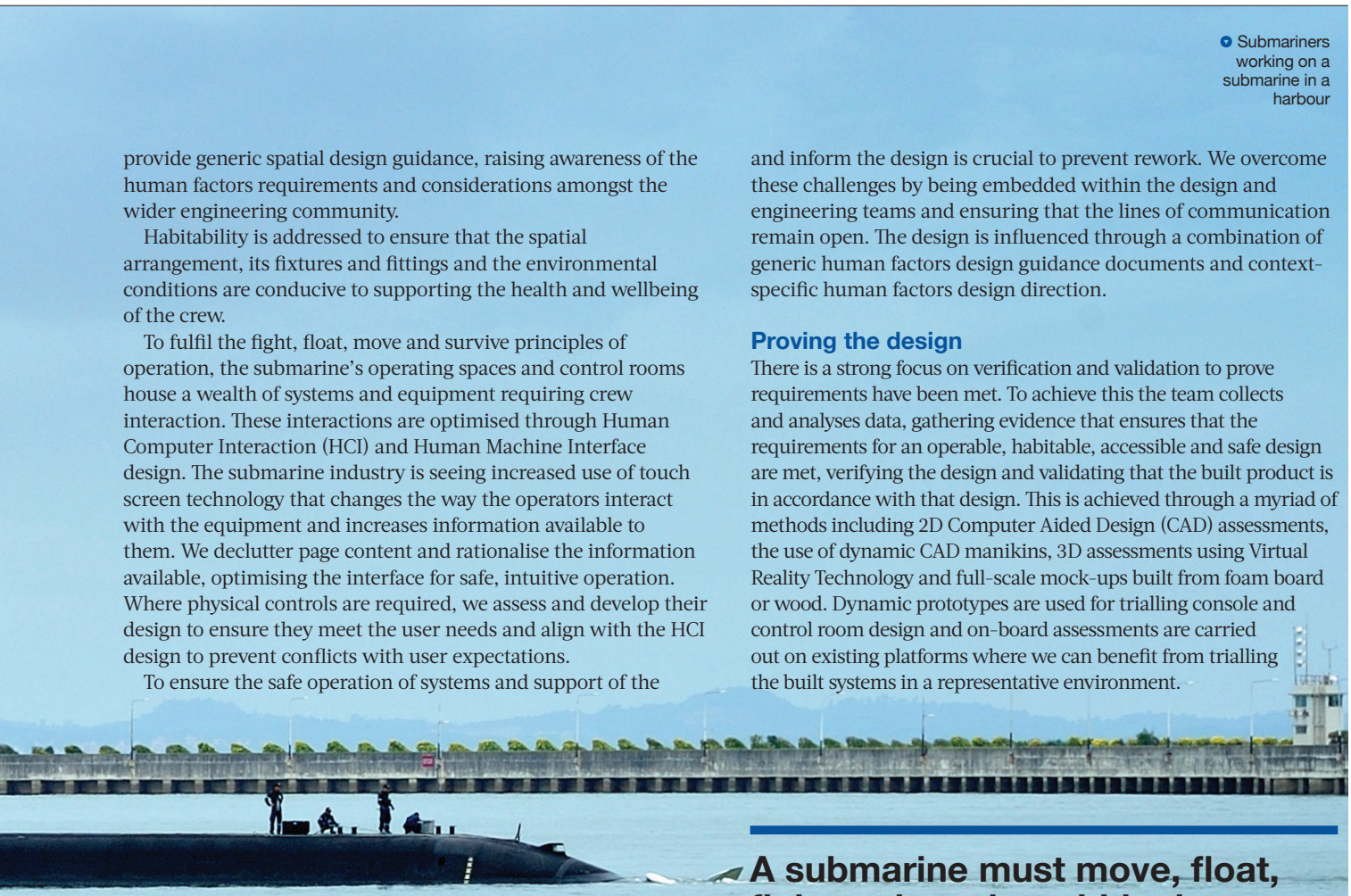
A submarine is a highly complex socio-technical system which brings with it complexities of environment. It's a warship and a workplace comprising watch-keeping positions, machinery spaces, offices and control rooms but also an accommodation space with sleeping quarters, bathrooms, dining and social areas. The submarine and its crew must be capable of carrying out life-sustaining activities such as producing water, maintaining air quality and disposing of waste, whilst producing power from the on-board nuclear reactor. The submarine is designed to move, float, fight and survive and it must do all this within a defined general arrangement subject to the spatial constraints of a self-contained, self-supporting vessel.

How we integrate human factors

To address these considerations and ensure that human factors is fully integrated, we undertake a broad but clearly defined scope of work under the categories of Manning, Human Factors Engineering, Human Reliability Analysis and Training Needs Analysis.

From the early concept phase of design, the Basic Manning Requirement is developed with the aid of subject matter experts to address the manpower needs. It outlines the make-up of the crew, specifying the roles, responsibilities, qualification and experience required within the Royal Navy for a submarine to meet its full operational capability. We test the manning solution through table-top activities that use operational scenarios and inform the development of the crew baseline.

We provide input to the general arrangement, conducting task analyses to understand the fundamentals of the task requirements and apply workplace design principles and anthropometry to ensure that the design of the spatial layout across the whole boat is accessible and operable by its male and female crew as defined in the target audience description. We



Submariners working on a submarine in a harbour

provide generic spatial design guidance, raising awareness of the human factors requirements and considerations amongst the wider engineering community.

Habitability is addressed to ensure that the spatial arrangement, its fixtures and fittings and the environmental conditions are conducive to supporting the health and wellbeing of the crew.

To fulfil the fight, float, move and survive principles of operation, the submarine's operating spaces and control rooms house a wealth of systems and equipment requiring crew interaction. These interactions are optimised through Human Computer Interaction (HCI) and Human Machine Interface design. The submarine industry is seeing increased use of touch screen technology that changes the way the operators interact with the equipment and increases information available to them. We declutter page content and rationalise the information available, optimising the interface for safe, intuitive operation. Where physical controls are required, we assess and develop their design to ensure they meet the user needs and align with the HCI design to prevent conflicts with user expectations.

To ensure the safe operation of systems and support of the submarine safety case, we assess the design of systems and equipment to identify performance-influencing factors and reduce error-inducing conditions. At a more holistic level, we conduct Human Reliability Analysis to assess and minimise the likelihood of human error across the whole boat operating scenarios.

Challenges we face

The Human Factors Department sits within the wider engineering function dedicated to a programme with over 3000 engineers. The team engage with a wide variety of stakeholders, including the Ministry of Defence, the Royal Navy, submarine crews, engineers, design integrators and other industrial participants.

The sheer size of a submarine design project brings with it challenges in terms of the way the team integrate human factors and our input needs to be scaled accordingly. We face the usual programme demands such as delivering our service to cost and schedule whilst ensuring a safe product to a high quality, but we also must make compromises to ensure functionality and buildability.

A further challenge is keeping abreast of the rate of change to design and the varying levels of maturity of all the interfacing elements of design. Items of equipment or systems develop at different rates and therefore identifying the right time to assess and inform the design is crucial to prevent rework. We overcome these challenges by being embedded within the design and engineering teams and ensuring that the lines of communication remain open. The design is influenced through a combination of generic human factors design guidance documents and context-specific human factors design direction.

Proving the design

There is a strong focus on verification and validation to prove requirements have been met. To achieve this the team collects and analyses data, gathering evidence that ensures that the requirements for an operable, habitable, accessible and safe design are met, verifying the design and validating that the built product is in accordance with that design. This is achieved through a myriad of methods including 2D Computer Aided Design (CAD) assessments, the use of dynamic CAD manikins, 3D assessments using Virtual Reality Technology and full-scale mock-ups built from foam board or wood. Dynamic prototypes are used for trialling console and control room design and on-board assessments are carried out on existing platforms where we can benefit from trialling the built systems in a representative environment.

A submarine must move, float, fight and survive within the constraints of a self-contained, self-supporting vessel

Through successful human factors integration, we're seeing a greater focus on the operator and a greater influence from human factors in submarine design. Crew retention is critical to the future of the submarine service and so the focus on operator wellbeing must continue. The recent changes to accommodate women on board submarines contributes to this, broadening the Navy's recruiting pool and bringing new challenges to ensure that female requirements such as reach and strength are catered for, in addition to those for the male population.

Integrating human factors into submarine design is no small task but our depth of input and seeing our efforts add value is hugely rewarding. A look back at historic submarine design serves as a good reminder of how far human factors has come in this sector. ●

Anna Welch is an Engineering Manager and Acting Head of the Human Factors Department at BAE Systems Submarines. The Department's work was recognised by the presentation of the CIEHF's President's Award at this year's Ergonomics & Human Factors conference.

Alan Felstead and Martin Thody also contributed to this article.

IMAGE: SHUTTERSTOCK

Re-thinking rail level crossing design

Collisions between trains and road vehicles at rail level crossings remain a persistent road and rail safety issue worldwide. **Paul Salmon** and **Gemma Read** describe a recent project involving level crossing design concepts and system reform recommendations

Most level crossings were built more than 100 years ago when there were fewer and slower trains on the railways and fewer cars on the road. But with trains travelling at higher speeds, intersections of roads or paths with the railway have become potentially more dangerous. Helping in the battle to increase safety, one team has embarked upon a major four-year research programme involving risk reduction at rail level crossings. The project was the first to apply complex systems approaches to the safety issues involved and included the development of a new methodology.

Human factors exists to support the design of technologies, environments, processes, and systems that optimise human wellbeing and performance. Despite this, the discipline often fails to satisfactorily influence design. A common criticism is that human factors methods do not directly contribute to design, that is, they are not used by designers to design. As a result, human factors issues can be overlooked, and practitioners often play the role of trouble-shooters, only brought in to solve problems that are identified once designs are implemented.

Sociotechnical Systems (STS) theory proposes a set of values and principles to support the design of systems that are jointly optimised and exhibit adaptive capacity. As part of a programme of research focused on rail level crossing safety, a Sociotechnical Systems Design Toolkit (STS-DT) was developed, a participatory design approach that aims to bridge the gap between human factors and design. The STS-DT supports the application of human factors and STS values and principles in design. It can be used to create design concepts aligned with STS theory, based on insights derived from human factors analyses.

The STS-DT process includes 14 stages which begin with analysis planning, moving through the human factors analysis process, requirements specification, design planning, concept design, evaluation and design refinement, and ending in testing and verification. The process is intended to be used in conjunction with human factors methods. For example, we've used the STS-DT in conjunction with methods such as Cognitive Work Analysis, Accimap, and the Event Analysis of Systemic Teamwork (EAST) to design transport ticketing systems, rail level crossings, road intersections, interventions to disrupt illicit trading in the dark net, and strategies for preventing injury in led outdoor activities.

Designing novel rail level crossings

Given the combined personal, societal and economic burden of collisions between trains and road vehicles at rail level crossings, they represent an area of strategic importance for road and rail safety authorities across the world. As part of the four-year programme described above, we used the STS-DT to develop rail level crossing design concepts and system reform recommendations aimed at preventing collisions between trains and crossing users.

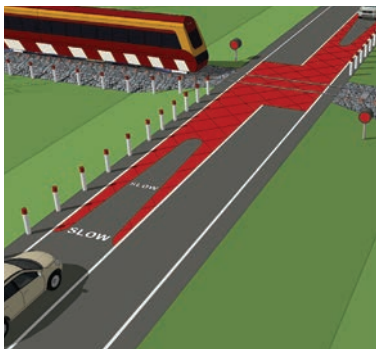
Initially Cognitive Work Analysis was used to describe and analyse rail level crossing systems and the behaviour of different users such as drivers, cyclists, motorcyclists and pedestrians. These analyses were based on various data collection activities including on-road studies of driver behaviour, cognitive task analysis interviews with drivers, a diary study of level crossing user behaviour, input from train drivers and a subject matter expert workshop. During the analysis process, 209 insights were documented within the following categories:

- **Assumptions:** underlying hypotheses, expectations and beliefs about the system and its behaviour.
- **Leverage points:** aspects of the system that, if modified in a small way, could produce large changes in behaviour.
- **Metaphors:** the comparison, interaction or substitution of two subjects on a symbolic level.
- **Pain points:** problems or issues impacting behaviour.
- **Scenario features:** key contextual information about the system and its behaviour.
- **Design solutions:** analysts' ideas for proposed design solutions.

Next, a two-day idea generation workshop was held involving 18 rail level crossing stakeholders including representatives from government agencies, safety regulators, rail operators and road user advocacy groups, as well as designers and human factors professionals. Participants engaged in various design exercises using tools from the STS-DT, including user personas, scenarios, an assumption crushing exercise, metaphorical design exercises and inspiration cards. As a result, over 150 design ideas were developed and then integrated into 11 design concepts. Following a ranking process, five full rail level crossing design concepts were prioritised for further evaluation and refinement via:

1. Reinsertion into the original Cognitive Work Analyses to identify any positive and negative impacts.
2. A Systematic Human Error and Reduction and Approach (SHERPA) to identify any errors that users might make when using the crossings.
3. Evaluation via ratings against STS content principles which included the system properties and the design process.
4. Evaluation based on their capability to control key rail level crossing risks, for example, users not aware of an upcoming crossing, users not aware of an approaching train, vehicles queuing on the crossing, pedestrians choosing to cross when a train is approaching.

Urban example concept: Community courtyard crossing based on shared space enhancing social interaction and community activity



Rural example concept: Ecological Interface Design based on making constraints explicit to users such as field of safe travel, emphasis on danger zone, drawing attention to the train

A design refinement workshop was then held with ten participants, eight of which had attended the original design workshops. As a result, six concepts were refined and selected for formal testing, three of which were intended for urban areas, and three of which were intended for use in rural areas.

In addition to the level crossing design concepts, recommendations were also made to improve other aspects of the systems such as risk assessment processes, monitoring of user behaviour, and incident reporting and learning. Formal testing of the six design concepts included driving simulator studies and online surveys incorporating videos of simulator-based drive, cycle, and walk throughs of each crossing. The findings were useful in identifying the strengths and weaknesses of each design and provided initial evidence of their efficacy compared to baseline level crossings.

A whole of lifecycle approach

A whole of lifecycle human factors approach in system design is something that's often recommended but not achieved. Using the STS-DT in conjunction with human factors analysis methods enables such an approach and ensures that the discipline is considered throughout the design process.

Applications of the STS-DT to rail level crossing design and other areas demonstrate that it enables human factors to be a driving force in the design process, rather than an afterthought. By using human factors insights and STS principles to develop initial design concepts and drive testing and refinement, the outputs are focused on optimising human performance and wellbeing. We encourage further applications of the STS-DT, and the development of similar design processes that support translation of human factors analyses in design.

Professor Paul Salmon is director of the Centre for Human Factors and Sociotechnical Systems at Australia's University of the Sunshine Coast. This project and Paul's team were 2019 winners of the Institute's prestigious William Floyd Award for outstanding and innovative contributions to human factors. The project team also includes **Gemma Read**, Michael Lenné, Thomas Triggs and Neville Stanton.

Further reading

Read, G J M, Salmon, P M, & Lenné, M G (2018). A sociotechnical design toolkit for bridging the gap between systems-based analysis and system design. *Human Factors in the Manufacturing and Services Industries*, 28:6, 327-341.

Salmon, P M et al (2016). More than meets the eye: using cognitive work analysis to identify design requirements for safer rail level crossing systems. *Applied Ergonomics*, 53, Part B, 312-322

IMAGE: ISTOCK

NATS

Optimising the human contribution in NATS

The NATS Human Factors team plays a key role in maximising the safe and efficient operation of more than 2.4million flights every year in UK airspace. The team includes ergonomists, psychologists and human factors specialists with a worldwide reputation for optimising human performance.

To find out more about the work we do, services we provide, or experience we might be interested in, please contact NATS Head of Human Factors neil.may@nats.co.uk or visit www.nats.aero and search human factors.

JOURNAL EXTRACTS

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Shrinking seats

1 As airlines get set to welcome record numbers of holidaymakers over the summer months, are we as consumers starting to feel the squeeze, literally? Are airline seats shrinking? The answer is yes!

In 1990, *The Telegraph* compared seat pitch on a handful of major airlines, including British Airways and Virgin. For long-haul flights, Lufthansa, Qantas and Virgin all had a seat pitch of 34 inches in economy, while British Airways' seat pitch was between 31 and 34, depending on the aircraft. Now only Qantas offers more than 31 inches (its Boeing 787s offer 32), while Virgin goes as low as 29.

IMAGE: ISTOCK

Airlines are also reducing seat width while individuals worldwide are getting larger. Flights are increasingly crowded, with load factors – the ratio of the lift of an aircraft to its weight – at a record high. Recent research explored the effects of seat width on passenger accommodation in several scenarios involving load factor, demographics and passenger seating allocation strategies.

The objective of this work was to demonstrate a method for examining the competing effects of secular trends in body size, seat size and configuration, and the increased load factor of aeroplanes. The method uses statistical modelling and virtual fit testing to provide a flexible environment for exploring the impact of various parameters on passenger accommodation.

Talking to Phys.org, researcher Emily Miller said: "You can ask almost anyone who travels on planes, they have probably had trouble fitting in a seat or they know someone who has," she said. "We saw that a bunch of surveys captured that people associated unhappiness, discomfort and dissatisfaction with seat size. We wanted to understand this from a quantitative perspective."

A case study demonstrated the method by exploring the effect of seat width on the accommodation of US civilians, based on seated hip breadth. The study revealed that recent trends of decreasing seat widths and increasing load factors lead to higher 'disaccommodation'. Based on anthropometry and virtual fit, women are also shown to be disproportionately disaccommodated compared to men as women tend to have wider hip breadths on average.

The team also looked at seat assignment strategy and how it can be used for better accommodation. Results state that if passengers are distributed more optimally by taking advantage of empty seats and leaving middle seats empty as much possible, more people are accommodated.

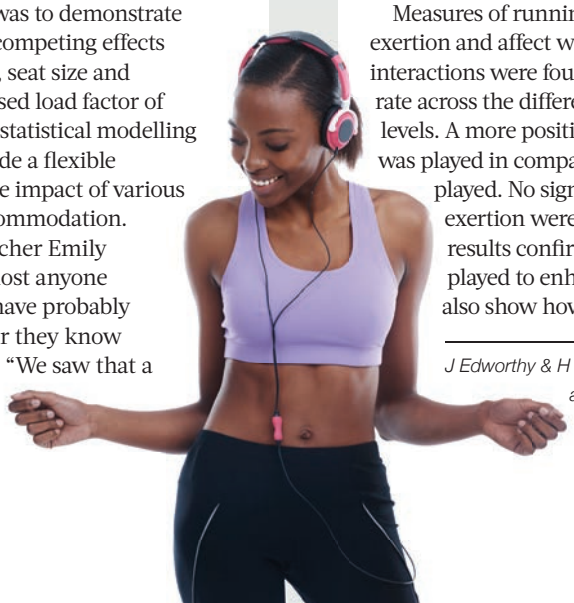
E L Miller, S M Lapp & M B Parkinson (2019) The effects of seat width, load factor, and passenger demographics on airline passenger accommodation, Ergonomics*, 62:2, 330-341, DOI: 10.1080/00140139.2018.1550209*

Up the tempo

2 Typing workout music into Google, thousands of playlists, top 100 songs for the treadmill and an array of albums fill the screen. We all know an upbeat song can make us feel happier and motivated, but what effects does music tempo and loudness level really have on treadmill exercise? A group of researchers are seeking the answer.

A recent study has examined the effects of loudness and tempo of background music on exercise performance. A total of 30 volunteers performed five ten-minute exercise sessions on a treadmill. The music listened to whilst exercising was either fast/loud, fast/quiet, slow/loud, slow/quiet or absent.

Measures of running speed, heart rate, perceived exertion and affect were taken. Significant effects and interactions were found for running speed and heart rate across the different music tempo and loudness levels. A more positive effect was observed when music was played in comparison to when no music was played. No significant differences for perceived exertion were found across conditions. These results confirm that fast, loud music might be played to enhance optimal exercising, and they also show how loudness and tempo interact.



J Edworthy & H Waring (2006) The effects of music tempo and loudness level on treadmill exercise, Ergonomics*, 49:15, 1597-1610, DOI: 10.1080/00140130600899104*

Designing human nature interactions

The wellbeing of people and nature is in crisis, but ergonomics has a role to play, says **Miles Richardson**, in promotion of a new relationship with nature

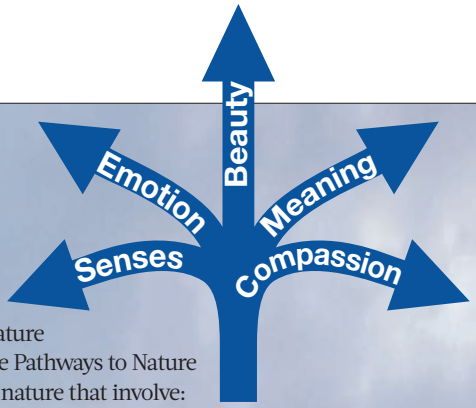
The Government's 25 Year Environmental Plan (25YEP) includes a nature for wellbeing programme, yet nature's wellbeing is in crisis with 60% of animals dying out since 1970 according to the World Wildlife Foundation's Living Planet Report. This decline threatens human civilisation with the United Nation's biodiversity chief warning that "humanity could be the first species to document our own extinction". One way to deepen the crisis in human wellbeing is an unhealthy planet and we're currently heading to a permanently unhealthy world.

Ergonomics is concerned with wellbeing. An object stated in the CIEHF's Royal Charter refers to the promotion of wellbeing. Yet, ergonomics cannot achieve its aim for human wellbeing without nature's wellbeing. Clearly, we need a new relationship with nature. Ergonomics is all about relationships, between people and the things they do. So, how can ergonomics inform Human Nature Interactions (HNIs) to help improve people's relationship with (the rest of) nature: their nature connectedness?

Nature connectedness is a psychological construct that captures the strength of a person's emotional relationship with nature and the degree to which they feel part of nature. Recently, when we asked 5000 people, most weren't confident that they were part of nature, but feeling part of nature is important for wellbeing and pro-nature behaviours. Indeed, emerging evidence suggests nature connectedness is more important for wellbeing than visiting nature. For this reason, there's been a surge of interest in people's connection to nature; from major conservation organisations, to the Government in the 25YEP and internationally with the *Nature For All* publication launched at the UN's Biodiversity Conference in Egypt.

I formed the Nature Connectedness Research Group at the University of Derby in 2013. Our work looks to understand and develop interventions to improve people's nature connection because it's good for both human and nature's wellbeing. Our work has recently been named as one of the 100 best research breakthroughs by Universities UK.

Central to the work has been the development of a framework



that can be used to design HNIs, that is, types of activity that help improve nature connectedness. These are the Pathways to Nature Connectedness, activities in nature that involve:

With the massive decline in wildlife and change in climate, it's clear that the current human relationship with nature has failed. There's an urgent need for a new relationship, yet much engagement still promotes nature as a resource, conquering challenges in nature and nature as facts and figures. What type of sustainable relationship is based on facts and figures?

We've been helping several organisations apply the five pathways to nature connectedness to various HNIs. In 2018, the National Trust adopted the pathways as a framework they could apply to the design of visitor programmes in order to foster a closer relationship with nature for both human and nature's wellbeing. In a fascinating year, I've been working closely with the National Trust to help roll out the pathways across various parts of the organisation.

Designing a great visitor experience

The first step in the work with the National Trust was an internal report introducing the evidence of the benefits of nature connectedness, and then the pathways that can be used to achieve it. Then a series of workshops with the people who develop and manage the visitor experience took place. These introduced the pathways and applied them to design scenarios.

The high level of thought that goes into designing a great visitor experience soon became apparent and the pathways were swiftly integrated into thinking. The feedback has been overwhelmingly positive about how the pathways can help tweak existing activities or inspire new ideas. Taking the focus away from knowledge and identification, although challenging for some, has been widely embraced. Feedback on the pathways as a design tool was that it was simple and accessible, yet wide reaching, allowing sophisticated interpretation and the opportunity to move beyond science, giving people a 'license to talk about emotions'.

One specific part of the work with the National Trust was a refresh of their '50 things to do before you're 11¾' campaign. During an early design session, it was great to see a blank wall quickly become covered with potential activities to engage children with nature. Some new, some adapted, some set free after talking through the pathways.

The pathways prompted simple revisions, for example, 'Climb a tree' became 'Get to know a tree'. Our wider research shows trees mean a great deal to people. Trees are remarkable places and favourite features of the landscape. Trees can be touched, smelt and heard. They provide exhilaration and shelter. They provide a home for wildlife. Trees can foster many types of relationship and be used to operationalise multiple pathways to nature connectedness. So, children can still climb but they're also encouraged to get to know a tree, hoping they become steadfast companions and meaningful places, be that beneath, within or atop a tree.

Other activities have also been re-framed and adjusted. For example, 'Canoe down a river' became simply 'Float in a boat', prompting less purposeful time to take a moment with the senses. The simple change from 'Go bird watching' to 'Watch a bird', takes the emphasis away from traditional identification to enjoying the day-to-day lives of birds, simply watching them fly, listening to them sing and noticing their beauty. The wider guidance around each activity also reflects the pathways approach, bringing them to life through artistic activities, for example.

It's not just about children. Our research has found that people need a prompt to notice nature and we've used that ever-present companion, the smartphone. We designed an app that knows where urban green spaces are and prompts people to notice the good things in nature by writing them down and sharing on social media. Using the app for seven days led to increased nature connectedness and clinically significant improvements in mental health. The locations of users' interactions with nature were also recorded along with ratings of those places for positive emotions and biodiversity.

The good things in nature

The data from users of the app provides valuable insight into how people interact with green spaces. For example, which types of green spaces bring the most benefit, which provide →

IMAGE: GETTY

How can ergonomics help improve people's nature connectedness?

guidance on designing urban green spaces. The good things people notice in nature have also been combined with the pathways to produce a matrix of micro-activities for nature connection and wellbeing.

When considering the design of urban environments and green spaces, we're producing recommendations on how places can afford a connection to nature, using design to prompt people to engage with nature in ways suggested by the pathways. This use of design to influence choices is also related to concepts such as 'nudge' and 'design thinking' where we use design to tackle social and behavioural issues.

Art installations can also be used to create these 'habitats for connection'. For example, 'Skyspace' by James Turrell at Tremenhere Sculpture Gardens in Cornwall influences behaviour through design by having seating that obliges the user to look-up, towards a void in the ceiling that brings attention to, and frames, the sky. A lower budget alternative to Skyspace, is Sky Glade at Rievaulx Terrace, a National Trust installation using sycamore pillars standing at an angle in woodland to encourage passers-by to pause, repose, and look upwards towards the canopy.

Using an art installation to prompt people to pause and listen to nature

Five ways to wellbeing

Wider guidance on wellbeing can also be adapted by the pathways to nature connectedness. The New Economics Foundation Five Ways to Wellbeing from 2008, provides straightforward and popular guidance on the steps we can take towards human wellbeing. The five pathways to wellbeing are based on an evidence report that, in 317 pages, includes no specific nature-based solutions. There are just two sentences noting that access to green space contributes to wellbeing. Similarly, guidance on the Five Ways to Wellbeing from the NHS and Mind overlooks nature; we seem to be transfixed by ourselves, but not the natural world that sustains us.

This situation is no surprise as, despite increasing recognition of the health and wellbeing benefits we get from nature and a connection to it, nature is not apparent in our everyday lives; cultural references to nature are in decline, models of workplace wellbeing and models of health overlook nature.

Recently, a 'One Health' model in British Medical Journal *Global Health* recognises that humans are embedded within the rest of the natural world, that the fundamental pathway to wellbeing is a healthy planet. Key guidance on wellbeing such as the Five Ways to Wellbeing should recognise this. Ten years on it's time for an update that reflects the latest evidence and a 'one health' perspective. A simple way to do this is to combine the Five Ways to Wellbeing with the five pathways to nature connection to arrive at 5 Ways to Natural Wellbeing:

- **Connect:** social relationships are important for wellbeing so be with and talk to people about anything, about what nature means to you.
- **Take notice:** be aware of the world around you, savour the moment, notice nature's beauty.
- **Give:** take part in community life, do something for a friend, do something for nature.
- **Be active:** walk or cycle when you can, to green spaces to connect with others, to notice, to give and learn.
- **Learn:** try something new, rediscover your childhood wonder for nature, learn that people are part of the wider natural world and nature matters for human health.

There's plenty of scope to include the benefits of nature, and a connection to it, within the pathways to wellbeing because it's easy, because nature needs to be in our health, and in every decision we make, as ultimately there's no wellbeing without nature's wellbeing.

Miles Richardson is Professor of Human Factors and Nature Connectedness at the University of Derby.

Further reading

Nature Connectedness Research Blog, on the web: https://findingnature.org.uk, on Twitter: @findingnature

Smart design

In today's tech loving culture, smartwatches have become an on-the-go gadget for many, and Google is reported to be spending $40million on Fossil's smartwatch technology this year, so **Tassilo Bouwman's** project on display design couldn't be more timely

With devices such as smartwatches, icons need to fit on small displays (some as small as 38mm) while users still need to be able to locate and recognise icons quickly. A more space efficient way of arranging circular icons is in a hexagonal layout.

Tassilo's study investigated visual search performance of hexagonal icon arrangements at different density levels. Twenty-four participants performed known-item searches on icon menus in an online experiment using their own smartphone. These menus varied in four ways:

1. The arrangement of icons in either a hexagonal or in a grid layout.
2. The amount of space between icons.
3. The number of colour distractors.
4. The menu stayed the same or changed with every trial.

Results showed that the effect of layout depends on the icon density and number of colour distractors. Hexagonal layouts performed better than grid layouts when the space between icons was zero and five colour distractors were present. When icons were further apart, and one colour distractor was present no difference between layouts was found. The study confirmed previous findings on the effects of colour distractors and location learning: participants were faster when fewer icons in the menu had the same colour as the target. With more practice with the same menu participants became increasingly faster finding icons.

The findings may help designers decide how to arrange icons on small devices such as smartwatches of the future. The results suggest that the icon layout of app launchers affects search performance when there is little space between icons. So it may be beneficial for search performance to use a hexagonal layout in cases where space is limited and icons need to be close together.

There are a multitude of ways in which people arrange icons on their smartphone app launcher, for example, based on relatedness or aesthetics. To develop a full picture of the effect of hexagonal layout, additional studies will be needed that take icon size into account. Findings on colour could be relevant to both software designers and computer users who seek to optimise search time in app launchers.

The findings may help designers decide how to arrange icons on small devices

Tassilo's supervisor, Duncan Brumby, Director of the Human Computer Interaction programme at University College London, said: "What makes Tassilo's experiment exceptional as a student project is that he developed all the technical software required to run the experiment himself and made it available to the general public in the Apple App Store. Interested participants then downloaded the app and took part in the experiment over a series of weeks. The results of the experiment are compelling and informative. Designers should employ hexagonal icon layouts on small devices to save space and improve search performance, validating the current design pattern used in some current generation smartwatches." ●

Tassilo Bouwman graduated from the MSc HCI course at University College London last year. He won the CIEHF's Ulf Aberg Award 2019 for the best student project for his MSc dissertation. He's now working as a User Interface Designer for Runtastic in Austria.

IMAGE: SHUTTERSTOCK

The future of work

70 YEARS OF ERGONOMICS 1949-2019

As the Institute's Ergonomics & Human Factors conference wraps up for another year, **Lou Boulden** takes a closer look at the big themes emerging in human factors that will impact the future of work

As the Institute celebrates its 70th year, we sought to ask the big questions: What does the future of work really look like, and will human factors be the catalyst for change towards a user-centred approach to the workplace and our future workforce?

Understanding the real world

Keynote Professor Paul Salmon from the University of the Sunshine Coast set practitioners some hefty, yet exciting challenges to reach that goal. Questioning how ergonomics can impact upon big global challenges such as terrorism, climate change and mental health, Paul urged us to broaden our scope: "If, as a discipline, we're all about the health and wellbeing of humans, we must do something about these worldwide threats, surely?" he said.

However, connecting the macro with the micro is where the first piece of the puzzle comes together. Where can we change our thinking and broaden the scope to make the most impact? Institute Lecturer Lauren Morgan from the University of Oxford urged us to look at the 'real world', get out on the frontline and begin tackling the research/practice gap. In her talk 'A prescription of human factors for the NHS', she encouraged our profession to work alongside clinicians at all levels. She expressed her determination to see human factors lifted from its basic level in healthcare into the more impactful realms of intervention and safety. Delegate Barry Kirby agreed: "We can no longer simply carry on with 'business as usual', we must challenge current thinking," he said.

And human factors in practice was demonstrated with force with many inspirational case studies featuring the unique ways the discipline is changing lives. Small lobster boat fishermen are still hauling over 200 10kg lobster pots over the sides of their boats every day but Helen Vosper from Robert Gordon University shed light on the work her team has carried out to transform the lives, and musculoskeletal health, of these dedicated seafarers.

Dstl's Rachel van Besouw revealed her latest project on the frontline to assess armoured fighting vehicle headset functions. She demonstrated that with a human factors team embedded, small design considerations can make a huge impact on our military personnel. Individually fitted helmets in place of standard provision was just one area she felt could help save our soldiers' hearing, for example.

People power

A lively keynote from BT's Innovation Team's Dr Nicola Millard served as an inspirational and stark reminder that we really are 'people people' and we must tap into the emerging trends shaping the way we live. Talking about the death of the office and future of work, Nicola challenged us to think how we can help create a flexible, mobile, digital working environment that suits people's needs now and into the future.

Tweeting from the event, University of Nottingham's Professor Sarah Sharples commended the talk: "People want agility and flexibility from work. In work we need to communicate, contemplate, concentrate and collaborate. Open plan good for communication and collaboration, but need areas for contemplation and concentration."

Simulation and patient safety expert Andrew Buttery, added on Twitter: "From an EHF perspective why do we simply define humans at certain times as 'patients/service users'?" It's much more complicated than that.

Learning from peers

"We cannot afford to sit in a silo in healthcare," said Nottingham University Hospitals NHS Trust's Bryn Baxendale in conversation with NES (education and training body for NHS Scotland) Programme Director, Paul Bowie. They both agreed that we must find commonalities in our approaches across the sectors and work towards some key guiding principles for how human factors should look for all. The group agreed that the Institute would be a great central hub for this.

And learning from around the world was another key focus of this event as the Institute welcomed colleagues from the US Human Factors & Ergonomics Society and the International Ergonomics Association. Both bodies presented and shared their thoughts on the discipline in the USA and how we can better learn from each other as we move ahead.

Sharing innovation

Pushing boundaries and questioning design and methods is at the heart of human factors. Such innovation was shared across two days, both from an academic and a practitioner perspective. Ayse Crossland from the University of Nottingham, and the Human Factors Engineering team at Southampton University certainly opened minds as they discussed hot topics such as touch screens in vehicles, F1 interfaces and situational awareness in autonomous vehicle take-over requests. Challenging questions were posed over the ethics and safety of such modern technologies and further reinforced the need for human factors research pioneers in these areas.

Following the theme of innovation and driving our profession forward, this event saw the highest ever number of posters. Over 20 specialists took to the stage, covering a wide array of projects, from biometrics, artificial intelligence and smart motorways, to eco-driving, naval navigation and farming.

Wrapping up this year's conference and representing both the IEA and San Francisco State University, Dr Kathleen Mosier gave her insights into the future whereby 'decent work for all' is a critical area for human factors where we can make huge impact. "We must optimise integral concepts of performance and wellbeing," she said.

As echoed by our new President, human factors and ergonomics is never applied on its own, but it sits in a 'bigger box'; we work with others in a multi-disciplinary team. CIEHF Chief Executive Stephen Barraclough brought this topic to the fore as he gave delegates insights into the new 2020 strategy including 'The Future Human', reinforcing the vision that 'integrated design that helps people excel' is where our strengths lie.

Delegates enjoy an evening by the river at EHF2019

Left to right: Nicola Millard, Lauren Morgan, Kathleen Mosier

We really are 'people people'

Q&A

MEMBER PROFILE

Following her notable work on the Farringdon Crossrail project, **Lizzie Rawlinson** from Atkins talks to Lou Boulden about her early career as an ergonomist

Tell us about the Crossrail project

Crossrail is a new east-west railway under construction beneath London, comprising upgrades to 90km of existing surface railway and 21km of new twin bore tunnels along its route. The project includes construction of ten new stations in London and upgrades to 30 existing stations, one of which, Farringdon, will become one of the busiest in the UK, connecting with Thameslink and the London Underground to provide links with outer London, the home counties, the City, Canary Wharf and three of London's five airports. Atkins was appointed as the detailed designer to help Network Rail accommodate longer trains and increase passenger throughput. The company was also commissioned by London Underground, who owns Farringdon, to provide concept and detailed design for the associated station entrances and integrated ticket hall, as well as the concourses and platforms.

How did you find out about ergonomics?

I came across the discipline at secondary school within my design and technology GCSE class. I had an extremely inspiring teacher who introduced me to the term 'ergonomics' and set me a task for my final year project to design something with the user in mind. I decided to design a bespoke orthopaedic stool which enabled me to delve further into anthropometrics and human anatomy and apply it to the design of products in the best interest of people. Yes I know, very typical of me to design an 'ergonomic chair' but this project and the passion I attained from my teacher, lead me to an understanding of a brand new, exciting subject and my interest in sport and psychology made the Loughborough ergonomics degree seem like a natural fit!

How did it go at Loughborough?

Brilliantly! I enrolled on the ergonomics BSc course and opted to do an industrial placement year as part of my degree. I spent a year with DSTL, the Defence Science & Technology Laboratory, where I gained a diploma in professional studies and experience in applying both qualitative and quantitative methods of assessment across close combat systems with the British military. Having thoroughly enjoyed my placement year, I then searched for a career opportunity which would give me life experience across a range of different sectors.

What came next for you?

On graduating from Loughborough, I joined the human factors team at Atkins on their graduate scheme and have never looked back. Now a senior member of the team, I've gained a diverse range of skills working across multiple high-hazard industries including in oil and gas, nuclear, rail and aviation. I've been a member of the Atkins human factors team for five and a half years now, and I'm confidently skilled in engaging

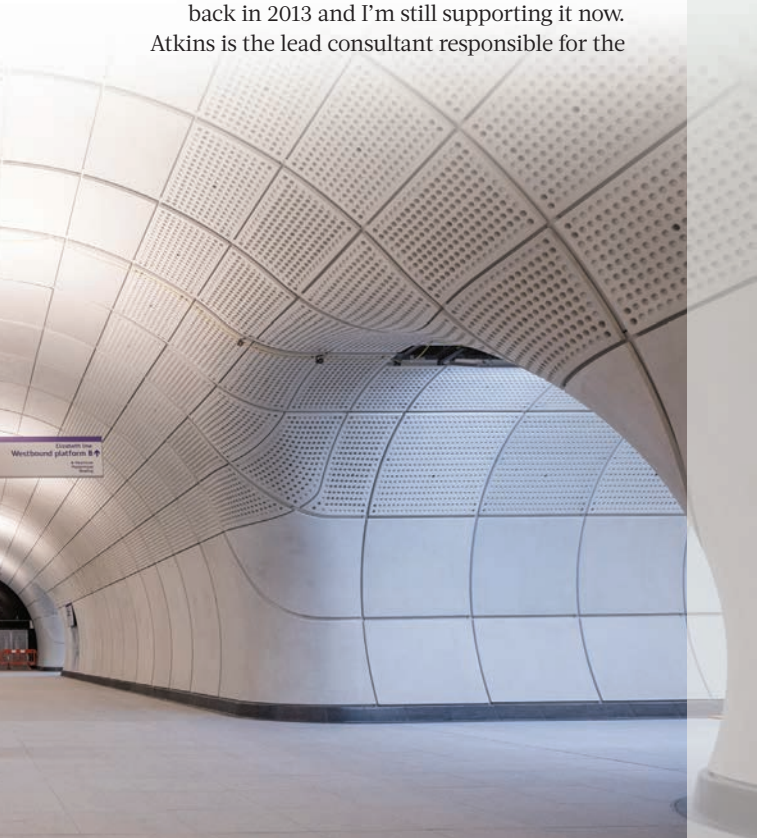
with stakeholders and developing solutions with multi-disciplined engineering design teams and architects to provide practical engineered and ergonomics design solutions. My broad expertise spans several oil and gas, aviation, Network Rail and London Underground projects from the concept design phase through to detailed design along with workload assessments, safety case studies and hazard identification methods. I gained Registered Membership of the CIEHF, together with Chartered status, in 2017.

What do you find attractive about the rail sector?

Atkins is a high hazard engineering company, and I'm fortunate enough within the human factors team to work across many different sectors. Being based in London, the rail and transportation sector is a hub of excitement. I use public transport, specifically rail, every day in order to get to work. I'm fully aware of how significant the design of such major transport systems are for the general public, not least for the enjoyment and contentment of people's commute. The rail sector is not just about the passengers who use the services of course, but those who work on the railway as well. I enjoy working with and solving problems for stakeholders in order to achieve an end goal of enhancing efficiency and productivity within the rail network.

Tell us about your award-winning project

The Farringdon Crossrail Station Upgrade Project was my very first project when I started at Atkins back in 2013 and I'm still supporting it now. Atkins is the lead consultant responsible for the completion of Production Information for all architecture, limited structural engineering, human factors, fire strategy, highway traffic and urban realm design for the redevelopment of Farringdon Station. The formal integration of human factors into the project ensures that a working environment is developed that's fit for purpose in normal, abnormal, degraded and emergency conditions.



Farringdon Station signage

I'm confident in engaging with stakeholders and developing solutions

The human factors integration into the design helps promote usability, operability and reliability, ultimately helping to reduce the associated risks to a level that's as low as reasonably practicable. I play a role liaising with architects and engineers to identify issues in the design which may have an impact on human interaction. This involves the identification and mitigation of issues detailed in a human factors issues log and a human factors engineering plan generation.

In the final design assurance meeting, the human factors contribution on Farringdon Station was held up by the Crossrail Chief Engineer as an exemplar of engineering assurance for the whole of the Crossrail project, and described as 'best in class'. It was amazing to then win the CIEHF's Best Early Career Professional award for this work too!

My next steps for this project, are literally to walk around the Farringdon Crossrail Station as a passenger when it opens and to admire all the hard work of the team!

What advice do you have for aspiring ergonomists?

My first piece of advice would be don't be afraid to ask questions. How else are we supposed to design something which is usable, accessible and practical for the user, if we don't have the courage to ask questions? My second piece of advice would be to explore as many different applications of human factors as possible. Go to the CIEHF Ergonomics & Human Factors annual conference – it's a joy to have your eyes opened to the many different career avenues ergonomics and human factors can provide. I personally enjoy the engineering and transportation sector, but don't stop exploring until you find what you love.

My third and final piece of advice would be to practise your elevator pitch because we don't just design chairs!

Lizzie Rawlinson is a Senior Human Factors Consultant at Atkins. She was presented with the CIEHF's Hywel Murrell Award for Best Early Career Professional by CIEHF President, Bob Bridger.

REGIONAL NEWS

SOUTHERN

Safety in healthcare

All human factors processes, methods and tools are readily transferable across domains and it was particularly rewarding to see the Human Factors Integration endeavours being applied in the healthcare domain described at a Southern Regional Group event on 22 March in Winchester. Laura Pickup, LP Human Factors Ltd provided an overview of the CIEHF Human Factors for Health and Social Care White Paper. She outlined several personal anecdotal experiences of errors being made due to lack of understanding of procedures, poor communication, poor user interface design and poor workspace design.

Saskia Revell and Paul Davis provided an overview of the Healthcare Safety Investigation Branch which began operating on 1 April 2017. They outlined the rationale that determines which cases to investigate in terms of the outcome impact (serious personal risks and/or impact on delivery of healthcare), systemic risk (common or widespread) and learning potential (potential to lead to positive changes and improvements). As with the other accident investigation branches a no-blame culture is adopted and they are provided with full access to the information. Their reports, which are available on their website at www.hsib.org.uk, provide safety guidance to the relevant regulators and NHS Trust personnel.

Dr Janet Anderson, Reader in Healthcare Improvement at Kings College London, presented the findings of research investigating the adequacy of learning from investigations of Never Events. A series of root cause analysis reports of Never Events was analysed and the potential of Safety II principles for deepening understanding of the causes and the design of effective interventions was explored. The importance of understanding how the work system context for understanding and learning was stressed. The regulatory pressures on hospitals to complete investigations in a short time and using accepted templates may contribute to the limited effectiveness of the process.

There were 18 delegates from a range of NHS Trusts across the south of England and this led to the opportunity for significant discussion throughout the afternoon. It also provided excellent networking opportunities for all the practitioners present.

CIEHF events at a glance

Eligible for CPD Lifelong Learning

For more details of all CIEHF events, see our website at **events.ergonomics.org.uk**

EVENT	WHEN & WHERE	DETAILS
Transport and Mobility	Thu, 22 August 2019, Crowthorne	Southern Regional Group event featuring presentations of TRL's projects and a tour of their impressive simulation facilities.
Designing for People	Wed, 9 October 2019, London	How inclusive design can be used to design better products & services for the widest range of human capabilities at a sensory, cognitive and physical level.
Medical Packaging and Labelling	Wed, 23 October 2019, Birmingham	Your chance to work collectively to understand and make recommendations for the future labelling and packaging of medicines and medical products.
Careers Day	Wed, 26 February 2020, Birmingham	Featuring the very best of careers insights, advice and inspiration from those already at work and from companies looking for new talent.

Please note that some events details may be subject to change after publication. Please check the events website for up-to-date information.

IMAGE: ISTOCK

New guidance for work modifications

The CIEHF is an active member of the Council for Work and Health (CWH), a representative body for more than 40 professional organisations involved in work and its relationship to work. The CWH was commissioned by the Government's Work and Health Unit, as one of a number of key initiatives to support the Improving Lives policy intent, to enable more people with illness or disability to remain in, or to be able to access, work.

New guidance for work modifications, called Talking Work, was developed starting with a comprehensive literature review, supported by a consultation workshop and then, through a number of iterations of development, responding to feedback from CWH members and other stakeholders. During January and February, a formal evaluation took place, and a final version of the resource was developed, which we revealed at this year's Health & Wellbeing event at the NEC, where it received strong positive feedback.

Many people, including CIEHF members, actively contributed to this complex project. With many differing needs, a tool was developed that provides generic guidance and which, whilst primarily aiming to support doctors talking to patients, can also be used by patients, employers and other healthcare practitioners to encourage consideration of work options. The tool contains some simple case studies and a list of links to other specialist support resources.

The resource is freely accessible and downloadable on the CWH website without restriction and can be reached on any smart device, PC or tablet, via a browser connection.

The process of development and the outcome of this project reflects well the purpose of CWH – to enable diverse professionals, with experience, interest and expertise in health and work, to collaborate to produce consensus advice.

See **www.councilforworkandhealth.org.uk/work-modifications** ●

Award for students

A cash prize is available both for a student and their mentor as part of an award for an ergonomics project. The Dieter W Jahns Student Practitioner Award recognises educational activities that demonstrate how professional ergonomists serve to make our lives at work and at home better. Deadline: 30 June. For all details, go to http://bit.ly/DWJaward. ●

Gateway opens

Access our new comprehensive research gateway that lets you perform highly-targeted searches on curated full-text information including journals, business magazines and trade publications from top publishers, plus critical news content. Available now as part of your current membership package, just go to MyCIEHF > My Journals. ●

Transport and mobility

The next Southern Regional Group event will take place at the head office of TRL in Crowthorne on 22 August 2019. TRL is a global centre for innovation in transport and mobility. Learn about their past and current projects and see their impressive simulation facilities. A networking lunch and refreshments will be provided. The event will finish with time for questions and discussions about TRL's work. ●

Winners revealed

A warm welcome to the Institute's new President, Bob Bridger, who was elected at our recent AGM. Also elected was our new President Elect, Amanda Widdowson, together with new Trustees on Council, Barry Kirby, Barbara Haward and Jon Berman, and new members of our Professional Affairs Board, Roy Cochran-Patel, Karen Priestman, Katharine Metters and Paul Clark. Find out more about them all and their hopes for their coming term on our website at www.ergonomics.org.uk > About us > Governance.

Our award winners

The winners of CIEHF awards 2019 were revealed at our recent Ergonomics & Human Factors conference in Stratford-upon-Avon.

- The President's Award for a group for significant and original research, development and application of ergonomics: **The Human Factors Department, BAE Systems Submarines**
- The Sir Frederic Bartlett Award for an individual for significant and original research, development and application of ergonomics: **Sue Hignett**
- The William Floyd Award for innovative contributions to ergonomics: **Paul Salmon, Gemma Read, Michael Lenné, Thomas Triggs & Neville Stanton**
- The Ulf Aberg Award for best postgraduate project: **Tassilo Bouwman**
- The Hywel Murrell Award for best early career professional: **Lizzie Rawlinson**
- The Paul Branton Award for outstanding service to the CIEHF: **Rebecca Charles**
- The Richard Clive Holman Award for effective communications: **Thomas Jun, Roger Haslam & Patrick Waterson**

More information about each of the awards, the winners and their work can be found on the awards pages of the CIEHF website. Congratulations to all!

IMAGE: GETTY / SHUTTERSTOCK

MTM - EAWS

Ergonomic Assessment Work Sheet

The need to identify the degree of exposition to biomechanical load has led at the beginning of the new millennium to the development of specific ergonomic risk screening tools; the aim of these tools is to analyse the risk factors that may lead to overload the operator and eventually to occupational diseases. As always, the final goal is the redesign of the work system so that the any risk can be minimized and the performance eased.

The basis of every ergonomic risk screening tool is to estimate the correlation between the task ergonomic characteristics (force, frequency, postures, etc.) and the probability to cause an occupational disease. The main difficulty is to establish how the different factors interact and lead to work related troubles or diseases.

For a quantitative ergonomic risk evaluation of a specific working sequence, generally two evaluation levels are used:

- First level tools: risk screening tools which require a quick checklist.
- Second level tools: risk evaluation tools which require a detailed analysis with index calculations. They are applied where a possible risk has been already detected by a 1st level system and the “risk generator” is not yet well identified.

The correct use of EAWS will provide the following:

0 -25 Points	**Green**	Low risk: recommended; no action needed
> 25 - 50 Points	**Yellow**	Possible risk: not recommended; redesign if possible, otherwise take other measures to control risk
> 50 Points	**Red**	High risk: to be avoided; action to lower the risk is necessary

For more information visit www.ukmtm.co.uk
Our International Partners are the IMD (International MTM Directorate)
And are found at mtm-international.org



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CONTENTS

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NEWS AND CURRENT AFFAIRS

APPLIED ERGONOMICS AND HUMAN FACTORS

COVER IMAGE: NIGEL MILLARD

RESEARCH MATTERS

CIEHF NEWS

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FROM THE PRESIDENT

Times to be remembered

Bob Bridger
CIEHF President

president@ergonomics.org.uk

These are interesting times for the Institute. The new strategic plan for the next five years is nearing completion and has stimulated a great deal of debate, both in the Strategy Working Group and at the Executive and Council meetings. The plan is outward looking and is focused on growth, both in income and in membership. Whilst there are clear opportunities here, particularly in sectors such as healthcare, where the appetite for human factors is growing, there are also challenges.

I was fortunate to spend three years as General Treasurer from 2013 to 2016 when I worked with our Chief Executive, Steve Barraclough, to renegotiate our royalty agreements with our publishers. We did our best and increased annual royalty income significantly, taking financial pressure off event organisers to name but one advantage. With the move by publishers to open access publishing the effect on future royalties is still very much an 'unknown unknown'. Prudence demands that we explore alternatives for ensuring the Institute's financial resilience and the means to do so are currently under discussion. Fortunately, Jon Berman has stepped forward into the role of General Treasurer and is already giving wise counsel.

At the same time, we are saying goodbye to Steve who has come to the end of his five-year term. I speak for all on Council in thanking him for his sterling efforts in modernising the Institute's operations and improving our financial resilience.

Prudence demands that we explore alternatives for ensuring the Institute's financial resilience

FROM THE EDITOR

Holiday reading

Summer is the time when many of us enjoy time by the coast but spare a thought for those whose job it is to protect us from dangers at sea. Our cover article examines the work of our amazing RNLI volunteers and Sarah Weedon's role in applying human factors to help keep them safe. If you're holidaying further afield in Greece this year, read Dimitris Nathanael's account of the encouraging state of ergonomics in the country, as it slowly recovers from its economic crisis.

Also at sea, but in another capacity, are offshore oil & gas workers who have a particular view of training as a risk reducer, as explained in an opinion piece by Scott Moffat. Risk reduction is also the subject of two other articles. The issue of low workload is discussed by Shirley Brennen, regarding attempts to recover situation awareness and make critical decisions. Michael Paton describes the HSE's award for reduction of risk for musculoskeletal disorders and the latest winning project in construction.

In the online world, Amanda Widdowson looks at cyberthreat from those within organisations, while Paul Salmon explains the little-known 'dark net' and how human factors can be used to help investigate and interrupt illicit activity.

Back out in the sunshine again, Dan Jenkins and Lisa Baker tell us how effective and rewarding truly inclusive design can be. They explain that designing to accommodate as diverse a range of people as possible also makes great business sense.

Enjoy the rest of the summer!

Tina Worthy
editor@ergonomics.org.uk
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With substantial reforms in the labour market, public administration and the structure of public spending, the Greek economy is slowly recovering. Alongside, the demand for ergonomics is also steadily rising, as **Dimitris Nathanael** explains

An ergonomics perspective from Greece

Greece and its islands are home to over 11 million people and the country currently has the seventeenth largest economy in the European Union. The service sector, largely in tourism, accounts for 80% of the economy, with the rest coming from industry (16%) and agriculture (4%).

Although ergonomics in Greece has a rather short history, during the last decade there has been significant progress on several fronts. It all started in 1988, when the country's few qualified ergonomists (there were less than ten of them at the time) set up the Hellenic Ergonomics Society (HES). Fast-forward to today, and ergonomics awareness and best practice is growing steadily. Now taught at university level, an increasing bank of research is being commissioned and carried out by a rising number of passionate ergonomists.

Located in the capital city of Athens, HES' aims are to develop and promote ergonomics through the cooperation, exchange of knowledge, methods and experience between ergonomists and other scientists. These professionals may specialise in human-centred design, production and use of machines, displays and production systems.

Most of HES' 43 active full members are engineers, others are work physiologists, occupational physicians and scientists in related fields. HES is a member of the Federation of European Ergonomics Societies and the Centre for Registration of European Ergonomists, and has five qualified European Ergonomists.

Research across the sectors

Ergonomics is taught in Greece at university level as a distinct subject at several academic establishments. These include the National Technical University of Athens, the Technical University of Crete, the University of the Aegean, the University of Piraeus and the University of Patras, at all of which students may also select ergonomics as a diploma dissertation topic. Ergonomics is also taught as a compulsory course at the National School of Public Health and at various physiotherapy departments across the country.

At present there are no dedicated graduate or undergraduate courses leading to a diploma in ergonomics, although students may specialise in ergonomics by obtaining a research doctorate, and currently there are ten postgraduate students preparing a PhD in fields related to ergonomics. Teaching ergonomics in schools of engineering also now equips future engineers with a solid understanding of the value of ergonomics and how to apply ergonomics principles or seek expert advice whenever a need arises.

There are currently three university laboratories active in ergonomics research, with several studies funded by the European Union and/or the Greek state. Research is actively being conducted in aviation, industrial safety, complex sociotechnical systems, driving behaviour/autonomous vehicles and intervention methodologies.

Legislation drives interventions

Practicing ergonomists in Greece mostly work in occupational safety and health employed in prevention and protection services though practitioners are also involved in specification and design of industrial retail and office workstations. Ergonomics in product design is far less developed with only intermittent demand for expert consulting.

National legislation includes several ergonomics requirements, in accordance with EU directives. These include legislation concerning the minimum requirements for manual handling of loads, work with visual display units, use of work equipment, personal protective equipment and the framework law. This law explicitly states that employers have a duty to adapt work to the individual including the workstation, the work equipment and the

methods of work and production. These provisions help practitioners in applying fundamental ergonomic principles through the provision of occupational safety and health services to enterprises.

Ergonomics interventions are conducted by consultancies and university laboratories mainly targeted at redesign of workstations in industry, in logistics centres and in retail. A recent example is the redesign and implementation of a new tram drivers' workstation at Athens Tram. Other project examples include a redesign of a major telecommunications company's furniture in its retail shops, a lighting redesign project to improve visual inspection tasks for staff at a white appliances' factory and gas cylinder handling reconfiguration at a central gas filling facility.

Besides asking for typical ergonomics and musculoskeletal health training for office workers, many companies now opt for personalised assessment of each office workstation where ergonomists assess each worker's needs and musculoskeletal issues, reconfigure each workstation and adjust and advise on equipment needs. This type of intervention has proven quite robust, with measurable improvements in workers' musculoskeletal health in more than 30 companies so far and demand from organisations is rising steadily.

Promoting ergonomics benefits

General awareness about the benefits of ergonomics, as well as the development of ergonomics best practice, is being advanced through various initiatives undertaken by HES. These include:

- Organisation of national ergonomics one day conferences every few years, where applied interventions and applied research work are presented. These events give the opportunity for the local community to share its work among members and with a wider audience. Typically, these events attract 80 to 100 participants and recent events have been dedicated to user experience and ergonomics in product design.
- Participation in the technical committee of the Greek Standardisation Organisation dedicated to occupational safety and health, providing expert advice on ergonomics issues.
- Publication of articles written by the society's members in the technical and general press concerning contemporary and local issues. Recent topics include driver safety, motorcycle delivery services (an issue of great concern in Greece), ergonomics for schoolchildren and lighting in office and industrial spaces.
- Organisation of 'Usability Days' events every year in association with the Greek chapter of the ACM Computer Human Interaction interest group and establishment of a public domain usability observatory. This initiative aims specifically at lobbying the wider public sector and at raising public awareness of the need to consider sound user-centred design principles and methods in the procurement of IT systems intended for workers and the general public.
- Organising students' dissertation project presentations to HES members; the most recent of these events took place in November 2018, with participation from country representatives from throughout Europe.

Besides HES's initiatives, the Hellenic Institute for Occupational Health and Safety (a Social Partners institution) through its ergonomics unit conducts industry audits, short training courses and dissemination of information to social partners and the public through leaflets and campaigns.

Although significant progress has been made in recent years involving education and public awareness, there is still a way to go to see satisfactory demand for ergonomics interventions, both from the private and the public sector, but there's no shortage of enthusiasm from the country's ergonomics researchers and practitioners, and this, together with the hard work of the HES, will undoubtedly bring reward.

Dimitris Nathanael is President of the Hellenic Ergonomics Society and Assistant Professor of Ergonomics in the School of Mechanical Engineering at the National Technical University of Athens.

Female statues called caryatids in the Erechtheum at the sacred rock of the acropolis of Athens

IMAGE: ISTOCK

OPINION

Changing work patterns

As energy companies seek to improve human performance, **Scott Moffat** tries to understand apparently misplaced perceptions about the value of non-technical skills training for oil and gas workers once the pressure of extended time offshore is reduced

Operational efficiency is top of the boardroom agenda in many sectors, and arguably nowhere more so than in oil and gas, as leaders balance heightened operational costs and lower financial returns. As oil prices fluctuate and with it the fortunes of the organisations involved, one of the more controllable aspects of the industry should be human performance, made better by embedding human factors knowledge and practice into operations.

So I was surprised to hear a delegate in my recent non-technical skills training course challenge this by saying that there was no further need for this type of training. Delving deeper, it seemed the observation was fuelled by a rumour that the UK North Sea offshore workers would soon be changing their work rotation patterns from three weeks offshore / three weeks onshore, or 3/3, to two weeks offshore / three weeks onshore, or 2/3. This is regarded as the 'easier' option as it means a shorter run of continuous days working and more time at home with families.

The 3/3 rotation was adopted to deal with the global oil price crash. Fewer staff changeovers can increase efficiency and save transport costs, so many of the industry's giants adopt this approach. But just last year the repercussions of this were being felt, as numerous North Sea platforms faced strikes over plans to have workers continue to spend more days offshore.

So why do oil and gas workers believe that human factors training only applies to the more pressured rotation patterns and not as best practice at any time?

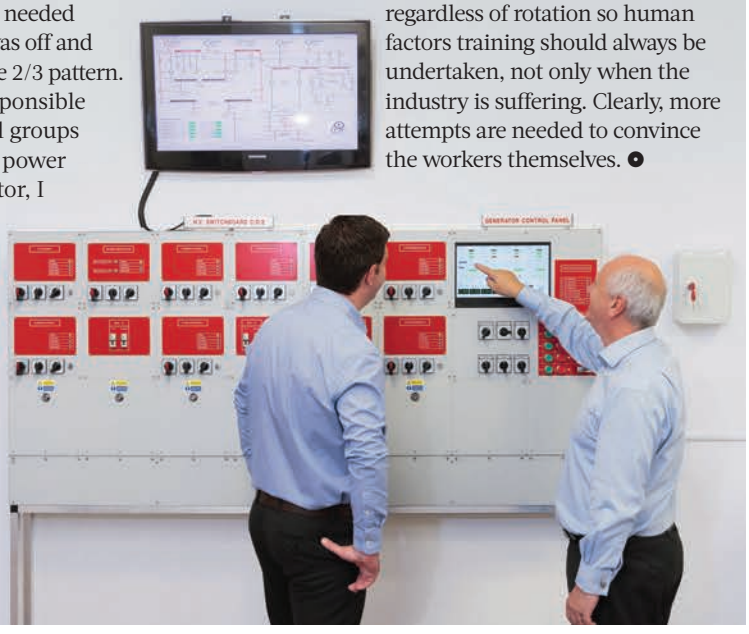
Talking to delegates on the course, they explained that the increased stress and pressure they've been under for the last couple of years when the oil price has been low, combined with job and pay cuts leading to running on skeleton crews, is exacerbated by working a 3/3 rotation. They felt that human factors and non-technical skills training wasn't needed when the pressure was off and they went back to the 2/3 pattern.

Observing 73 Responsible Electrical Personnel groups in our high-fidelity power distribution simulator, I obtained the most data focusing on the 2/3 rotation. Now the errors which were made back then are the same errors that are still being made today in the 3/3 rotation. This strongly indicates that regardless of the type of rotation workers are operating within, they still require non-technical skills training.

While workers might perceive this training to be more important at times of increased stress and pressure on the 3/3 pattern, if you have a basic understanding of the human factors concepts when times are 'good', then in my opinion, when times become harder these skills will become part of your conscious working lives and will better equip you to work safely and effectively.

I related this to all the simulations I've observed at our premises. When there is no stress or pressure in the simulator, some of the groups are successful, although some were, in my opinion, extremely lucky. When the situation changes and the stress increases, their 'luck' tends to run out and they don't perform well in the simulation. Moreover, when there is no stress or pressure in the simulator and the group are not doing well, a situation change that can occur suddenly offshore can turn their performance from bad to worse in the blink of an eye. For example, those who have had no prior training in communication can talk and sometimes listen to each other. But when the group are faced with an unfamiliar and stressful situation, their communications, including listening, will break down or stop altogether and then the group is in big trouble.

Working offshore is stressful and tiring regardless of rotation so human factors training should always be undertaken, not only when the industry is suffering. Clearly, more attempts are needed to convince the workers themselves.



Training session in PFC's high-fidelity Power Distribution Simulator

Scott Moffat is a human factors specialist at People Factor Consultants, who provide technical and non-technical safety training, which includes practice in their high-fidelity Power Distribution Simulator.

Increasing city resilience

With an estimated three million people moving to cities each week worldwide, the need to build resilience within our urban spaces has never been more important. BSI has published a new British Standard, BS 67000 City Resilience, to preserve the health and wellbeing of cities in the face of rapid urban expansion, climate change or disruptive events such as pandemics. It would allow our cities to enhance their ability to absorb and adapt in a changing environment. Such resilience will minimise the disruptive and deflating effect of shocks and stresses on city strategy and future direction.

All parts of this standard, in some way, have been applied in cities somewhere in the world, and are captured within a framework that provides a path to future city resilience evolution. That framework supports:

- Consistency in the language used within and between organisations.
- A reliable process to steer users through activities and interactions.
- A truly interoperable system so that resilient approaches can be developed incrementally, taking city scale and bespoke needs into account.
- The ability to share best practice and approaches to common issues.
- More agile planning, systems resilience and performance measures.
- A set of guidance documents that fit together to make the picture progressively coherent.

Anne Hayes, Director of Sectors at BSI, said: "The potential cost and risk around not building resilience into our cities is concerning. As the impact following shocks, disasters or even social tension and disruption could devastate a city, its ability to recover will not be through luck and hope but by proper continuity preparation and its agility to respond. This standard supports those responsible to advise and guide them through the various scenarios from preparation to aftermath, to tackle future challenges and exploit opportunities."
For more details, go to **https://shop.bsigroup.com** and search for 'BS 67000 City Resilience'.

Exoskeleton vest test

Spring-loaded upper body exoskeletons are being trialled by a company to help with lifting and handling activities. Morrison Utility Services are using the vests to support workers in loading and unloading heavy roadwork equipment from vehicles. The company hopes to see significant safety, health and wellbeing benefits for those carrying out physically demanding, repetitive activities over long periods of time.
For more details, visit **www.shponline.co.uk/technology-2/utility-workers-to-test-exoskeleton-vests/**.

IMAGES: SHUTTERSTOCK / ISTOCK

Modelling motion

Motion sickness can occur when conflicting signals are sent to your brain such as when your eyes are focused on something that's not moving but your inner ear senses motion, for example, as a car passenger reading a book. This can result from harsh braking or accelerating, and cornering.

But with autonomous vehicles on the horizon, more passengers could be tempted to use the travel time to read or watch a film, and with this in mind, researchers from Cranfield University have worked out a formula that may reduce the effects of motion sickness. Results are being validated in high-fidelity simulations using models of the human vestibular system. The formula considers the road profile of a journey while the driving algorithm, based on a mathematical model of motion sickness, works out the optimal steering and acceleration to mimic human driving behaviour, apparently reducing the chances of passengers feeling car sick.
For more details, visit **http://bit.ly/2Yjenpq**

Using electricity as fuel

An EPSRC-funded research network, called Decarbonising Transport through Electrification (DTE), is being created in the UK to tackle the challenges of electrifying the transport system, including its impact on the National Grid.

The Engineer reports the network will consider the use of electricity as fuel across integrated systems involving automotive, aviation and rail. It will cover vehicle technologies, charging infrastructure and energy systems. The researchers will also carry out large-scale data analysis and human factors studies to support the project.

Organisations involved in the project include the National Grid, Transport for London, Transport for Wales, Aston Martin, aerospace researchers from Cranfield and Bristol Universities, and rail specialists from Birmingham and Southampton Universities.
For more details, visit **http://bit.ly/electrifyall**

Ergonomics & Human Factors 2020

27-29 April 2020 • Stratford-upon-Avon

Chartered Institute of Ergonomics & Human Factors

Call for submissions

Themes

This flagship event showcases the latest in research and application across all sectors. We are looking for submissions covering, but not limited to, these themes:

- The 'Augmented Human' including use of robots, exoskeletons, wearable IT
- Autonomous vehicles
- New forms of transport
- Productivity and rewarding work
- Wellness at work
- Ability, partial ability and disability
- Technology and ethics
- Cyber psychology, security and impact on social media
- Healthy ageing
- Future learning environments
- Ecological and environmental issues
- Change management

Submit your work between 1 September and 1 November 2019

Social events...

will include an informal BBQ, and the annual dinner with awards ceremony

Masterclasses

We are inviting proposals for Masterclasses, in particular about tools and techniques, such as:

- Risk assessment
- Human reliability
- HF integration
- Accident investigation techniques
- Task analysis
- Training needs analysis

Find out more on our website

LEARN. MEET. DISCUSS. BE INSPIRED.

events.ergonomics.org.uk

CHIEF EXECUTIVE'S PERSPECTIVE

Five years on

The past five years in context: my pressing contribution on becoming Chief Executive in October 2014 was probably little different to the challenge faced by incoming CEs the world over: that of balancing the books. By the end of December, finances were in ruder health and we recorded a small loss. But things could have been rather different. In the absence of an atypical contribution of a surplus of almost £70k from an oil and gas event in Aberdeen in the fourth quarter (a contribution from an Institute event never since equalled, nor likely to be) and the impact of an unbudgeted new database of over £50k, then your Institute could have faced a year-end deficit of over £100k in 2014, something which would have left the future less certain, perhaps impairing our capability without a draw on reserve. Indeed, our reserve today remains almost exactly as it was five years ago.

Micro-charities need to thrive rather than simply survive in order to inspire and enthuse the public because many future members are to be found there. Five years on and there has been good progress. Income from memberships has grown in each of the last four years, and with some determination this should continue, with income potentially topping £200k for the very first time by year end. This has been achieved without undue increases in subscription fees, indeed no increase at all in one year. Today, 40% of income comes from individual subscriptions - average for peer bodies of our size.

Another income stream, royalties from two ergonomics journals, was doubled in 2016. This stream accounts for about 30% of total income today, and currently one on which trustees must keep a very careful eye. The growing desire for open access to information could radically undermine this revenue, and I believe it is not an overstatement that the current envisaged changes in Europe in how content is commercialised could absolutely affect the Institute in the future. For this reason, I recommended to trustees at the end of last year that one of them be appointed to support your incoming CE in monitoring and ameliorating the march of open access, and that your new strategy focus very clearly on other income generation over the next five years. This is not just desirable but plainly essential.

The events we run each year make up 20% of the remaining 30% of our income. Events were successfully transformed in 2015 from being pivotal to annual income to being contributors of income but future events will need to be increasingly commercial in nature if we are, across the board, to bring in new revenue to compensate for lost income in future. That is where our strategy for the next five years is so key to the Institute's future, about which you will be hearing once Council has met in September.

On other fronts, the CPD system has been modernised, and new avenues for Technical Membership have been introduced, working with partners to do so. Staff costs have been reduced to allow more funding for professional PR representation. We have a project pot that has increased ten-fold, with more funds also made available to our Regional and Sector Groups. We have delivered a redesigned, reinvigorated member magazine, the envy of many peer societies, working with an industry-leading publishing partner and added a digital catch-up, Spotlight, between issues. We have held the costs of meetings, at the same time improving the location of venues we use and the all-important catering we offer. We have held the costs of accommodation that we work in, at the same time re-locating to brighter, better-located premises and consolidating a work-from-where-you-are partner model which has enabled us to attract high grade talent to better support you. And we have met the not insignificant challenge of safeguarding and handling data, ushered in by the General Data Protection Regulations, taking the opportunity to overhaul, separate and securely shred a mass of paper application records from the last century, in parallel establishing a secure and separate archive of valuable historic material about the Institute. We introduced market-leading cloud-based administration, communication and member engagement systems that have enabled routine remote working and reduced many of the risks that we faced previously by operating servers sitting right under our desks at a single fixed location.

I wish the Institute every success as it continues to punch above its weight

Much to be proud about. As I leave, I wish the Institute every success as it aims high with its strategy to continue to move ahead and to continue to punch above its weight.

Steve Barraclough
Chief Executive of the CIEHF
s.barraclough@ergonomics.org.uk

IMAGE: ISTOCK

How people affect cyber security

Reports suggest that the majority of cyber security incidents are caused by employees. So how do we stop them? **Amanda Widdowson** presents nine factors that can be addressed to reduce the risk of insider threat

Our critical national infrastructure is constantly under attack from cyber criminals. At the time of writing, the UK is under severe threat from international terrorism; an attack is highly likely. Hostile cyber-attacks are expected from foreign states, 'hacktivists' and terrorists. A successful attack could disable our energy supply, transport and communications networks. The UK Government has responded with significant investment, including the launch of the National Cyber Security Centre in 2017.

So where does human factors fit in? Insider threat, or the human element, reportedly accounts for many cyber security incidents. Failure to consider the human element in a cyber security control system is like installing window locks throughout your house but leaving your front door wide open.

The majority of insider threat incidents are unintentional, so a focus on the motivations of a malicious attack would be insufficient. We also need to understand non-malicious human limitations and causes of cyber security incidents. Nine factors have been tried-and-tested to reduce insider threat.

1 Policy and procedures

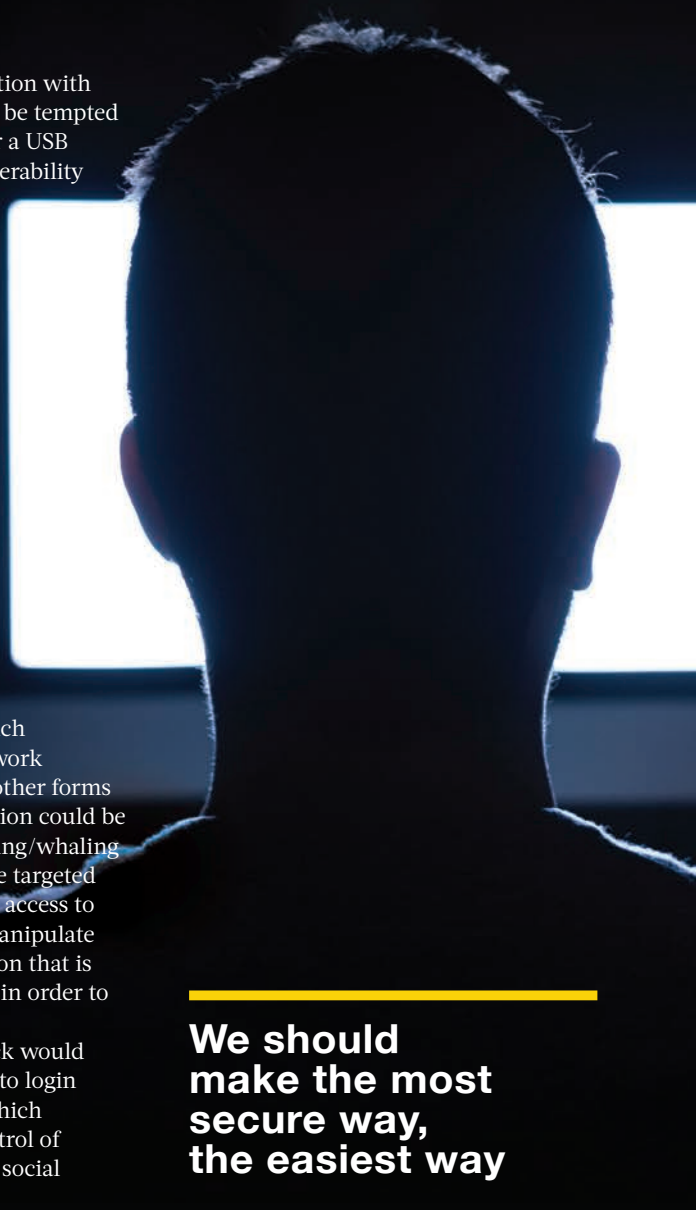
If cyber security policy is too strict, people will find workarounds. For example, if security procedures make it too difficult to share information with third parties, employees may be tempted to use their personal email or a USB device, thereby creating vulnerability and rendering the technical controls redundant.

Rather than punish this behaviour, we should accept it as 'human nature' and make the most secure way, the easiest way. In order to do this, we need to design policy and procedures around people's jobs. This means talking to them and really understanding how the procedures will affect their work.

2 Information sharing and data protection

Employees may share too much information about sensitive work projects on chat groups and other forms of social media. The information could be used to facilitate spear phishing/whaling attacks, where individuals are targeted because of their position and access to information. These attacks manipulate context bias, using information that is relevant to the target's work, in order to appear more genuine.

A successful phishing attack would likely give an attacker access to login and password information which could allow them to take control of services. Employees who use social



We should make the most secure way, the easiest way

media as a platform to complain about their employer could make themselves attractive targets for a social engineering attack. Here, a malicious outsider would persuade them to leak information about their employer. We can address these vulnerabilities by monitoring and open source intelligence surveys.

3 Culture

One of the most important factors to determine an organisation's cyber security culture, is whether managers 'walk the talk'. It's not enough to tell people to follow cyber security procedures; it's also necessary to be observed to follow them.

If the perceived message is "job performance and productivity are more important than cyber security", cyber security policy will be undermined. Reward mechanisms need to address cyber security behaviours as well as productivity.

Assessments identified a tendency for employees to trust their IT department to protect them from a cyber-attack. This allows them to absolve themselves of responsibility. In a mature culture, all individuals have ownership of cyber security. Employee engagement surveys can be adapted to identify cyber security culture and engagement. These work best when combined with interviews and/or focus groups in an organisational transformation programme.

4 Physical environment

Networks and sensitive information can be compromised by unauthorised access to the physical working environment. The tendency to hold doors open for others is a human vulnerability here. It can be mitigated by automatic turnstiles and/or intermittent presence of uniformed security personnel at entry points.

If employees are used to seeing people they don't know in their working environment, they are less likely to challenge an attacker who has gained unauthorised entry. Good visitor management policy can address this. Visitors should be obvious to employees, for example, by the badge they are assigned.

IMAGE: ISTOCK

Once inside a building, an attacker may be able to gain information from printers, desks and unlocked computers. This can be mitigated by good housekeeping and encouraging employees to lock their computers when they leave their desks.

The implications of mobile, remote and lone working also need to be considered. Encryption techniques and information storage can mitigate risks.

5 Job design

Job factors can affect vulnerability. For example, frequent time pressure could affect susceptibility to phishing emails. As well as email management advice, the reliance on email as a means of communication could be challenged.

Poor design of equipment and software can increase the risk of error, in particular for information security personnel, so ergonomic design principles are important.

In accordance with good data protection practice, sensitive information should be separated so that individuals only have access to the information they need to do their work. Jobs should be assessed to identify any cyber security workarounds and associated actions.

6 User authentication

A common cyber security policy violation is writing down passwords or storing them in a mobile phone. We all have multiple passwords to remember in our personal and professional lives. It is simply beyond human memory capacity to recall that many different, complex passwords. Whilst this is a deliberate policy violation, it is not usually malicious. A cyber security policy which requires users to remember complex, automatically generated passwords, which frequently change, is vulnerable. Therefore, password safes or alternative means of user authentication, such as biometrics (for example, facial or fingerprint recognition) are advisable.

7 Education and awareness

Cyber security training programmes need to convey vulnerabilities specific to the target audience, to convince them attacks don't just happen to other people. Phishing email recognition and visitor management should be included. An organisation should be able to measure how many employees have received cyber security training and understand their level of competence. The competence of information security personnel should also be assessed and monitored.

8 Individual factors

A successful cyber-attack could start with one employee, so we need to consider individual factors. Certain personality types are more vulnerable; someone with a high degree of social compliance might be more likely to share passwords or hold doors open. An individual's sense of duty affects how well they are likely to follow cyber security procedures. Existing personality tests are often used as part of recruitment but they could also be used to profile cyber security-related facets.

An individual's emotional state is likely to change over time. After recruitment, they may incur personal or job-related circumstances that increase their desire to support a malicious attack or information leak. Assessment of engagement and support mechanisms is important to determine the level of this type of risk.

9 Incident management

Cyber security incidents and near misses should be captured and identified lessons put into practice. Best practice would ensure these nine factors are considered as part of each investigation. Human factors professionals can support this. The investigation should avoid blame and consider mitigating factors such as those described above – training is not the only solution.

With these nine considerations, we can better frame the insider threat to organisations and ensure that the unintentional, as well as malicious activity, is managed effectively.

Amanda Widdowson is President Elect of CIEHF and Human Factors Capability Lead for Thales Cyber & Consulting.

Inclusive design is often confused with designing for people with disabilities; true inclusive design is much more than this. It's about designing for as diverse a range of people as possible. It's a philosophy that encourages us to consider how size, shape, age, gender, sexuality, ethnicity, education levels, income, spoken languages, culture and customs, and even diets, shape the way we interact with the world. More importantly, it's about designing products and services that take all this into account.

Not long ago, the term 'inclusive design' did not exist. There was also a view among many that one-size fitted all and designing for the 'average man' was enough. Today, we're still surrounded by products that only work well for a limited range of people. Some are hard to use if your hands are small or you have limited strength or dexterity. Others don't fit because of the shape of your nose or your torso, others are biased toward those who speak a certain language or follow certain customs.

Designing for diversity

With the increasing recognition that no-one is truly 'average', the focus is now on inclusive design. It's not easy, but the rewards of getting this right are far greater than most realise, as **Dan Jenkins** and **Lisa Baker** explain

It's not always clear why apparently well-designed products exclude people. Often, it's a perceived efficiency-thoroughness trade off; a variant of the 80:20 rule, that crudely suggests that you can get it right for 80% of the people for 20% of the effort. Often, it's simply that designers haven't thought enough about the diversity of the people interacting with the product, a view frequently driven by company culture.

The exclusion zone

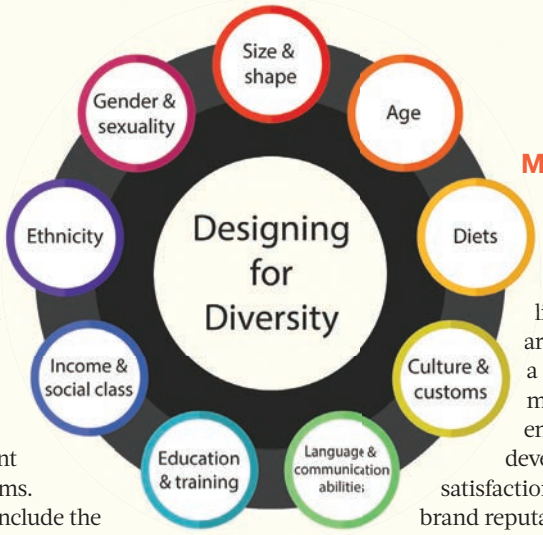
Often, the number of excluded people is dramatically underestimated. Capabilities are frequently considered in binary terms. For example, you can either see or you can't, or you can hear or you can't. Our sensory, cognitive and physical capabilities all sit on a long spectrum, so some people are excluded altogether, while a much greater number are inconvenienced. To complicate things further, these spectrums are rarely linear; in many cases, they are multi-dimensional.

Taking sight as an example, the range of capabilities is complicated. Some people can see perfectly well without any form

IMAGE: ISTOCK

of correction, others require spectacles to see things that are far away or very close, others take longer to shift focus, or perhaps struggle in low light, some are unable to perceive colour, while others have a limited field of view - tunnel vision or only peripheral vision - or monocular vision. The remaining senses are just the same, whether it's hearing touch, smell or taste. Some people may have no sensation at all but a much larger group have different capabilities on multi-dimensional spectrums.

Physical capabilities are similar. These include the kind of capabilities that we might naturally think about when we consider inclusive design such as mobility, strength, flexibility, dexterity and reach. Our cognitive abilities also lie on a spectrum and it's not quite as simple as a link to IQ. Some people may have exceptional memories, problem-solving skills, communication abilities, recognition or attention but our capability in one aspect is rarely an accurate predictor for another. To complicate things even further, our capabilities are rarely fixed. As we become tired or fatigued, our capabilities may drop off. Likewise, things change as we age or as a result of events in our lives, perhaps from some form of trauma.



Designs should take into account and accommodate a wide range of characteristics of people

Reaching our peak

The adage "it's all downhill from 40" is not strictly true; in terms of our capabilities, it's more like mid-30s. In early childhood our sensory, cognitive and physical capabilities improve very quickly. We master our senses at a relatively young age while it typically takes much longer until we reach our peak in terms of physical and cognitive capabilities. That doesn't happen until our early 30s. However, by our mid-30s we're broadly at our peak on all of these so from then on, we tend to start to see a general degradation as we age.

By the time we reach retirement age, strength may be down to 50% of its peak, we tend to shrink by around 5%, while our sensory abilities also tend to deteriorate. Eye reaction time doubles, we require around twice as much light to read, we lose high-frequency hearing and our sense of taste and smell become much less.

However, we're increasingly remaining in work for much longer, so the role of inclusive design is becoming more important if we wish to remain an efficient and effective part of the workforce.

Making the case

The ethical case for inclusive design is simple. Most of us want to live in a world with an equal opportunity to engage with people, to participate in different activities and to live independently. With an ageing population around the globe, it also makes a good case at a societal level. But it's a philosophy that also makes great business sense and is one that's embraced by many world-leading companies to develop larger customer bases, improve customer satisfaction, reduce returns and servicing, increase brand reputation and improve staff morale.

Perhaps the most credible business case is designing products that a greater number of people choose to buy and remain happy with, largely because of a greater fit with their capabilities. When thinking about capabilities it's useful to think of them on three levels:

1 **Permanent,** such as having one arm.
2 **Temporary,** such as an arm injury.
3 **Situational,** such as holding a small child.

The market for a product for people with one arm is relatively small, but the market for a product that can be used by people carrying a small child (or using one of their arms for another task) is much larger. As such, designing for the smaller market of permanent exclusions is often a very effective way of developing products that make the lives of a much wider group of customers more flexible, efficient and enjoyable.

Taking the first step

The first step on the path to designing more inclusive products is to understand the current challenges. The second step is to make informed decisions about the product specification. This includes balancing the needs of inclusion with other measures of system performance such as efficiency, efficacy, safety, flexibility and satisfaction. At the early stages of the design the specification should always be treated as a 'living document' to be refined and updated as the design matures.

The remaining step is to continually test and evaluate the design throughout the design process. This means testing against the specification (and any relevant standards) but also testing with as diverse a range of users as possible.

Understanding how to make the product better is, of course, just one part of the challenge. Getting more inclusive products to market relies on the buy-in of the wider product team. It needs a commitment to design better products that are appreciated and valued by a diverse range of people and, by doing so, an organisation can achieve better commercial success.


Dan Jenkins is Head of Research (Human Factors and Interaction) and **Lisa Baker** is Research Skill Leader - Human Factors at DCA Design International.

Meeting the medical needs of millions

The UK is not alone in its challenges in embedding human factors into healthcare, as **Fran Ives** found out when she attended a healthcare symposium in the Windy City, on behalf of the CIEHF

Chicago, the Windy City, situated on the shores of Lake Michigan, is famous for deep dish pizzas, the Sears Tower and gangster, Al Capone. For the last two years however, Chicago has also been home to the US Human Factors and Ergonomics Society's Healthcare Symposium. This annual gathering brings together human factors and ergonomics professionals from around the USA and beyond, to discuss, share and learn.

Within the UK, there are very few qualified human factors professionals embedded within NHS organisations. In the US, it appears that the situation is very similar. One of the lively discussion sessions at the conference, led by Ken Catchpole from the Medical University of South Carolina and colleagues, explored how many human factors professionals are employed by healthcare organisations and where they sit within the organisational structure.

Similar to the UK, many of the human factors professionals were sole practitioners located in a wide variety of departments within their organisations. Job titles varied, as they do within the UK, which can add to confusion for some when trying to understand the breadth of the discipline and the benefit it can add to safety, efficiency and wellbeing of both staff and patients within healthcare.

There was recognition from clinicians at the conference of the benefits of embedded human factors professionals within organisations. James Abernathy, Associate Professor of Anaesthesiology and Critical Care Medicine from Johns Hopkins Medicine, felt that there were insufficient human factors resources in the US within organisations, which is a similar picture here in the UK. Abernathy therefore felt it important for human factors professionals to develop relationships with colleagues such as clinicians within their

Chicago city over Lake Michigan, pictured below

own organisations in order to work collaboratively. Developing such relationships can be hard and human factors work within healthcare can be challenging. It's therefore important that human factors professionals should be clear about what can be achieved.

Shawna Perry, Associate Professor from the University of Florida, like many in healthcare began her human factors journey by becoming interested in patient safety and crew resource management before discovering human factors as a scientific discipline. She described healthcare as being a very loosely organised system that has emerged and yet somehow, it manages to meet the medical needs of millions of people.

Perry felt that it was important for human factors professionals to be prepared to be adaptable in order to help organisations understand the breadth of the science. As in the UK, healthcare in the US needs to understand the measurable changes that can be achieved through the application of human factors. Perry felt that working collaboratively with clinicians within healthcare organisations could help identify ways that human factors has brought about positive change.

Despite some of the challenges of embedding human factors within healthcare organisations, it was clear that there is a wide variety of work being carried out both in and out of the hospital setting. Not only are there human factors professionals embedded within healthcare organisations, there is also a wealth of human factors expertise within academia and consultancies.

Many of the symposium sessions focused on the human factors associated with the design and development of medical devices and technology. The Center for Devices and Radiological Health (CDRH) is the US branch of the Food and Drug Administration (FDA) and is responsible for the premarket approval of all medical devices, in addition to overseeing the manufacture, performance and safety of these devices. Representatives from the CDRH discussed their desire for increased communication between themselves and industry, particularly prior to submission of data to ensure the safety and effectiveness of a device.

The testing of medical devices was discussed, including the specific FDA guidance and 'IEC 62366-1:2015 Medical devices – Part 1: Application of usability engineering to medical devices' which specifies a process for manufacturers to analyse, specify, develop and evaluate the usability of a medical device as it relates to safety. There was a discussion around the importance of ensuring:

- That test participants represent intended users.
- All critical tasks are performed during the testing.
- The device user interface represents the final design.
- Test conditions are sufficiently realistic to represent actual conditions.

The importance of considering the environment in which a product would be used was discussed and in particular, noting how a development environment may differ from this. For example, consider the impact of altitude on how a device functions. Can a device that's developed at sea level, function (or function as expected) when used in high altitude mountain environments, or on an aeroplane?

The Bresslergroup product development consultancy discussed their work around long form contextual inquiry and the use of pre-filled syringe pumps. Contextual inquiry is a semi-structured interview method used to obtain information about the context of use of equipment and devices. Participants are asked a set of standard questions and then observed and engaged in discussion while they work in their own environments. By spending several hours with participants, researchers can get to know the individuals better and gain a depth of understanding by observing how a person responds to situations authentically. For example, keeping sharps containers away from location of injection, using items such as an old laundry detergent bottle as a sharps bin or removing a sharps cap with teeth. Through discussion with individuals over a number of hours, researchers can understand not only what happens on a typical day, but also how participants cope in more unusual situations, such as moving to a new house or going on holiday.

Healthcare needs to understand the measurable changes that can be achieved through the application of human factors

Spending such long periods of time with participants may be challenged by some due to it being a more expensive way of data collection. The increased length of time with participants will likely reduce the total number of participants observed and there may be a large amount of data collected which is deemed to be out of scope of the project.

The Bresslergroup however felt that the advantages of such a method included observing the impact differing environments and circumstances had on the way a product was used. Whilst each participant may have the same set of instructions, the differing environments and circumstances may lead to varying interactions. For products used in uncontrolled environments, such as the domestic setting where the products or users move from one context to another, or where in-depth studies have not previously been carried out, long form contextual inquiry could be considered.

Inevitably, the number of human factors professionals based within healthcare in the US is much greater than the UK. However, it appears that there are a great number of similarities between the types of work being carried out in both countries although each experiences its own challenges. It was clear, however, that the desire, enthusiasm and interest to integrate human factors further into healthcare is growing on both sides of the Atlantic.

Fran Ives is a Chartered Ergonomics and Human Factors Adviser based within Therapy Services at University Hospitals Birmingham NHS Foundation Trust. She provides advice to all areas of the organisation on ergonomics and human factors including task and environment design, work processes and systems.

IMAGE: ISTOCK

Extraordinary courage by ordinary people

The Royal National Lifeboat Institution is a 24-hour search and rescue service covering the UK, the Republic of Ireland, the Isle of Man and the Channel Islands. Over 142,700 lives have been saved since its formation, by its mainly volunteer crews and lifeguards. **Sarah Weedon** explains how the service is recognising and embracing the merits of human factors in its work

Imagine having to move around a lifeboat to carry out your work as the rain lashes down, the wind howls and the waves crash around you. Obviously, there is a greater risk of injury in conditions like this and if a crew member is injured, it can jeopardise the whole rescue mission. There's no doubt about it – working on a lifeboat is a hazardous activity. The RNLI's crews put their lives on the line every time they launch their lifeboats, particularly in rough weather and heavy seas.

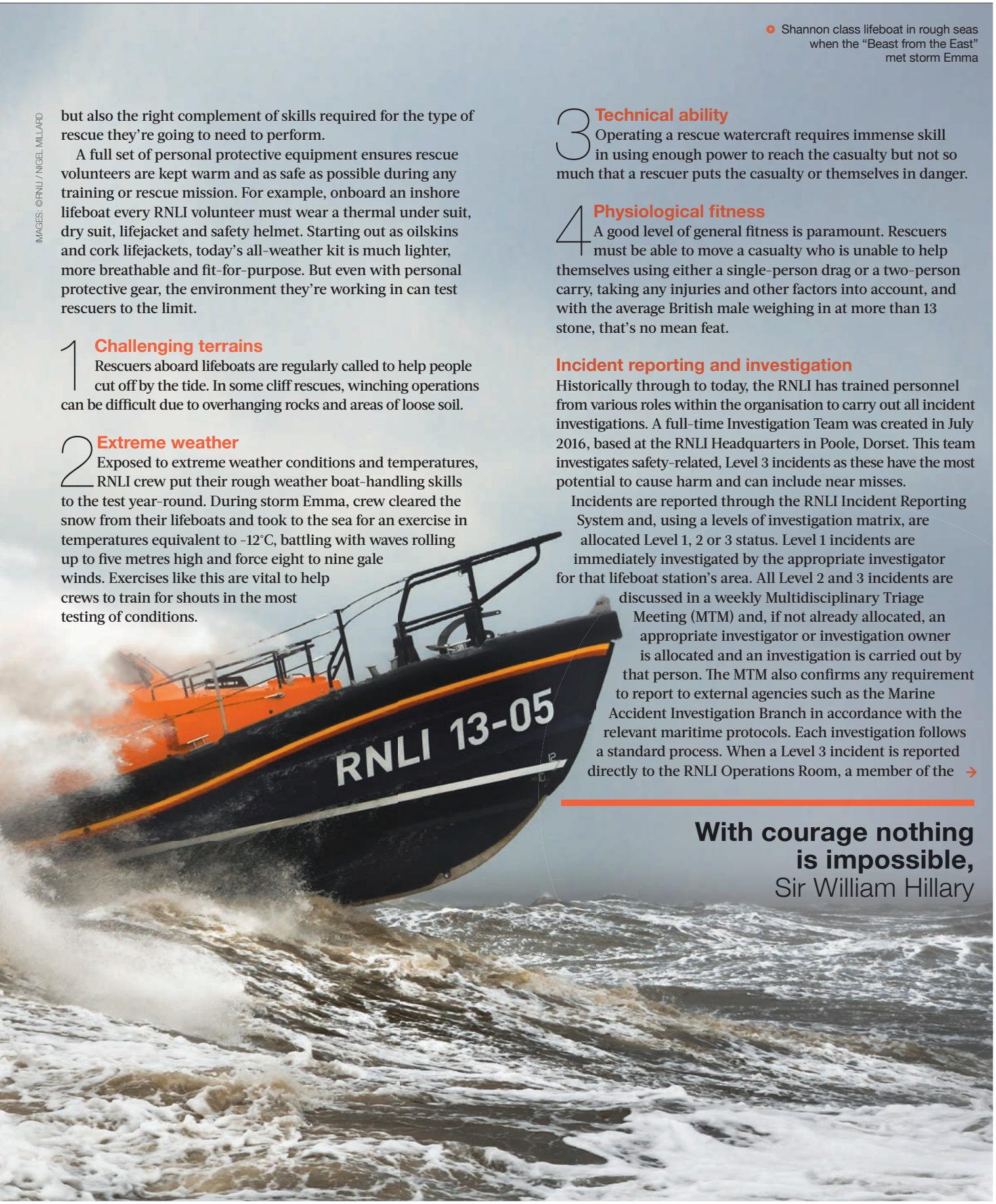
So how did it all begin? Back on the 28 February 1823, Sir William Hillary, an English philanthropist and experienced sailor, appealed to the nation for a dedicated service to save lives at sea. On 4 March 1824 the Royal National Lifeboat Institution (RNLI) was born, known at that time as the National Institution for the Preservation of Life from Shipwreck.

Now with 238 lifeboat stations and 349 lifeboats, the RNLI launched 8,964 times and rescued 9,412 people in 2018. RNLI lifeguards helped 32,207 people and saved 118 lives on over 240 of the UK's busiest beaches in that time. The RNLI has over 4,700 dedicated operational volunteers from all walks of life but they have a common desire to help and an extraordinary level of courage and commitment to the cause. Their roles include crewing the all-weather lifeboats and the inshore lifeboats.

When a lifeboat is requested and launched to carry out a search and rescue mission, it's known as a 'shout'. Crew members are alerted to a shout by a pager and, as soon as the pager goes off, they'll drop whatever they're doing and make their way to the lifeboat station immediately, aware that somebody is potentially in trouble in the water and needs their help.

Caring for the rescuers

The duty of care the RNLI has for crew members answering a shout begins as soon as the pager goes off. Crew selection for a shout is based not only on having the right number of people



Shannon class lifeboat in rough seas when the "Beast from the East" met storm Emma

IMAGES: ©RNLI / NIGEL MILLARD

but also the right complement of skills required for the type of rescue they're going to need to perform.

A full set of personal protective equipment ensures rescue volunteers are kept warm and as safe as possible during any training or rescue mission. For example, onboard an inshore lifeboat every RNLI volunteer must wear a thermal under suit, dry suit, lifejacket and safety helmet. Starting out as oilskins and cork lifejackets, today's all-weather kit is much lighter, more breathable and fit-for-purpose. But even with personal protective gear, the environment they're working in can test rescuers to the limit.

1 Challenging terrains

Rescuers aboard lifeboats are regularly called to help people cut off by the tide. In some cliff rescues, winching operations can be difficult due to overhanging rocks and areas of loose soil.

2 Extreme weather

Exposed to extreme weather conditions and temperatures, RNLI crew put their rough weather boat-handling skills to the test year-round. During storm Emma, crew cleared the snow from their lifeboats and took to the sea for an exercise in temperatures equivalent to -12°C, battling with waves rolling up to five metres high and force eight to nine gale winds. Exercises like this are vital to help crews to train for shouts in the most testing of conditions.

3 Technical ability

Operating a rescue watercraft requires immense skill in using enough power to reach the casualty but not so much that a rescuer puts the casualty or themselves in danger.

4 Physiological fitness

A good level of general fitness is paramount. Rescuers must be able to move a casualty who is unable to help themselves using either a single-person drag or a two-person carry, taking any injuries and other factors into account, and with the average British male weighing in at more than 13 stone, that's no mean feat.

Incident reporting and investigation

Historically through to today, the RNLI has trained personnel from various roles within the organisation to carry out all incident investigations. A full-time Investigation Team was created in July 2016, based at the RNLI Headquarters in Poole, Dorset. This team investigates safety-related, Level 3 incidents as these have the most potential to cause harm and can include near misses.

Incidents are reported through the RNLI Incident Reporting System and, using a levels of investigation matrix, are allocated Level 1, 2 or 3 status. Level 1 incidents are immediately investigated by the appropriate investigator for that lifeboat station's area. All Level 2 and 3 incidents are discussed in a weekly Multidisciplinary Triage Meeting (MTM) and, if not already allocated, an appropriate investigator or investigation owner is allocated and an investigation is carried out by that person. The MTM also confirms any requirement to report to external agencies such as the Marine Accident Investigation Branch in accordance with the relevant maritime protocols. Each investigation follows a standard process. When a Level 3 incident is reported directly to the RNLI Operations Room, a member of the →

With courage nothing is impossible,
Sir William Hillary

IMAGE: ©JOHN MICHAEL STEVENSON

The RNLI added specialist human factors knowledge to enhance the expertise of the Investigation Team

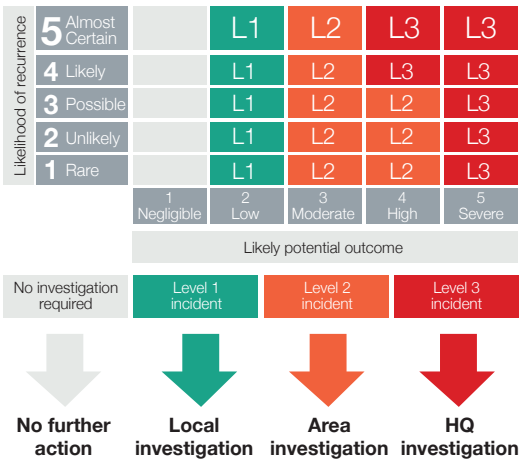
IMAGE: ©RNLI

Atlantic 85 rescuing a person stuck on a cliff and pictured right: a crew member on board Shannon class lifeboat reaching out to help

Investigation Team is immediately informed and will deploy as soon as practically possible.

Towards the end of 2018, the RNLI increased the number of investigators in the Investigation Team. Although the RNLI has always taken human factors into consideration in its investigations, the organisation wanted to add specialist human factors knowledge to enhance the expertise of the Investigation Team. Such an addition would help ensure RNLI investigation reports were further supported in identifying human factors risks and generated appropriate recommendations to remove those risks or implement mitigations to reduce them.

RNLI levels of investigation matrix



In November 2018 I joined the RNLI as an investigator with a background specifically in human factors investigations. I came to the RNLI from the Ministry of Defence where I spent four years as a specialist, investigating military aviation accidents. Prior to that I had served in the Royal Navy for 12 years as an aircraft engineer before gaining my qualifications in psychology and accident investigation.

On joining the RNLI, I recognised that the human factors I was used to considering, such as workload, distraction and decision-making, would still be relevant in a national search and rescue service, but with volunteers who carry out their search and rescue duties outside their full-time jobs, there are other considerations to take into account when identifying means to manage or mitigate risks. I'm involved in the ongoing work being carried out to explore these and other factors to fully appreciate them and any associated risks in order to prevent and mitigate them appropriately.

There are processes in place to identify and manage risks such as 'mission' briefs prior to all launches, self-reporting if feeling fatigued, as well as Coxswains assessing their crew members' readiness before launching. The RNLI is continuing its work in this area including identification of fatigue, educating its personnel to understand the risks and to ensure appropriate procedures are in place to remove or mitigate them.

Overall, the RNLI is an incredible organisation to work for and I'm proud of how seriously its people take the importance of human factors. It's great to see how much work is going on to grow this knowledge and understanding to continue to safely and successfully save lives at sea. ●

Sarah Weedon is a Human Factors Investigator with the RNLI and an Associate Member of the CIEHF. Email Sarah at sarah_weedon@rnli.org.uk. Hannah Macklin of the RNLI also contributed to this article.

Further reading

https://rnli.org/magazine/magazine-featured-list/2014/october/sims-technology-that-puts-crew-safety-first
https://rnli.org/magazine/magazine-featured-list/2018/october/always-ready-to-rescue
https://rnli.org/magazine/magazine-featured-list/2018/september/crew-kit-gearing-up

Medical Packaging and Labelling

23 October 2019 • Birmingham

Unsafe pharmaceutical packaging, and look-alike labelling, have both been identified as major contributing factors to medication errors. Feedback about reports of medication errors show that a systems-wide approach to how the label is developed, used and amended is needed. Human factors can address many of the issues.

This one day event will provide a unique opportunity for key stakeholders representing academia, healthcare, the pharmaceutical industry, and patient communities, to work together to identify the key issues and to make recommendations. The aim is to identify a group who will go on to work collectively to implement the recommendations that come out of this event.

Programme highlights

Keynote: Labelling challenges from a clinical perspective, Professor Jamie Coleman, University of Birmingham

This presentation will focus on the issues of look-alike labelling and the potential for medication errors associated with labelling and packaging. We will also hear perspectives from patients who have difficulties with labelling.

Taster workshop: A human factors approach to tackling labelling issues.

Syndicate workshops:

- Implementing a systems based approach to delivering education around labelling in clinical practice.
- Using a systems based approach to achieve an industry wide consensus for consistency on type font, size and label colours for both generic and proprietary medicines.
- How would a systems based approach to the layout of packaging information on medicines help to mitigate erroneous use of medicines by patients?

Book now and be part of a group examining the next steps needed to ensure future optimal labelling of medicines and healthcare products

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Chartered Institute of Ergonomics & Human Factors

events.ergonomics.org.uk

Designing for musculoskeletal health

Celebrating ergonomic design and innovation, and recognising that training is not the answer, **Michael Paton** showcases award-winning solutions helping to address the UK's single biggest cause of pain and disability

According to NHS England, across the UK population, musculoskeletal conditions affect at least 9.6 million of us; that's one in four adults. Musculoskeletal conditions or disorders include aches, pains and strains of the back, arms, legs, neck, joints, muscles, tendons and ligaments. They often arise from a combination of, or interaction between, work and non-work factors.

Of these, the Labour Force Survey identified 0.46 million cases known to be caused by, or made worse by, work, contributing to 6.6 million working days lost annually. These are found across most industries and are associated with many different physical activities such as manual handling, repetitive tasks, muscular fatigue, load lifting, neck extension and awkward fixed postures. The highest incidence rates occur in agriculture, construction, health and social care, transport and logistics, and public administration sectors. However, physical and ergonomic factors are only part of the underlying causes, with other psychosocial factors also known to contribute.

These sobering statistics are made worse by many employers trying to control the risk of musculoskeletal disorders primarily through manual handling training. Research findings published by the Health and Safety Executive (HSE) show that simplistic off-the-shelf training involving bending your knees to lift a cardboard box doesn't make any difference and is a waste of time and money.

As part of its health priority plan for musculoskeletal disorders, HSE has published advice to encourage employers to take a more holistic approach and, where necessary, seek the most appropriate help. The intention is to shift the emphasis away from generic manual handling training and up the hierarchy of control towards risk elimination or reduction through work design and organisation.

A new award is born

Out of this, the HSE 'Risk Reduction Through Design' award was born. Now in its second year, the award is jointly sponsored by the HSE and CIEHF and is intended to inspire businesses to consider how ergonomics–based design changes can reduce the risks of work-related musculoskeletal disorders and recognise or reward design changes that have made a real impact.

The competition has identified several important features that contributed to successful outcomes including:

- Use of data to initiate and support changes.
- Involvement of the workforce in both generating ideas (e.g. competition) and trialling solutions.
- Applying what works from other industries, such as technology transfer, in using a conveyor from a manufacturing environment in construction.
- Using different and multiple indicators of success such as productivity benefits, improved patient care, employee engagement or incidents/case numbers.
- Considering all relevant job roles, for example maintenance, shift or remote workers.
- Incorporating a holistic approach within the design solution, such as looking across the health and safety risks.
- Reducing the potential for human error and confusion.
- Measuring the impact of design changes, for example, by using wearable devices.

The competition was deliberately broad in scope, hoping to attract design solutions from sectors such as manufacturing, where participatory ergonomics is well developed, and sharing this with other sectors to show what good design looks like.

Freyssinet, the inaugural winner, showcased a construction project to refurbish the Glasgow underground, involving significant movement of materials and overhead working. Borrowing ideas from manufacturing to design a conveyor system that eliminated significant manual handling of materials, was only one commendable aspect of their innovative approach.

Attracting more entries

This year's competition attracted a 55% increase in entries, extending to the whole of the UK, and encompassing a wider range of sectors including manufacturing (automotive, food and engineering), transport/logistics, railway, local authority, utilities, construction, education and pharmaceuticals. The entries were assessed by a judging panel consisting of representatives from employers' organisations MakeUK (formerly EEF), GMB trade union, CIEHF and HSE.

IMAGE: ISTOCK

Henry Bros and CPD award-winning entry: steel riser being lifted (left) and steel riser in position (right)

The 2018 award winner was announced and presented at the CIEHF's Ergonomics & Human Factors 2019 conference in April. **Henry Brothers Ltd and Construction & Procurement Delivery** used an off-site design and manufacturing approach to eliminate repetitive pulling, handling and awkward postures involved in the installation of pipework in a three-storey building for the Northern Ireland Prison Service.

This design solution was informed by past experience and involved a collaborative and participatory approach between designer, client, contractors, plumbers, fitters and maintenance workers to test and develop solutions. The holistic approach provided wider health benefits, reducing exposure to noise, vibration and silica dust and reduced risks from working at height. The approach is transferable to other construction activities across a range of sectors.

Other commended entries included:

A collaborative effort between **Airbus and HTL Group**, sourced and developed from the oil and gas sector, resulted in a small, lightweight and low maintenance hydraulic tooling solution under 5kg in weight.

Trent Vale Infant & Nursery School and Jolly Back addressed a gap in the supply of ergonomic solutions for low height working.

Network Rail and McCulloch modified a Trac Rail Transporter with a bespoke lifting attachment that can safely lift a point machine without the need for manual handling.

Network Rail and Geismar designed a new trolley made of lightweight components which can be easily assembled and eliminates manual pushing of the trolley.

Given the scope of the award, there was no surprise at the breadth of nominations which ranged from specifically designed personal protective equipment and lifting aids, digital risk assessment tools, a redesigned occupational health scheme to a multi-million pound construction project.

The judges had a difficult job in deciding between entries that reduce risks of musculoskeletal disorders for the greatest numbers of workers and those that were novel, innovative or niche solutions. Reflecting on the award criteria may therefore be necessary and consideration given to whether subcategories are warranted for future competitions. There is also a case for offering sector-specific awards to encourage innovation and design, where this is less prevalent.

Maximising the impact

Maximising the impact of the 'Risk Reduction Through Design' award is an important objective of the competition. As well as a dedicated webpage, HSE promotes the design solutions through presentations, conferences and social media (Go Home Healthy) and where possible develops case studies to illustrate what good looks like. Hopefully, the growth of this competition will be a measure of how successful HSE has been in encouraging employers to move towards musculoskeletal disorder risk elimination or reduction through work design.

HSE's message continues to be that risks from musculoskeletal disorders must be controlled and that employers should eliminate risk at source where possible. Training in manual handling techniques has a place as part of wider safety training in a workplace once risks have been reduced as far as is reasonably practicable. Never has the age-old 'prevention is better than cure' been more appropriate than with respect to musculoskeletal disorders.

Michael Paton is Senior Policy Advisor in the Health & Work Branch at the Health & Safety Executive.

More information

http://www.hse.gov.uk/msd/awards.htm

As the 'dark net' feeds vast networks of untraceable web sites and illicit activities, **Paul Salmon** and colleagues are investigating whether human factors techniques can disrupt criminal behaviour

Disrupting the dark net

Forming part of the deep web, estimated to be up to 550 times bigger than the 'surface web' or internet, the dark net is not accessible through regular search engines such as Google. It comprises websites, discussion forums and marketplaces that support the trade of both legitimate and illicit products and services. Dark net marketplaces are popular with individuals and groups seeking to anonymously trade in illicit products such as drugs, firearms, child pornography and stolen identity credentials.

Dark net applications work by enabling internet traffic to route through random pathways to disguise their point of origin. In dark net marketplaces, transactions are made using cryptocurrencies such as Bitcoin, which means that both buyer and seller remain pseudonymous. This allows criminals to enact transactions without their real identity becoming known to authorities.

Probably the most well-known marketplace, *Silk Road*, was first launched in 2011. New dark net marketplaces continue to emerge, and existing ones are evolving. With the capacity to support worldwide trading, market administrators can potentially generate millions of dollars in profit, according to the US Department of Justice.

Law enforcement agencies worldwide have used various approaches in attempts to shut down marketplaces. Even *Silk Road* was shut down in 2013, resulting in the arrest and prosecution of its founder. However, this occurred more as result of luck than through effective operational planning, with the administrator's email and shipping address being intercepted outside of dark net operations.

Beyond closing marketplaces and charging and arresting suspects, interventions can also achieve positive outcomes simply by disrupting trading alone. This can limit sales, reduce the criminal activities required to generate products and prevent harm to victims of crime. As dark net marketplaces continue to evolve and grow, and anonymity remains, there is a need to explore ways of disrupting trading.

Disrupting dark net trading

Researchers at the University of the Sunshine Coast, the University of Queensland, and the University of Southampton

are currently engaged in a programme of research involving the use of human factors methods to understand trading behaviour in the dark net and to support the development of interventions that aim to disrupt dark net trading.

The work builds on the idea of using human factors to 'break bad systems' that we have researched previously. As well as being used to optimise system performance, human factors methods can also be used to help degrade or disrupt the performance of systems that are designed to achieve illicit ends.

We've used two human factors methods to help identify strategies that could be used to disrupt trading in the dark net: the Event Analysis of Systemic Teamwork (EAST) from University of Southampton's Neville Stanton and team, and Work Domain Analysis.

EAST is used to analyse behaviour by constructing task, social and information networks, so it was used in this context to analyse the processes involved when buying and selling identity credentials via *Dream Market*, a dark net marketplace that has since been shut down. At the time of the study in January 2018, *Dream Market* featured close to 100,000 listings, predominantly advertising drugs and fraudulent identity data. The EAST analysis described:

- The tasks involved during the trading of identity credentials, for example, create an account, search products, arrange delivery.
- The agents involved in identity credential trading, for example, buyer, vendor, wallet, administrator, product listing.
- The information used by agents during identity credential trading, for example, username, product, price, shipping details, product reviews, vendor reviews.

The outputs were subsequently used to conduct an EAST-Broken Links (BL) analysis, an approach developed by Neville Stanton and the University of Nottingham's Catherine Harvey, which aimed to identify ways in which the transmission of information could be interrupted to the detriment of the trading process. The EAST-BL process involved breaking the links in the initial EAST networks to identify how trading would be impacted if information was not transmitted between agents and between tasks.

Overall, 802 possible broken links were identified, with 102 of them being classified as having potentially a high impact in terms of disrupting or halting the trading process. The analysis helped identify various targets for law enforcement intervention, many of which involve preventing or manipulating the presentation of key information on the marketplace or in product advertisements.

Second, we used Work Domain Analysis to develop a generic systems model of dark net marketplaces and used it to identify different ways in which marketplace functioning could be disrupted. Dark net marketplaces were described across five levels of abstraction:

- Functional purposes: the reason the marketplace exists in the first place (such as financial gain, secure and safe organised trade, form community of interest).
- Values and priorities measures: used by stakeholders to determine if the marketplace is achieving its functional purposes (such as profit, volume of sales, product and service range, delivery reliability, payment security, anonymity).
- Purpose-related functions: functions required for the marketplace to achieve its functional purposes (such as establish identity, product management, purchase products and services, financial transactions, delivery of products and services, reputation management, administrative functions, maintain security).
- Object-related processes: the processes that objects in the marketplace enable in support of the purpose-related functions (such as transfer information, host financial services, secure financial transactions).
- Physical objects: the objects used within the marketplace (such as servers, BIT Torrent, TOR, wallets, VPN, cryptocurrency, products, Tumbler, ESCROW).

Human factors methods can help degrade or disrupt systems designed to achieve illicit ends

Disrupting not optimising

The next phase of the project will develop and test the interventions identified through the analyses. This has begun with the recent conduct of a participatory design workshop involving cyber security and law enforcement stakeholders.

The work builds on previous research, further evidencing that systems human factors methods provide a useful approach to disrupting system performance. Primarily this is possible because systems methods focus on the interactions between components across a system. In doing so, it's possible to explore the negative emergent properties that arise when such interactions are prevented or degraded. It appears that these methods are just as good at helping to break systems as they are at helping to optimise them.

Whilst a closer analysis of each of the interventions identified is required, including their costs and feasibility, the findings and indeed the approach taken will support future disruption activities. This and other work lead us to conclude that systems human factors methods are useful for identifying ways in which to disrupt systems that have been designed to achieve illicit ends. This potentially opens a range of new application areas in which human factors can be used to disrupt such systems. For example, issues such as terrorism, child sex abuse, doping, fraud and the trading of other commodities in the dark net all represent application areas in which a similar approach could be adopted.

Paul Salmon is Professor of Human Factors at the University of the Sunshine Coast. The project team also includes Ben Lane, Dennis Desmond and David Lacey from the University of the Sunshine Coast, Adrian Cherney and Gayan Kulatilleke from the University of Queensland, and Neville Stanton from the University of Southampton.

Further reading

Stanton, N A, and C Harvey (2017). Beyond Human Error Taxonomies in Assessment of Risk in Sociotechnical Systems: A New Paradigm with the EAST 'Broken-Links' Approach. *Ergonomics* 60(2): 221–233. doi:10.1080/00140139.2016.1232841

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IMAGE: GETTY

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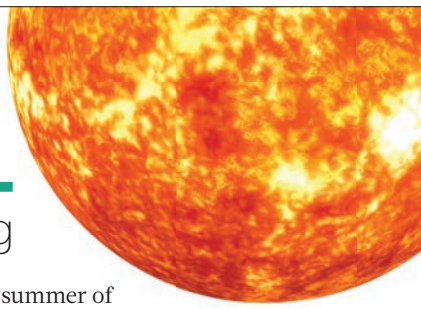


Cool clothing

1 With another summer of soaring, record-breaking temperatures, the news often features images of packed beaches or people cooling off in water fountains but spare a thought for those who have to work outside in these conditions. Mitigating heat stress of physically active outdoor workers in hot climates remains a major unsolved challenge.

Hot temperatures and high humidity can combine with physical exertion required in manual jobs such as in construction or agriculture and result in heat stress or worse. So how can you improve the thermal comfort of workers in such hostile environments? Finding shade or increasing air movement is not always possible so researchers in Hong Kong and China have studied a combination of materials that could be used to design clothing that provides more comfortable and safe conditions for workers.

Human trials carried out in a hot environment of 36°C and relative humidity of 59% showed that significantly lower mean skin and torso temperatures were registered

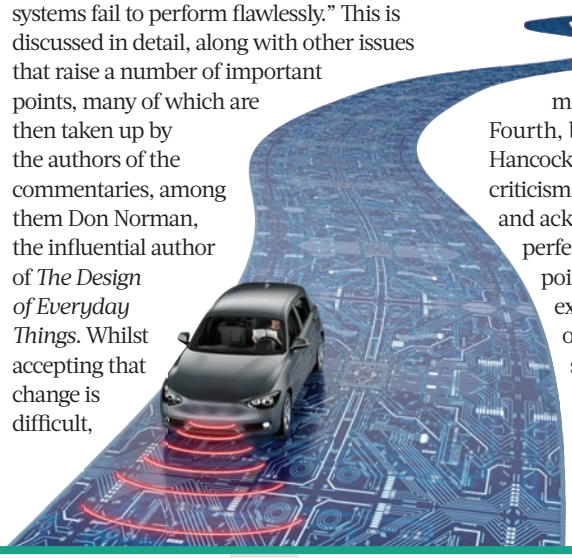
Commentary collection

Whilst news about 'driverless cars' has taken a back seat with strong competition from world class sporting events this summer and, of course, the 50th anniversary of the moon landing, much has been written on the human factors issues involved in development and use of such technology.

A series of commentaries in response to an article by Professor Peter Hancock, called *Some pitfalls in the promises of automated and autonomous vehicles*, has been published in the same issue of *Ergonomics* (volume 62, issue 4). This is an unusual format for the journal but it recognises the far-reaching impact of human factors on the design of transport systems and on the future widespread public acceptance of automated vehicles. It also provided a forum for airing opinions on just how influential we can be as professionals.

As Hancock says in his abstract: "Differing forms of self-operating transportation are already among us and some have been in operation now for an extended period of time. From elevators and escalators to airport transit trams, we already use many fully automatic systems. Now such technologies are very publicly and prominently penetrating into the on-road environment of everyday personal vehicle usage."

He goes on to note: "One particular concern is that of identified responsibility when such systems fail to perform flawlessly." This is discussed in detail, along with other issues that raise a number of important points, many of which are then taken up by the authors of the commentaries, among them Don Norman, the influential author of *The Design of Everyday Things*. Whilst accepting that change is difficult, Norman and his co-author say that human factors professionals should stop talking to each other and start sharing recommendations in a more accessible way with those in the industry: "First, understand the ecosystem of the industry and the complexity that naturally exists in the industry. Second, ensure the recommendations are sensitive to the critical issues faced by executives: safety, cost, customer requirements, regulatory factors and competitive pressures. Third, present findings at the conferences and magazines read by senior executives. Fourth, become senior executives."



Hancock is given a chance to respond to the criticisms levelled at him in the commentaries and acknowledges: "Although we are not in perfect agreement about each and every point, I think the general level of accord exhibited attests to the internal strength of ergonomics. The challenge largely seems to lie beyond our boundaries and how to exert our meaningful impact in the wider world."

Read the entire discussion at www.tandfonline.com/toc/terg20/62/4

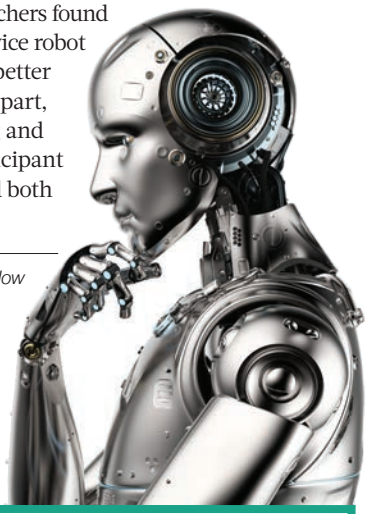
when clothing incorporated phase change materials (which use stored latent heat), ventilation fans and insulation. This indicates that hybrid personal cooling clothing can provide a relatively cool microclimate around the wearer's body while working in hot environments. Not perhaps the easiest of answers, but something that we might seriously have to consider in the future if temperatures continue to rise.

Udayraj et al (2019) Performance enhancement of hybrid personal cooling clothing in a hot environment: PCM cooling energy management with additional insulation, Ergonomics, 62:7, 928-939, DOI: 10.1080/00140139.2019.1596318

After you

2 In a future world where we regularly share our environments with robots, if they are humanoid (they have 'faces' and resemble humans) we might expect them to share our social norms in terms of behaviour, for example, they should 'look' at us when they are communicating with us. But what if they are non-humanoid robots, such as vacuum cleaners or autonomous parcel delivery machines? What would make us accept them or even like them?

German researchers think that robots' communication skills are expected to play an essential role, whatever their design and function. Like people, machines can use body language to communicate nonverbally through posture, gestures and movement. The researchers found that an autonomously moving service robot that appeared to act politely was better appreciated by its human counterpart, in this case, by the robot stopping and moving aside to let a human participant through an entrance after they had both approached it at the same time.



F G Kaiser, K Glatte & M Lauckner (2019), How to make nonhumanoid mobile robots more likable: Employing kinesic courtesy cues to promote appreciation. Applied Ergonomics vol 78. https://doi.org/10.1016/j.apergo.2019.02.004

Best papers

The Liberty Mutual Award for the best paper in *Ergonomics* has been won this year by Ewart J de Visser, Richard Pak and Tyler H Shaw for their 2018 paper, 'From 'automation' to 'autonomy': the importance of trust repair in human–machine interaction'.

The authors argue that "Modern interactions with technology are increasingly moving away from simple human use of computers as tools to the establishment of human relationships with autonomous entities that carry out actions on our behalf." They propose a human-centred approach aimed at ensuring that future human–autonomy interactions remain focused on the user's needs and preferences, and have created a framework to build and repair trust in autonomous systems.

E J de Visser, R Pak & T H Shaw (2018), From 'automation' to 'autonomy': the importance of trust repair in human-machine interaction, Ergonomics, 61:10. https://doi.org/10.1080/00140139.2018.1457725

Runners up for the award were researchers looking at two different scenarios involving physical and cognitive demands of work.

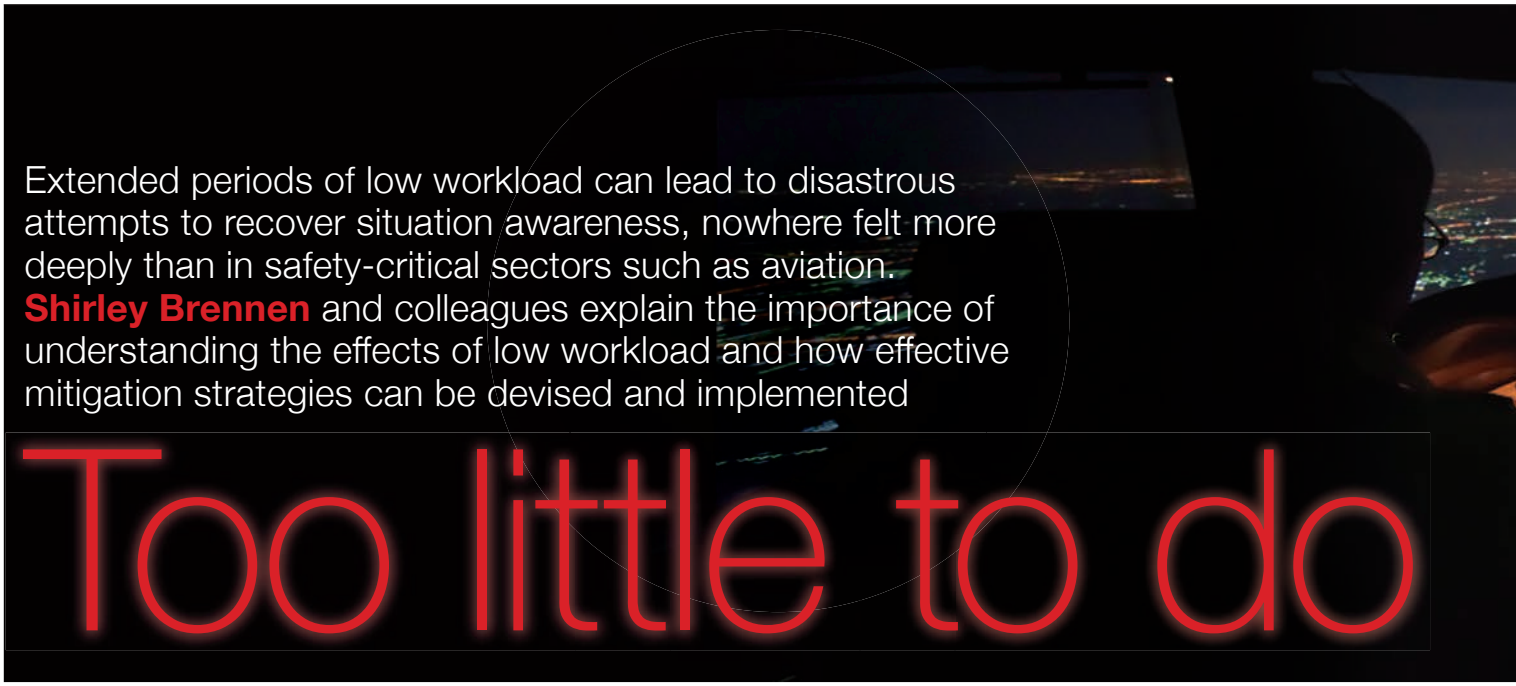
Concerns about prolonged sedentary posture, especially in office workers, have led to calls for more provision to enable people to stand at work as an alternative to sitting. However, research by Richelle Baker and colleagues has found that prolonged standing may have health and productivity impacts too. In a laboratory study involving two hours of prolonged standing, discomfort increased in all body areas, reaction time and mental state deteriorated while creative problem-solving improved.

R Baker, P Coenen, E Howie, J Lee, A Williamson & L Straker (2018) A detailed description of the short-term musculoskeletal and cognitive effects of prolonged standing for office computer work, Ergonomics, 61:7. https://doi.org/10.1080/00140139.2017.1420825

How do clinicians in intensive care units make judgement calls when faced with incomplete information and less than optimal resources? An interview study by Tom Reader and colleagues examined how such decisions are made and found that clinicians must often make risk trade-offs on patient care. They say "It can be difficult, if not impossible, for clinicians to evaluate with certainty the safest course of action, for example, on deciding whether to discharge a patient before they have fully recovered in order to create a bed for another, sicker, patient." They conclude that decision-making can be inconsistent as a heterogeneous mixture of risk assessments, factual knowledge and prior experience are used to make judgements.

T W Reader, G Reddy & S J Brett (2018), Impossible decision? An investigation of risk trade-offs in the intensive care unit, Ergonomics, 61:1. https://doi.org/10.1080/00140139.2017.1301573

IMAGE: ISTOCK / SHUTTERSTOCK



Extended periods of low workload can lead to disastrous attempts to recover situation awareness, nowhere felt more deeply than in safety-critical sectors such as aviation. **Shirley Brennen** and colleagues explain the importance of understanding the effects of low workload and how effective mitigation strategies can be devised and implemented

Too little to do

Imagine yourself as a pilot, three hours into the cruise phase of a long-haul flight. The plane is flying itself and there have been no problems. There's very little for the crew to do, other than routine monitoring, so workload levels are low. How do you keep engaged and alert? How do you maintain your situational awareness and preparedness to act in an emergency?

This is the situation faced by crews on long-haul flights. Although the adoption of automation in demanding contexts has been successful in reducing workload levels, increasing levels of automation can drive workload levels to the other extreme. Low workload has accompanying reductions in situation awareness and increases in boredom levels, leading to task disengagement. The consequences of behaviours exhibited during periods of low workload can be as catastrophic as those exhibited during periods of high workload. This was recognised in the investigations into the Airbus Voyager and Croydon tram incidents resulting in disruption and injuries, with fatalities in the latter.

Within the military, this issue is recognised by personnel involved in the conduct of flying operations across all aerial vehicles, manned and unmanned. Beyond the military flight deck, this is documented as a concern for a range of safety-critical industries, nationally in the UK and internationally, including in civil aviation, nuclear and transport. There is increasing awareness of the need to support personnel, whether pilots, train drivers or air traffic controllers, with strategies to mitigate the effects of low workload by maintaining task engagement during periods where there is little work to do but attention to task needs to be maintained.

The significant impact that low workload can have on human performance has generally been overlooked, with the need to address high workload being a major driver in achieving optimal and sustainable human performance. Despite this, it's generally recognised that maintaining alertness is critical in maximising situation awareness and performance levels for safety-critical tasks. Many studies have been conducted to understand the contribution made to alertness levels by a number of factors, such as fatigue, but little attention has been paid to the contribution of low workload. For example, when the impact of taking the opportunity to carry out activities during periods of low workload distracts too much from the primary task and requires too long to re-focus, particularly when an emergency occurs.

There is little work currently being conducted in this area although there is consensus that low workload periods need to be managed effectively and that mitigation strategies would be most beneficial for application in operational environments across military and civilian domains. Evidence-based low workload mitigation strategies for safety-critical environments will provide structured support for the prevention of incidents and a number have been identified that show some promise. These largely fall into five categories:

1 **Attention management**, involving the effective switching of attention between directed, divided and distracted states, and the focusing of attention on the task, for example, physically pointing out and naming features in the environment.

2 **Workload management**, involving the introduction of a secondary task to increase task demand, such as trivia quizzes, or rescheduling of tasks by pre-loading, performing planned tasks early, or delaying, performing planned tasks later.

3 **The environment**, involving interaction with others, in particular conversation, reducing constraints within the working environment to allow physical movement, or having breaks and engaging in specific physical activity or exercises.

4 **The job**, where strategies are employed by the individual to increase variety and enhance interest in the task.

5 **Personnel selection**, where methods, including psychometric tests or measures, are used to assess the suitability of an individual to undertake a specific task and/or job.

The significant impact that low workload can have on human performance has generally been overlooked

Several strategies that mitigate against fatigue as well as low workload have been identified, such as controlling noise and temperature within the workspace. The close relationship between low workload and fatigue is highlighted by such strategies, which may provide multiple benefits. However, such assumptions need to be carefully tested given the multi-dimensional nature of fatigue and workload.

Attention and workload management strategies have been the subject of more detailed investigation in relation to low workload mitigation than any of the other categories, so there is more scientific evidence to support their application. Anecdotal evidence from across rail, military air platforms and air traffic control, suggests that environmental and dual fatigue-low workload strategies are also consistently applied. During the cruise phase of a long-haul flight, flight crew are equally as likely to indulge in task and non-task related conversations, taking breaks and adjusting the temperature, as they are to exhibit behaviours around pointing out and naming features in the environment, participating in quizzes and refreshing skills.

Secondary tasks have been the subject of numerous investigations to establish their utility in enhancing attention levels during periods of low workload. Intuitively, increasing workload would seem to be an obvious strategy to ensure continued task engagement, while avoiding imposing a level of workload resulting in overload. A variety of secondary tasks have been applied across several domains and primary tasks, such as driving a car or a train and in air traffic control. These investigations have largely been conducted using simulations, with limited examination of the impact on live tasks. Although Multiple Resource Theory postulates that attention can be divided between tasks, as long as the tasks do not demand the same attentional resources, there is a need to establish the level of attention required for a secondary task that will make it sufficiently engaging, whilst allowing quick and easy disengagement when necessary to attend to the primary task. This will support the maintenance of situation awareness and focus on the job in hand, preventing errors that may occur if too distracted. Additionally, account needs to be taken of the benefits of providing the human operator with 'down-time' where cognitive processes can be relaxed with benefits to subsequent performance.

The suitability of strategies varies with the demands of the situation, individual preferences and workspace characteristics. For a given combination of circumstances, some strategies will be more effective than others. Ultimately, a range of mitigation strategies with proven benefits are needed, such that each strategy can be appropriately and effectively applied for given situations, individuals and workspaces. A selection of mitigation strategies that don't distract from performance of the primary task, nor increase workload excessively, will have wide-ranging benefits across several industries where the impact of low workload is of concern.

The safety of highly automated flights relies on the anticipation and prevention of accidents whatever the underlying cause. The importance of low workload and the consequences of poor management of such working periods should not be underestimated, especially as levels of automation increase. Increased understanding of the opportunities and constraints for the application of strategies to mitigate issues arising from low workload will raise recognition of the importance of low workload as a system design issue and will inform future system design. Strategies that support current operational procedures and working practices will be the easiest to implement and most acceptable to personnel. Evidence of the utility of such strategies is needed to support practical application of the strategies within safety-critical environments.

Shirley Brennen is a Senior Consultant in Psychology and Human Factors at QinetiQ. **Sonny Gates** is an Applied Physiologist in the Human Performance Team at QinetiQ. **Dr Carole Deighton** is a Chartered Fellow of the CIEHF, a Chartered Psychologist and Director of Systemica Ltd.

Further reading

Military Aviation Authority (2014) Service Inquiry: incident involving Voyager ZZ333 on 9th February 2014.

Rail Accident Report (2018). Overturning of a tram at Sandilands junction, Croydon 9 November 2016. RAIB Reference Report 18/2017 v2, Oct 2018.

IMAGE: SHUTTERSTOCK

SHAPING THE FUTURE OF RAIL

Providing the link between people, processes and technology, the Network Rail Ergonomics team deliver human-centred solutions to improve safety, enhance performance and accelerate innovation on Britain's railway.

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For further information please scan the QR code or go to www.networkrail.co.uk/careers and search for 'ergonomics'.

Complex issues unpicked

Changes to the world economy prompted researchers to consider the contribution of ergonomics to wider issues facing workers around the globe. The long-lasting result continues to bring the brightest minds together, as **Patrick Waterson** explains

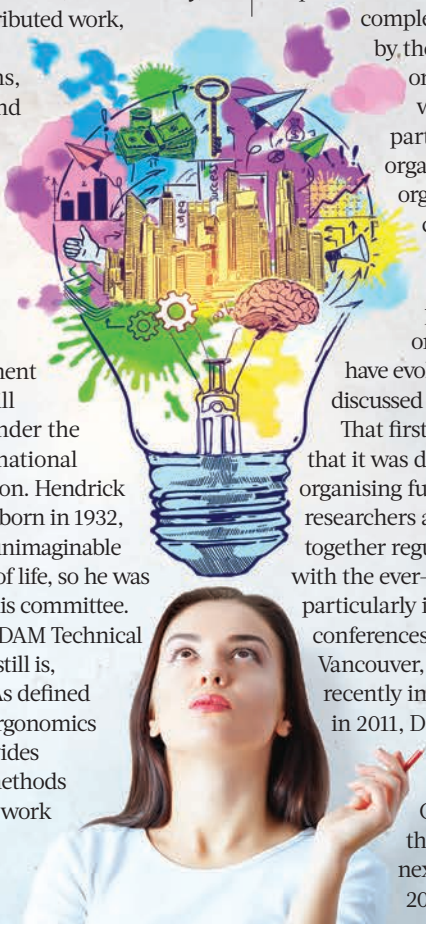
In the early 1980s, a group of American human factors researchers, led by the late Hal Hendrick, was prompted by world economic changes, the globalisation of production systems and the growth of service and knowledge work to consider the contribution ergonomics could make to these developments.

Their conclusion was that as a result of these changes, the human factors and ergonomics profession was being challenged by a variety of new work situations and accompanying issues within practice and in research. These include the all-important work-life balance, sustainability, collaborative but distributed work, global redistribution of production systems, virtual production and digitalisation.

To tackle the problem further in a more structured way, the researchers formed a Technical Committee called Organisational Design and Management (ODAM), which is still in existence today, under the auspices of the International Ergonomics Association. Hendrick himself, having been born in 1932, had seen previously unimaginable change in all aspects of life, so he was well-placed to lead this committee.

The focus for the ODAM Technical Committee was, and still is, 'macroergonomics'. As defined by Hendrick, macroergonomics is "a science that provides the knowledge and methods necessary to improve work systems and develops the effectiveness and performance of companies". Within the UK and Europe, the term 'systems ergonomics' is more usually used and is associated with much of the work of many of the pioneers of ergonomics including Tom Singleton, Neville Moray and the late Professor John Wilson. John left us with a succinct definition of systems ergonomics: "it examines, accounts for and enhances the design of a system, and people's interactions with it, rather than concentrating on an individual part of it".

The Technical Committee organised its first conference in 1984 to bring together the brightest and best minds to discuss, unpick and tackle the difficult issues and complex problems brought to light by their work. Themes included organisation and management, work systems design, participatory ergonomics, organisational culture, organisational and technological change, learning organisations, organisational communication, lean production systems and work organisation. These topics have evolved but they are still being discussed and debated today.



That first event was so successful that it was decided to continue organising further conferences to enable researchers and practitioners to come together regularly to keep up to date with the ever-increasing pace of change, particularly in technology. Subsequent conferences have taken place in Vancouver, Canada in 1986 and more recently in Brazil in 2008, South Africa in 2011, Denmark in 2014 and Banff, Canada in 2017.

The ODAM Technical Committee has invited the CIEHF to organise the next event in the UK in July 2020, the 13th International Symposium on Organisational Design and Management (ODAM 2020), and planning is well underway. The topics will include tools and methods, work analysis, activity theory, socio-technical systems analysis, intervention studies, macroergonomics and systems ergonomics, risk management, simulation and quality improvement. Application areas under consideration include healthcare, service industries, manufacturing industries, knowledge-intensive companies, sustainability, small and medium sized enterprises, and information and communication technology.

The second day of the conference will feature special sessions on the topic of 'Human Factors in Complex Systems' (HFICS). Automation, systems ergonomics, human factors and safety, applications of systems ergonomics to complex work environments such as transport, healthcare and nuclear power will be covered. HFICS was the subject of a series of successful CIEHF events, the last, held in Nottingham in 2016, celebrated the life and work of John Wilson.

With a year still to go, keynote speakers are already lined up, including Professor Chris Baber from the University of Birmingham and Dr Neelam Naikar from DSTO, Australia. Selected papers from the conference will be published in a special issue of a journal.

Submissions will open on 11 November 2019. For more details visit events.ergonomics.org.uk/event/odam2020/

Dr Patrick Waterson is Reader in Human Factors and Complex Systems at Loughborough University and a Chartered Fellow of the CIEHF. Email p.waterson@lboro.ac.uk, twitter: @PatrickWaterso1

Further reading

Hendrick, H W 1986. Macroergonomics: a concept whose time has come. *Human Factors Society Bulletin*, 30, 1-3.

Wilson, J R 2014. Fundamentals of systems ergonomics/human factors. *Applied Ergonomics*, 45, 5-13.

IMAGE: ISTOCK

New route to Technical Membership

We are very pleased to announce the launch of a unique professional development Learning Pathway, the first of its kind, created specifically to address a business need for human factors skills. The Pathway unfolds over three levels, each one delving deeper into human factors topics. Each level includes learning resources, question sets to consolidate understanding and activities through which to apply the newly acquired knowledge.

The framework behind the Pathway has been developed for use across different sectors and has been designed to take someone with little or no knowledge of human factors along a mentored route over two years. Anyone completing the Pathway will be eligible to apply for CIEHF Technical Membership in that sector and, if successful, to use the title *Technical Specialist*.

The first Pathway is specific to energy and has been established in collaboration with the Energy Institute and I-CAB. It's called *Human Performance in the Energy Sector*.

- **Level 1** introduces eight individual topics giving a high-level overview of each. For example, in the task analysis topic, a critical task is defined and how to identify where mistakes could be made. Activities include walk-throughs, observations and discussions.
- **Level 2** is where specialisation begins in five selected topics relevant to business needs and individual job roles. For example, in the Workload, Stress and Fatigue topic, approaches to managing stress and performance under pressure are explained and activities include carrying out reviews, participating in studies and applying methods and tools.
- **Level 3** advances understanding in a choice of two of the five selected topics with the help of a mentor. For example, in the Procedures topic, a range of human factors tools and methods are explained to enable development of procedures. Activities include writing reports, carrying out investigations and coaching colleagues.

It all starts with a free eLearn, developed by the Energy Institute, and available now as an online hour-long introduction to human performance. Anyone can sign up and get a taster of what's to come. It's a convenient and practical way for businesses in the energy sector to increase awareness across their workforce.

For more details, visit **www.ergonomics.org.uk/HPenergy**

MEMBERSHIP

Our latest professional members

Congratulations to the following members whose applications for professional membership of the CIEHF over the past few months have been successful. Registered Members and Fellows also have Chartered status.

Technical Members

- Antonio Javier Gaspar Marichal
- John Fink

Registered Members

- Alice McDougall
- David Keane
- Lorraine Braben
- Beth Lewis
- Adam Smith
- Kate Moncrieff
- Gemma Innes-Jones
- Mike Chamberlin
- David McNeish
- Phoebe Richards
- Michael Hespley
- Helen Vosper
- Charlotte Morrison
- Jenny Day

Fellows

- Steve Jarvis
- Michael Bradley
- Ron McLeod

Grateful thanks

We say thank you to Sarah Tapley, who's moving on after two years with us. As Membership Manager, Sarah provided insightful advice to many who wished to join us, upgrade or apply for course accreditation. She worked with our Professional Affairs Board to help streamline our accreditation processes and was key to the success of our new CPD system that launched in January. We wish Sarah very best wishes for the future.

Insuring success

If you're running your own business it can be an exciting time, but it can also be daunting to ensure you have all the right procedures and policies in place. When it comes to insurance, you need to consider if you can afford not to have them in place. Towergate Insurance Brokers explains why professional indemnity and public liability insurance is important:

Professional Indemnity cover can protect against claims made against you should you be accused of Professional Negligence, this can include things such as incorrect advice or recommendation, breach of professional code of conduct, loss of documents or breach of confidentiality. A client could allege that as a result of a recommendation you made, they have suffered an adverse effect and as a result they have been harmed. This type of policy can cover the costs to defend you against this allegation, and ultimately if the client is successful in suing you, will pay out the damages awarded.

Public Liability cover protects you in the event of claims made in respect of accidental injury or damage to a client or a member of the public, and it also covers loss or damage to public property. If, for example, you accidentally spilt coffee on a client's laptop this would be covered or if a client were to trip over whilst visiting you, this policy would cover the legal costs to defend you, and again pay out if the client was successful in suing you.

Towergate Insurance Brokers are partners of CIEHF and their Professional Liability policy provides cover for both Professional Indemnity and Public Liability, meaning you only need one policy.

For more information please visit **www.towergateinsurance.co.uk** or call **0330 123 3594**.

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Sad farewell

It is with sadness that we report the death, in July, of Dr Ted Lovesey, following an illness. He was one of the Institute's longest serving members, having joined the Ergonomics Research Society as it was then, in 1965. He became a Fellow in 1985 and an Honorary Fellow in 2014. An obituary will follow to remember and celebrate his life in ergonomics.

Meet the community

We know the value that you put on the networking and CPD opportunities we provide through our events and webinars throughout the year. We also know that a sense of community is really important to many of you. So, to build on this, we're excited to enter a new phase of member communication by providing you with an environment in which to connect, engage and share critical human factors and ergonomics knowledge, news, information and best practices in real time...

Announcing the launch of Communities, our new online member discussion forum, where you can contribute, share and collaborate. It's a secure area just for CIEHF members through a single sign-on via MyCIEHF, and is accessible at any time from any computer, tablet or mobile device. You can use it to ask questions, discuss and debate issues, share ideas and compare notes.

Through the accompanying Library Resources, together we can build up a human factors and ergonomics knowledge base that's searchable, easily discovered and downloadable, and of benefit to all members.

This is an evolving resource that will change and improve as we go but it does rely on your engagement and involvement. We're starting with a community called 'Open Forum', where any member can jump straight in and ask a question, put forward an idea or share information. We'll also be setting up a number of smaller communities as and when we see particular interest in various sectors.

So please take a look and try it out. We look forward to your feedback and suggestions on how we can make this a member benefit you can't do without.

For more details, including how to set up your profile and notification preferences, the 'rules of the road' and how to access this new resources, log in to your **MyCIEHF** account and look for **Communities** on the MyCIEHF menu.

IMAGE: SHUTTERSTOCK / ISTOCK

MIDLANDS

SAMMIE saves lives

Why are heavy goods vehicles overrepresented in accidents involving cyclists and other vulnerable road users? Dr Russell Marshall and Dr Steve Summerskill from Loughborough Design School's Design Ergonomics Group use digital ergonomics, via SAMMIE, to explore drivers' visibility from heavy goods vehicles in order to understand this, to influence policy and to save lives.

This evening event on 18 September in Loughborough will give a fascinating insight into how applied ergonomics is having a direct impact on the safety of vulnerable road users. Loughborough Design School's state of the art Digital Human Modelling has led to the development of a new Direct Vision Standard for London and is being written into the General Safety Regulations for Europe. This demonstrates how ergonomics can be used to affect real world policy change, improving system performance and human wellbeing.

For more details, visit **events.ergonomics.org.uk/event/sammie-saves-lives/**

Investigating health and safety

Hard hats ready for use

Learn about the vital work of the HSE Science and Research Centre in health and safety investigation on 18 September. During this afternoon event at the Centre in Buxton (formerly known as the Health and Safety Laboratory, HSL) you'll have a site tour and be able to listen to talks on the ergonomics work that is carried out there.

The Centre's expertise includes detecting and addressing workplace health and safety hazards, developing and improving the safety of products or equipment, and assessing the potential impact of real-world incidents. The Centre can also help businesses adopt industry good practice in process safety, Major Accident Hazard control and risk management.

For more details, visit **events.ergonomics.org.uk/event/health-and-safety-research/**

CIEHF events at a glance

For more details of all CIEHF events, see our website at **events.ergonomics.org.uk**

Eligible for CPD Lifelong Learning

EVENT	WHEN & WHERE	DETAILS
Health and Safety Research	Wed, 18 September 2019, Buxton	Learn about health and safety investigation, developing and improving equipment safety and assessing the potential impact of real-world incidents.
SAMMIE saves lives	Wed, 18 September 2019, Loughborough	Using digital ergonomics to explore drivers' visibility from heavy goods vehicles to understand cycle accidents, to influence policy and to save lives.
Designing for People	Wed, 9 October 2019, London	How inclusive design can be used to design better products and services for the widest range of human capabilities at a sensory, cognitive and physical level.
Medical Packaging and Labelling	Wed, 23 October 2019, Birmingham	Your chance to work collectively to understand and make recommendations for the future labelling and packaging of medicines and medical products.
Careers Day	Wed, 26 February 2020, Birmingham	Featuring the very best of careers insights, advice and inspiration from those already at work and from companies looking for new talent.
Ergonomics & Human Factors 2020	Mon-Wed, 27-29 April 2020, Stratford-upon-Avon	Masterclasses, keynotes, talks, posters, workshops, discussions and lively social activities packed into a three-day showcase event.
Organisational Design & Management 2020	Sun-Wed, 26-29 July 2020, Stratford-upon-Avon	An in-depth look at work systems design, technological change, learning organisations, communication, lean production systems and much more.

Please note that some events details may be subject to change after publication. Please check the events website for up-to-date information.

Optimising the human contribution in NATS

The NATS Human Factors team plays a key role in maximising the safe and efficient operation of more than 2.4million flights every year in UK airspace. The team includes ergonomists, psychologists and human factors specialists with a worldwide reputation for optimising human performance.

To find out more about the work we do, services we provide, or experience we might be interested in, please contact NATS Head of Human Factors neil.may@nats.co.uk or visit www.nats.aero and search human factors.

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CONTENTS

The magazine of The Chartered Institute of Ergonomics & Human Factors

NEWS AND CURRENT AFFAIRS

APPLIED ERGONOMICS AND HUMAN FACTORS

COVER IMAGE: GETTY

RESEARCH MATTERS

CIEHF NEWS

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FROM THE PRESIDENT

A vision and plan for the future

Bob Bridger
CIEHF President

president@ergonomics.org.uk

Our Council has just approved the outline of CIEHF's new Strategic Plan for the next five years. The plan will guide the Institute in deciding how and where to allocate our resources in accordance with our mission and where to scale back activities that no longer align with the plan.

The vision underpinning the plan is *"A world where integrated design improves life, well-being and performance"*. This seems to be admirably succinct, firmly rooted in the original aspirations of our founders to *'fit the task to the man' (sic)* whilst conveying a positive and forward-looking message with the emphasis on design. At the same time, it suggests a systems approach where people are part of the system from the start. Our mission is also conveyed very succinctly: *"The pre-eminent professional home and voice for human factors"*.

So, we know who we are and we know what our mission is. But is our voice as unified as it should be? In the space surrounding human factors and ergonomics, including domains such as healthcare and safety, misconceptions of human factors are common, focusing on human behaviour and how it affects operational safety. Deeper questions and the systems approach are lacking.

Human factors is about systems; the processes used to design systems and taking into account the 'human factors' that place constraints on the design, while providing opportunities for innovation. In contrast, the 'folk models' of human factors that surround our space focus on people and attempt to change the way they behave: *'fitting the man (sic) to the task'* and offering a 'sticking plaster' model for the cottage industries of the 21st Century.

These and many other strategic matters will be taken up by our new Chief Executive, Noorzaman Rashid. A warm welcome to Noorzaman who arrives at an exciting time and introduces himself in this edition of *The Ergonomist*.

Our vision is admirably succinct, conveying a positive and forward-looking message

FROM THE EDITOR

Big companies, big impact

In this issue, we're very pleased to feature the impact of human factors work taking place at three major organisations. For our cover article, Peter Beecroft explains some fascinating safety-critical work taking place at Rolls-Royce, which focuses on the company's drive to enable aircraft engines to independently understand their own condition and autonomously request actions from the flight or maintenance crew.

The diverse and invaluable work of Network Rail's Ergonomics team is captured with great clarity by Richard Bye who describes the team's instrumental role in everything from implementation of new machinery, to digital interface design, to policy decisions.

We also get a behind-the-scenes look at the human factors work taking place at distribution giant, Amazon. Raz Osman talks us through the drive at fulfilment centres to ensure technology is used to best serve the people that work there, from picking ordered items to loading of trucks.

Barry Kirby reveals plans to ensure public engagement in development of smart towns and cities, whilst Kirsty Angerer gives an insight into her business success as a consultant. Jo Davies reports on a great Regional Group event looking into transport research.

Pharmacist Keith Long provides details about the human factors elements of managing a pharmacy, and Francis Micallef explains the work and culture of the Mediterranean island of Malta.

And, last but definitely not least, we introduce two new colleagues.

Tina Worthy
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LEADERSHIP

A new hand on the helm

Noorzaman Rashid joined the CIEHF as our new Chief Executive on the 1st of October. He's already hit the ground running in working closely with his predecessor, Steve Barraclough, together with the Trustees, to gain an understanding of our organisation and to input to our strategy for 2020-25.

He brings to the CIEHF a track record of leading and working with professional services firms, membership and regulatory bodies. He is a former Master of the Livery Company for Management Consultants and has chaired several national organisations focused on education and healthcare. At Warwick Business School, he led work in South Africa, Japan, the USA and Russia.

Noorzaman studied Three-Dimensional Design (and ergonomics) at university. After winning a bursary he studied operational research and manufacturing. His career spans several phases that include public service and private practice. Noorzaman has complemented his career with leading and chairing several national and international charities. The founder of a Multi-Academy Trust, he opened 30 new academies across England between 2007 and 2012. He's also served as non-Executive Director of the NHS Institute for Innovation and Improvement for five years.

His clients over many years have included The Law Society, British Dental Association, Royal Institution of Chartered Surveyors, Royal Institute of British Architects, Royal College of Nursing, The Environment Agency, The Medicines and Healthcare Products Regulatory Agency and the Human Fertilisation and Embryology Authority. Government Departments he has worked for include the Cabinet Office, the Ministry of Defence and the Departments of Health, Education and Transport. This broad experience, he says, provides him with deep empathy and understanding for the sectors that CIEHF is focused on.

Noorzaman says: "Our discipline is a growing science in a rapidly evolving world. We have an opportunity to become the pre-eminent professional home and voice for everyone working in ergonomics and human factors."

He believes that the CIEHF punches well above its weight and is on a journey to become a world-class body representing, supporting and helping its members achieve more. Noorzaman himself is an extremely energetic and articulate leader, collaborative in style, a teamster, he listens intently and is very good at joining the dots between quite diverse issues. He says he is completely dedicated to making CIEHF the best membership body it can be.

Born in Yorkshire, he carries a recognisable twang in his accent. Outside of work and charitable activities he is an avid book collector and is building a private library. His interests include future-tech, fine art, Formula 1 race strategy ("There's no point in watching a race if you don't understand the strategy!") and rugby union. When he gets bored, he teaches cookery for fun!

Our discipline is a growing science in a rapidly evolving world. We have an opportunity to become the pre-eminent professional home and voice for everyone working in ergonomics and human factors

Noorzaman Rashid

Response to critically unwell patients

An independent report by the Healthcare Safety Investigation Branch (HSIB) into recognition and response to critically unwell patients has been released.

The HSIB undertook a national investigation exploring the human factors issues which may influence recognition and response to a patient who is critically unwell. It followed the case of a 58 year-old woman who was admitted to an Emergency Department with severe abdominal pain after surgery 13 days previously. Despite regular observations and review, and transfer to the Intensive Care Unit, her condition deteriorated and she died.

HSIB was notified anonymously with specific concerns relating to the limited recognition and response to the seriousness of the patient's condition. The investigation reviewed relevant research and safety literature, engaged with subject matter advisors and consulted with professional bodies. The investigation also explored human factors issues, focusing on: situation awareness and decision making; patient assessment models for the emergency department; the number of publications and guidelines available to clinicians; and the use of the National Early Warning Score (NEWS).

HSIB found that contributory factors that influenced decision-making were interrelated and systemic. One factor was that information about the patient was spread across different types of documentation and clinical staff, and the design and presentation of this information did not support staff in making a complete and accurate assessment of the patient. Another factor was that the information eroded at each stage of the patient's care pathway.

Recommendations from HSIB included continued evaluation by the Royal College of Physicians NEWS advisory group of the implementation and use of NEWS2. This is the latest version of the National Early Warning Score first produced in 2012 and updated in December 2017, which advocates a system to standardise the assessment and response to acute illness. HSIB recommended particular notice be taken of the consistency of recording and response and communication of patient details.

Following publication of the report, the Royal College of Physicians has formed a NEWS2 advisory group which recognises that there are key areas of focus including "assessing the use of NEWS2 in practice and its effectiveness in identifying the level of acute illness in different patient groups and settings, how the presentation of NEWS2 supports clinicians to identify trends, and training on the use of NEWS2".

For the full report, visit **www.hsib.org.uk/investigations-cases/recognising-and-responding-critically-unwell-patients** ●

IMAGES: ISTOCK

Passengers allowed in self-driving cars

Chinese automaker SAIC motor group, Germany's BMW and ride-hailing company Didi Chuxing are the first companies to receive permits to carry passengers and freight in self-driving vehicles on Shanghai's streets. Trialling a fleet of 50 vehicles, each applicant must have carried out more than 24,000km and 1200 hours of passengerless testing in Shanghai's Jiading district without accidents to get approval.

The move, which saw the country do away for the first time with rules limiting companies to passengerless road tests, could be a step towards allowing widespread adoption and commercialisation of autonomous driving in the city.

For more details, visit **technode.com/2019/09/17/shanghai-first-permit-av-pilot-service** ●

Guidelines for work systems

The International Ergonomics Association is collaborating with the International Labour Organization to create high-level guidelines and recommendations for human factors and ergonomics in work systems. These guidelines will be used by regulators, policy makers and heads of organisations to implement effective human factors and ergonomics in the design and maintenance of sustainable work systems and for new initiatives for worker safety, health and wellbeing. The document will be circulated globally and should have a significant impact on national and organisational policies regarding human factors and ergonomics in work systems design. See **www.iea.cc**. ●

Malta is a small country with just over half a million inhabitants. It's experienced a veritable sea change in its economy and demographics especially since the country became a member of the European Union in 2004. **Francis Micallef** tells us more

An ergonomics perspective from Malta

During recent decades Malta's employment profile shifted from a situation where the British Services (up to 1979) and government employment were the major source of jobs and careers, to an economy based on financial services, manufacturing, tourism and online business. The manufacturing base is represented by a very strong pharmaceutical and life sciences sector, food and beverage industries, aircraft and ship maintenance services, and a host of other manufacturing concerns. International names in these sectors have set up shop in Malta. Primarily attracted by cheaper manufacturing costs, they are now more attuned to the Island's favourable position as part of the EU, incentives and taxation structures, strong IP framework and English-speaking population.

Malta has established itself as a logistical centre. Boasting one of the largest freeports in the Mediterranean and with a growing shipping and aviation register, the logistics sector has grown considerably and with it a host of new job sectors in transshipment, transportation, warehousing and associated activities. This has also resulted in a rise in containers and goods using the roads and ports.

From an ergonomics perspective, there has been a definite shift from labour-intensive jobs with a heavy manual component to more desk-based jobs. Manual labour has shifted from repetitive factory jobs to more automated production processes and specialised technology-based careers.

An influx of workers from other countries has resulted in a cultural mix in the labour force. Such a mix is culturally enriching but also presents problems in communication, diversity in work practices and work standards. An example is the very vibrant healthcare industry which is nowadays mainly staffed by workers from Asian countries like India, Pakistan and the Philippines.

A look at the developments in industry and future niches that are being developed indicate a more diverse workforce and a wider spectrum of occupations. An example is the budding medical cannabis industry, which is expected to take off in the next five years, bringing with it a host of new jobs in cultivation, extraction, analysis and production, which are virgin territory for local ergonomics specialists.

Ergonomics in Malta is very much at an embryonic level. In truth, concepts of occupational health and safety have only gained ground in the past 20 years but are mainly focused on the traditional concepts. Ergonomics is mostly associated with very basic approaches, with specialists in the field being few and far between, and there is no organisation that represents them and sustains this profession.

The construction industry remains one of the primary sectors in Malta. Despite its small size, the country has a very vibrant (some say too vibrant) construction industry. High rise buildings are now being actively promoted to cope with the increased demand for residential and commercial units, and to safeguard the limited

People fishing in Marsaxlokk village, Malta

Workers monitor the beer brewing process from the control room at the brew house at Farsons Brewery in Mriehel, Malta

footprint of the island. A very vigorous road network upgrade is also contributing to a spike in this sector. However, this industry is notorious for its general lack of occupational health and safety ethos and ergonomics is very much conspicuous by its absence. The interaction between humans and heavy machinery is rarely understood and applied, resulting in a high incidence of injuries and long-term postural issues.

Malta boasts of a good level of healthcare both in the primary sector and also in acute care. Its hospitals are relatively new with general and oncology hospitals having been built in the last 15 years, with paediatric and mental health hospitals in planning. A thriving private sector is also present. Geriatric care is also well established and expanding, reflecting the ageing population and its needs. The ergonomic aspects of patient handling is an area that is being tackled by the individual institutions but a more generic and systematic approach would be preferred, given the high mobility of staff within this sector. A growing area of concern in this sector is stress and patient-carer psychological interactions.

The tertiary sector covers a wide range of activities including banking, financial services, fiscal representation companies, aviation maintenance, insurance, gaming and betting industries, and call centres. Mostly desk-based work and, in many cases, requiring long hours at computer workstations, this sector presents a host of issues in ergonomics especially with regards to postural problems, high stress levels, office environmental standards, etc. Corporate names such as HSBC, Microsoft and Lufthansa Technik have centres in Malta and such corporate giants bring with them internal competencies in this field. However, a large number of other companies do not have the in-house capabilities to cover ergonomics and rely on third party consultancies.

A strong pharmaceutical and life sciences sector, together with university and higher technical colleges has resulted in over 500 active laboratories in Malta including medical/clinical, educational, quality control, research, forensic, petroleum analysis and construction material analysis. Though widely varying in function, these environments present a wide range of issues, and analysts and laboratory personnel seem to be unaware of adverse interactions and their consequences.

A culture change and increased awareness of ergonomics in the workplace is something that needs to occur in the Maltese population in general, and the workforce in particular. Managements are still grappling with the basic concepts and more often than not are just paying lip service to this science and its application in their organisations. A recent empirical study amongst a selected group of educators has also exposed a scant knowledge of ergonomics issues regarding teaching staff, school support staff and students.

Specto Ltd has carried out a gap analysis to identify areas where the country still lacks educational and training opportunities in these sectors. A number have been identified and ergonomics is one such area that formal educational institutions barely cover. Specto hopes to set up a training academy in these areas and to include ergonomics as part of the academy's curriculum.

Francis Micallef is Managing Director of Specto Ltd, a company focused on environmental and waste issues, as well as occupational health and safety, and ergonomics. A graduate in industrial chemistry, Francis is in the process of setting up a training academy in applied sciences.

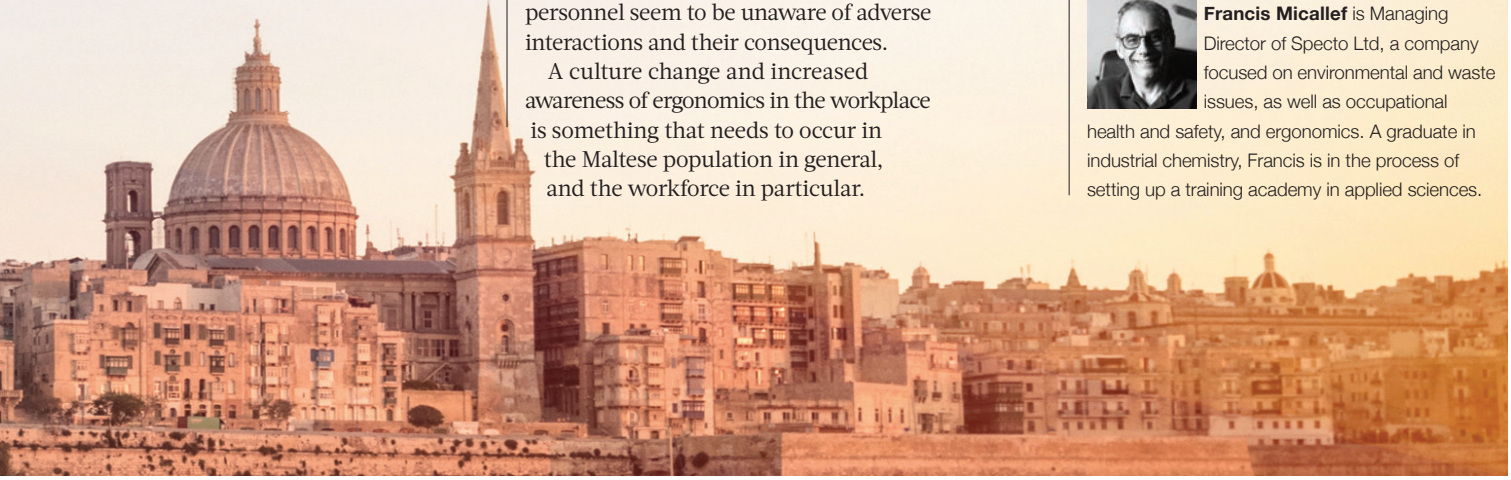

IMAGE: ISTOCK / REUTERS / ALAMY

Autonomous vehicles, plant-based burgers and Beijing International airport below

CHIEF EXECUTIVE'S PERSPECTIVE

The next twenty years

Ensuring that integrated design contributes to improving human life, wellbeing and system performance is a good mantra to help explain to others how our discipline and science will continue to make the world a better place.

In the next two decades, the rise of the flexitarian (someone following a plant-based diet with occasional meat) will have a major impact on food farming and production, impacting everything from school meals to medicines, as the young move increasingly to a completely plant-based diet. Burger King has seen a 50% increase in burger sales since the introduction of the 100% plant-based 'impossible' burger in the USA. Ethical debates around the consumption of animals and the environmental impact will play its part in this evolution.

As gaming technologies advance exponentially, they will continue to influence the design of everything from parking systems to fighter aircraft, like the sixth generation *Tempest* (a proposed stealth fighter aircraft). Due to be in service by 2040, pilots will be wearing helmets designed to anticipate their reactions, providing a full view of all instruments projected onto the helmet visor. The pilots flying this aircraft may not yet be born! Suzy Broadbent, Human Factors Lead at BAE Systems and Amanda Widdowson, Human Factors Capability Lead at Thales, separately reminded me that we need to correct historical anthropometric data being downloaded and used by designers to ensure that the data is inclusive.

Autonomous vehicles on our roads are likely to be a reality in this period too. But how much of what's going on is about the aesthetic design and technology versus the human factors? There is no doubt that the creators are still struggling with the technology. Joseph Giacomin, Professor of Human Centred Design at Brunel University, points out that designers of autonomous vehicles need to increase their attention to anthropomorphism - the attribution of human traits, emotions or intentions to non-human entities. As these vehicles will be sold around the world, there's a requirement to consider diversity and inclusion, as different cultures are likely to react and respond differently to everything from colour, shape and voice. The same will be true for the design of the helmet for the *Tempest* fighter aircraft.

You might almost believe 2040 has arrived when looking at the recently opened Beijing Daxing International Airport, designed by the late internationally renowned architect Zaha Hadid. The single terminal airport covers 700,000 square metres (equivalent to 97 football pitches) and with seven runways planned, it will ultimately handle 100 million passengers a year by 2040. The airport's terminal manoeuvring area is the first in China to deploy MAESTRO's (Means to Aid Expedition and Sequencing of Traffic with Research of Optimisation) AMAN and DMAN (Arrival and Departure Management) function technology to optimise flight sequencing and airport efficiency. It does this by continually calculating a proposed landing sequence and helping to determine the separation between the arriving aircraft. The TopSky Air Traffic Control system, along with the one deployed for Area Control Centres and Towers, forms the largest scale Air Traffic Control system in the world, with 290 controller working positions covering the northern China region. And yes, you guessed it, there will be lots of customer-service robots to deliver flight information and facial recognition-enabled check-in.

As the new Chief Executive of the Chartered Institute of Ergonomics and Human Factors, my strategic objective over the next five years is to promote CIEHF to become the pre-eminent professional organisation for our discipline and science. I know that many of our members work in the areas I've highlighted here and, if you're one of them, I'd be very interested to talk to you about your thoughts and ideas for the future of the discipline and its influence in seeing these advances come about. Please do get in touch.

Noorzaman Rashid
Chief Executive of the CIEHF
Noorzaman.rashid@ergonomics.org.uk

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Gaming technologies will continue to influence the design of everything from parking systems to fighter aircraft

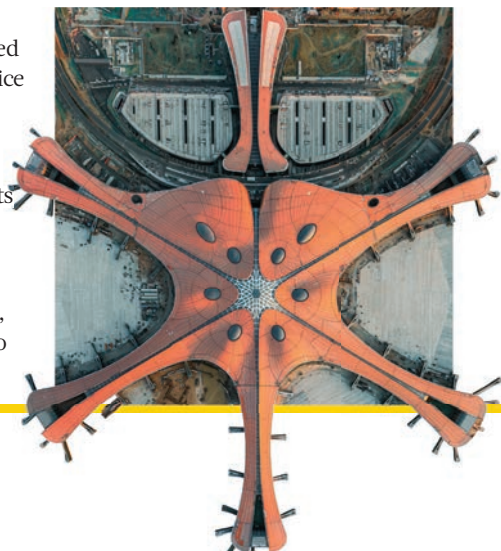


IMAGE: SHUTTERSTOCK / ALAMY

Stress inspections to stop work 'burnout'

The Health and Safety Executive (HSE) has started inspections for the first time to tackle work-related stress, a significant workplace mental health issue. Work-related stress is at its highest levels since the HSE started to collect data in 2001 and has been in a relentless upward trajectory since 2014. The HSE's step towards ensuring companies are proactively reducing work-related stress with its 'Go Home Healthy Campaign' comes after the World Health Organisation classified 'burnout' as a legitimate diagnosis.

According to HSE research, stress is the second most commonly reported cause of occupational ill health in the UK, accounting for 44% of all work-related cases and 57% of all working days lost due to ill health. The legislation which states employers are responsible for doing a stress risk assessment and acting on it to prevent work related stress isn't new, and has been a part of the Management of Health and Safety at Work Regulations since 1999. Work related stress has also been a health priority for the HSE since 2009.

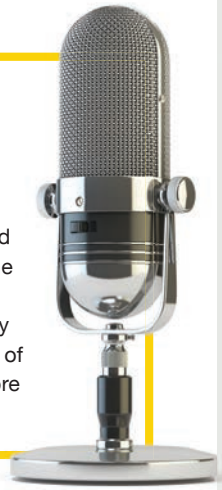
The HSE has stated in its management standards for tackling work-related stress document that, "The HSE expects organisations to carry out a suitable and sufficient risk assessment for stress, and to take action to tackle any problems identified by the risk assessment. The standards are intended for the employer to do this and to show they have done so."

The HSE has also stated it's looking for employers to take a proactive stance to managing work-related stress through the adoption of a management standards approach with more HR and safety professionals trained to competently implement them. The clamp down follows the introduction of the 'Time to Change' pledge, a national programme developed to address stigma in the workplace around mental health.

For more information on the HSE Go Home Healthy campaign visit **campaigns.hse.gov.uk/go-home-healthy/work-related-stress**

New human factors podcast

Barry Kirby of CIEHF Registered Consultancy K Sharp has launched '1202 Human Factors Podcast' on Instagram to discuss some of the latest findings, musings and thoughts surrounding human factors. In his most recent podcast, Barry talks about agile working, the way human factors in defence differs from other environments and a bit of the crossover between human factors and user experience. For more details, visit **https://bit.ly/2kNU0z1**



IMAGES: ISTOCK

VR safety training

The Human Factors Research Group at the University of Nottingham is applying Virtual Reality (VR) to training to help improve employee safety. Their study looks at health and safety training, such as evacuation drills, offering guidance on the implementation of virtual environments, to provide a more engaging and effective training experience.

Evidence suggests, unsurprisingly, that the more realistic the training, the more appropriate the reactions of people in a real emergency. But realism is obviously difficult to achieve in training if it means there is a risk of injury, or worse, to participants.

The VR system developed allows a more realistic situation to be experienced than through audio-visual alone. It stimulates people's perception of temperature, smell, sight and hearing to investigate their behaviour in different scenarios. In one case, participants escaped from a virtual fire in an office, seeing and hearing using a VR headset but also experiencing heat from three heaters and smoke from a scent diffuser, creating a multisensory virtual environment.

As part of the study, traditional classroom training using slides was compared to the VR training. Participants completed questionnaires which tested their knowledge of two safety situations, before and after training and one week later. Despite apparently gaining more knowledge through classroom training immediately afterwards, knowledge of those participants faded more in the week following than for participants undergoing the VR training.

Talking to *The Manufacturer*, CIEHF Fellow, Dr Glyn Lawson, Associate Professor in the Faculty of Engineering at Nottingham, said: "Health and safety training can fail to motivate and engage employees and can lack relevance to real-life contexts. Our research suggests that virtual environments can help address these issues by increasing trainees' engagement and willingness to participate in further training."

For more details, visit **https://bit.ly/2kx92sL**

A DAY IN THE LIFE OF A...

PHARMACIST

Keith Long, Pharmacist

Many days involve me in practising my profession in the capacity of a locum, and on those days I start early. I've recently curtailed my journeys to within the immediate area of my home in Dorset; I previously accepted appointments in the surrounding counties which involved very early starts, though the long drive allowed me to mentally prepare for the day. All dispensaries are different and in order to effectively work in them I need to know where such things as office items and bins for confidential waste are placed. The human body takes time to adjust I find. If I'm not thoughtful I spend my time automatically going to where things were at a different branch yesterday. Thinking ahead gives my brain the time to adjust and make the day slightly easier.

On most occasions I'll be operating as the Responsible Pharmacist which involves being in overall control of the particular pharmacy. Requirements for me involve monitoring and recording refrigerator temperatures. This may seem trivial but it's very important because a lot of new generation drugs are proteins which are readily destroyed or deactivated by heat and therefore need appropriate storage. These drugs are delivered separately and an audit trail has to be maintained to ensure there is no degeneration.

I also have to sign in and display an approved notice identifying that I am in control of the pharmacy and including my General Pharmaceutical Council registration details. I enjoy my time with the staff, many of whom I've worked with before. It's very important that there is cohesion in our activities so I'm happy to perform any functions that are needed and of course, being involved makes it easier for me to be aware of what's happening.

There are two main elements to the work of a Responsible Pharmacist. The first is the familiar one of being involved in the receipt of prescriptions, both NHS and private, together with their subsequent dispensing. There are many things which can be problematic in this process, for example, the legality of the document is of primary importance. On rare occasions, I've received stolen, altered prescriptions, or 'scripts', associated once with the mis-use of a doctor's telephone number as a back-up. I hesitate to describe too precisely as I have to be open to novel possibilities. Identification of the correct patient is obviously important too and scripts with incorrect personal details are not so rare. Electronic scripts will help to reduce these possibilities in the future, though new technology can introduce its own potential for things to go wrong.

We also need to evaluate as best we can whether or not the components of the script are compatible with each other and suitable for the patient's medical situation, age, gender, etc. Anomalies can arise and perhaps cause a delay which is, in my experience, never well-received; parking charges, appointments at hairdressers, orders for coffee, dogs outside, all seem to be considered more important. An ability to be somewhat assertive is helpful and one of my functions is to protect staff from unreasonable patient behaviour.

Being able to assess risk is crucial in understanding the analysis of procedures

The delivery in-store of medicines involves us in advising as to the dosage of the individual items and where appropriate, the methodology of use of any devices such as inhalers, potent steroid creams or surgical items prescribed. Again, there is a requirement to be absolutely certain as to the correctness of the process.

All these components require real-time, active supervision. An ability to monitor a number of current events is vital and it's important to be prepared to intervene as and when required.

The other main component of my day is the supervision of the sales of medicinal items. This is a duty laid down by laws going back to the Pharmacy and Poisons Act of 1933. A foundational, friendly test case involving the then Pharmaceutical Society of Great Britain and Boots Cash Chemists (Southern) in

1951 established the rules governing our responsibilities. It was this case that established that items in shops are being *offered* for sale by the retailer, who is under no obligation to sell such items. The retailer has to consent to the sale. This is where things can become difficult. Many people think they have an absolute right to purchase any item they wish. In the case of medicines, their use has to be within the requirements of its licence, so I would be wrong to allow a sale which may be injurious to the patient or would not improve their situation. The concept of guilt by omission is constantly with me! Take the patient with a persistent cough; they could perhaps have a more serious condition. Rather than sell a product, a referral to his GP would be much more appropriate. Again, such advice is not always received with unbridled enthusiasm. So, I need to oversee or hear the many conversations and requests that occur during the day and to act accordingly.

Provisions of the Misuse of Drugs Act require me to record the receipt and delivery, either by sale or by way of dispensing, of any items listed in appropriate Schedules of the Act. I prefer to do this when the transactions happen, as the details of recipient and other data are fresh in my mind. The Safe Custody Regulations require me to ensure that all appropriately Scheduled items are stored in an approved, locked Controlled Drugs Cabinet.

Other interests of mine include researching the background to patient safety issues. In my view, healthcare lags other safety-critical industries such as aviation, military and nuclear in addressing safety. Its record worldwide, as seen on the World Health Organisation website, leaves no room for complacency. I intend to help academic colleagues to improve the methods of introducing healthcare students to better training. My contribution is augmented by my membership of CIEHF, since I have access to excellent articles and advice about the situation in healthcare and other industries.

Reading around the topic involves me learning many other subjects, for instance, I've had to gain a knowledge of statistics. Being able to assess risk is crucial in understanding the analysis of procedures. Some events are random, others are the result of a chaotic origin, and prevention of these requires different approaches. Likewise, a background in psychology is needed. What is the origin of cognitive dissonance, or contradictory beliefs, for example? I recently read an article addressing the effects on performance of not being busy enough. Moving from an idling situation to a busy work environment without some sort of break can be problematic. This is an area which until now has not been adequately researched and is one which I'm studying at the moment.

My main thrust now is the use of Standard Operating Procedures (SOPs). Are they orders or do they leave room for individual decision-making? What happens if you follow an SOP and there are adverse consequences? There have been situations where following such laid-down procedures has resulted in horrendous consequences, for example, the Piper Alpha tragedy. All in all, I'm seeking to understand these issues in the context of pharmacy. ●

Keith Long is a pharmacist with interests in science and has studied with the Open University and with professional bodies allied to his own. He's a Senior Associate of the Royal Society of Medicine, a Fellow of the Linnean Society of London, and a Member of the Royal Institution.

Keeping it all on track

No complex socio-technical system would be complete without its own set of equally complex human factors considerations, and there's no better example to be found of this than on Britain's railway, as **Richard Bye** explains

With 20,000 miles of track, weekly investments of millions of pounds in improvement projects, and a workforce that includes over 5,000 signallers and controllers, the GB railway relies on multiple strands of human factors activity from its infrastructure manager, Network Rail. Responsibility for Network Rail's human factors work lies with the organisation's in-house Ergonomics team. Led by Head of Ergonomics, Mike Carey, the multidisciplinary team works to manage, undertake and co-ordinate physical, cognitive and organisational ergonomics activity across the whole of the rail network.

A rich history

The team was formed in 2001 amidst a growing recognition of the need for human factors integration within the rail industry. The catalyst for the increased interest in rail came from the train accidents at Southall and Ladbroke Grove in the late 1990s. Subsequent public inquiries, and the resulting recommendations, highlighted the need for a specialist systematic focus on a number of issues including human error, alertness, fatigue management, signalling system design, training and supervision. This attention on human factors galvanised the rail industry and ultimately helped to bring about the first incarnation of what's now known as Network Rail's Ergonomics team.

The original remit to embed human factors and ergonomics activities throughout the organisation remains at the heart of the team's work today, as does the systems thinking approach championed by Professor John Wilson, who was a Principal Ergonomist at Network Rail.

Described as "the father of rail human factors", John made some of the most important contributions to the discipline and his seminal work continues to be studied across the globe. Sadly, John died in 2013 but his legacy looms large, indeed when faced with philosophical questions the team often invokes the *What Would John Wilson Do?* cognitive ergonomics method!

Pivotal role

The importance of ergonomics work to Network Rail cannot be overestimated. Although the organisation has seen massive changes over the past two decades, and whilst the political, economic, social and technical landscapes

Railway track workers and Network Rail Senior Ergonomics Specialists Balraj Sreenivasan and Gareth Tucker

that shape the rail industry have shifted, human factors activity remains a constant at the intersection of railway engineering, operation and maintenance.

With that being said, there is no Network Rail human factors playbook, no ergonomics silver bullet. Instead, each piece of work is subject to individual consideration. Articulated and unarticulated needs, objectives and expectations are identified, whilst context and nuances are carefully examined. What then follows is the creation of bespoke strategies and solutions; combinations of tried and trusted tools and techniques, augmented with applied research and lessons learned.

To deliver ergonomics support to the business, team members, who have an average of 12 years of rail industry experience each, draw upon their own academic work and domain knowledge, as well as expertise gained from previous roles in a variety of sectors, including oil and gas, nuclear, automotive, defence, banking and aviation. Importantly, the team also depends on the additional support and capabilities offered by CIEHF Registered Consultancies, and Chartered members, who work throughout the rail supply chain on remits specified and assured by the team.

Breadth of work

Deployed country-wide, the team works across a diverse array of initiatives. Indeed, a quick straw poll on the day this article was written found members variously testing the operability of a twin-track stair climbing machine, completing a walkthrough inspection of a new station, evaluating incident room observations, system data analysis, workshops, cognitive task analysis and structured interviews.

The analysis found that the successful roll-out of monitoring technology had outpaced the ability of the FEs to keep-up, with more data streams coming online without the parallel activities required to consolidate information and workflows. The high workload required to monitor daily activity had removed the capacity necessary for both non-critical calibration and trend analyses, and this reduction in proactive work was leading to compounding increases in the volume of spurious alerts and alarms.

The Ergonomics team made a number of recommendations, detailing proposals for:

- Investments in human-centred technology development.
- The refinement of business processes.
- Additional training.
- Specific levels of staffing increases.

Implementation of the recommendations is currently in progress, and as a result the resilience of the railway infrastructure, and the people in place to look after it, has already been significantly improved.

CASE STUDIES

Manual handling improvement project

More than 60,000 people work on the railway tracks every year, many of whom move supplies and equipment to and from site, over long distances, and across uneven terrain. These manual handling activities increase the risks of slips, trips and falls, and can result in lost time injuries, musculoskeletal damage and long-term absence.

A manual handling improvement project was set up to reduce the risks of injury that result from the transport and use of machinery by those who work on, and alongside, the rail track. The project involved Network Rail's Ergonomics team collaborating with maintenance specialists to complete risk assessments, restructure procedures, and design and deliver new tools and equipment.

So far, the project has developed systems to:

- Eliminate the need for manual handling, using mechanisation and process redesign.
- Reduce the risks of physical work, through innovations to tools and equipment.
- Inform and educate the people who plan and complete the work.
- Control risks through standards, assessments and feedback processes.

A number of important benefits have already been produced by the initiative, including lighter and easier to use equipment, improved processes and risk management, and a greater awareness of good practice amongst track workers. Work is ongoing, with significant investments in time, money and expertise being made to ensure that maintenance teams have exactly the right tools, processes and equipment for the job.

Flight Engineer operational demand

Flight Engineers (FEs) work in Network Rail control centres to monitor the outputs of predictive maintenance technologies so that frontline staff can be directed towards faulty equipment and fix it before it fails. The role of an FE is a complex mix of engineering, data analysis and maintenance co-ordination, performed by calibrating and tracking the trending data and alarms from the thousands of loggers that make up the railway's Internet of Things.

Network Rail's Ergonomics team were asked to review the operational demand of FEs who monitor the signals, points and track from London to Ashford in Kent. Reports of high workload were investigated using control

IMAGES: GETTY / NETWORK RAIL

Senior Ergonomics Specialist Marcia Togara undertaking design assessments at Liverpool Street station

TEAM MEMBER PROFILE

Marcia Togara

Marcia is the team's newest member. With a degree in Psychology and Ergonomics from Loughborough, Marcia worked for Michelin, NCR and Ford before joining Network Rail as a Senior Ergonomics Specialist a year ago.

My first 12 months… have gone by in a flash. It's been a very busy, but extremely rewarding time.

The best part of the job… is the many opportunities for human factors interventions at Network Rail. There is so much to see, do and learn, so much scope for ergonomics work that can produce tangible benefits. It's incredibly satisfying to see the positive changes the team can effect.

The worst part of the job… is also the many opportunities for human factors interventions at Network Rail! There's so much going on in the team that it's easy to get a bit of ergonomics FOMO (fear of missing out)!

The biggest surprise… has been discovering how different this job is to the others I've had. Coming from an automotive and manufacturing background where everything was very structured and methodical, here I've had freedom to innovate and create new approaches, which has been really eye-opening. It's made me feel like I can make a real difference, which is very exciting.

I'm currently working on… maintenance trials for new points equipment. We've built a section of track inside a warehouse and are running through processes to create design improvements. I'm also evaluating seating requirements to enable specifications for the national procurement of specialist control centre chairs.

Over the next year, I'm most looking forward to… being involved in some of the big projects and initiatives the team have on the horizon. There's a lot of really interesting and important work coming that I'll be able to contribute to. Also, I hope to finally get to grips with railway acronyms!

IMAGE: NETWORK RAIL

management software, and discussing changes to rest break policy with Trades Union representatives.

The majority of activity undertaken by the team is either on national projects or for any one of the organisation's five regions and their associated route businesses. With each route having different priorities, the Ergonomics team must be flexible and adapt their approaches to cover a seemingly infinite range of tasks. Whether it's looking at the processes required to safeguard the use of footpath level crossings in Ipswich, analysing the workload of electrical controllers in Glasgow, managing the interfaces to HS2 in Crewe, or delivering decision support tools in Cardiff, the work required across the routes is immensely varied.

Over the years the team has made a number of invaluable contributions to the rail network, playing an instrumental role in the delivery of novel rail technologies, processes and equipment. Recent notable examples include: the introduction of smartphones, tablets and the first set of mobile apps for frontline staff; the implementation of European Rail Traffic Management Systems (ERTMS) onto the GB railway; and the design and development of enhanced equipment, tools and assessments to reduce the risks of musculoskeletal disorders.

Tomorrow's world

To respond to the ever-advancing rail system, Network Rail's Ergonomics team is closely involved with the industry-wide Digital Railway programme, contributing to its technical architecture, design and safety case, and producing and specifying human factors requirements, guidance and plans. Moreover, macroergonomic issues are driving in-house predictive and anticipatory human factors work to inform, and draw from, the ergonomics research and development agenda.

Network Rail's human factors work is helping to ensure the safety, efficiency and effectiveness of the GB railway

Predicting an influx of new technology, including inspection drones, exoskeletons and automatic train operation, the team is building on the classic works of cognitive systems engineering and ironies of automation, whilst extending the Safety-II approaches required to support successful human adaptations to the uncertainty and dynamic complexity of future safety-critical work.

By maintaining its systems-oriented perspective, and keeping a focus on innovation, Network Rail's human factors work is helping to ensure the safety, efficiency and effectiveness of the GB railway. Going forward, the Ergonomics team will continue to occupy the liminal spaces between the railways of yesterday and tomorrow, optimising the now, whilst planning for what's to come. Exciting times are ahead!

Richard Bye is a Principal Ergonomics Specialist at Network Rail.

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The journey towards autonomous flight

From artificial intelligence in engine operation to the latest technologies enhancing information on the flight-deck, **Peter Beecroft** reveals some of Rolls-Royce's vision on the future of flight, taking into account the complexities of human behaviour

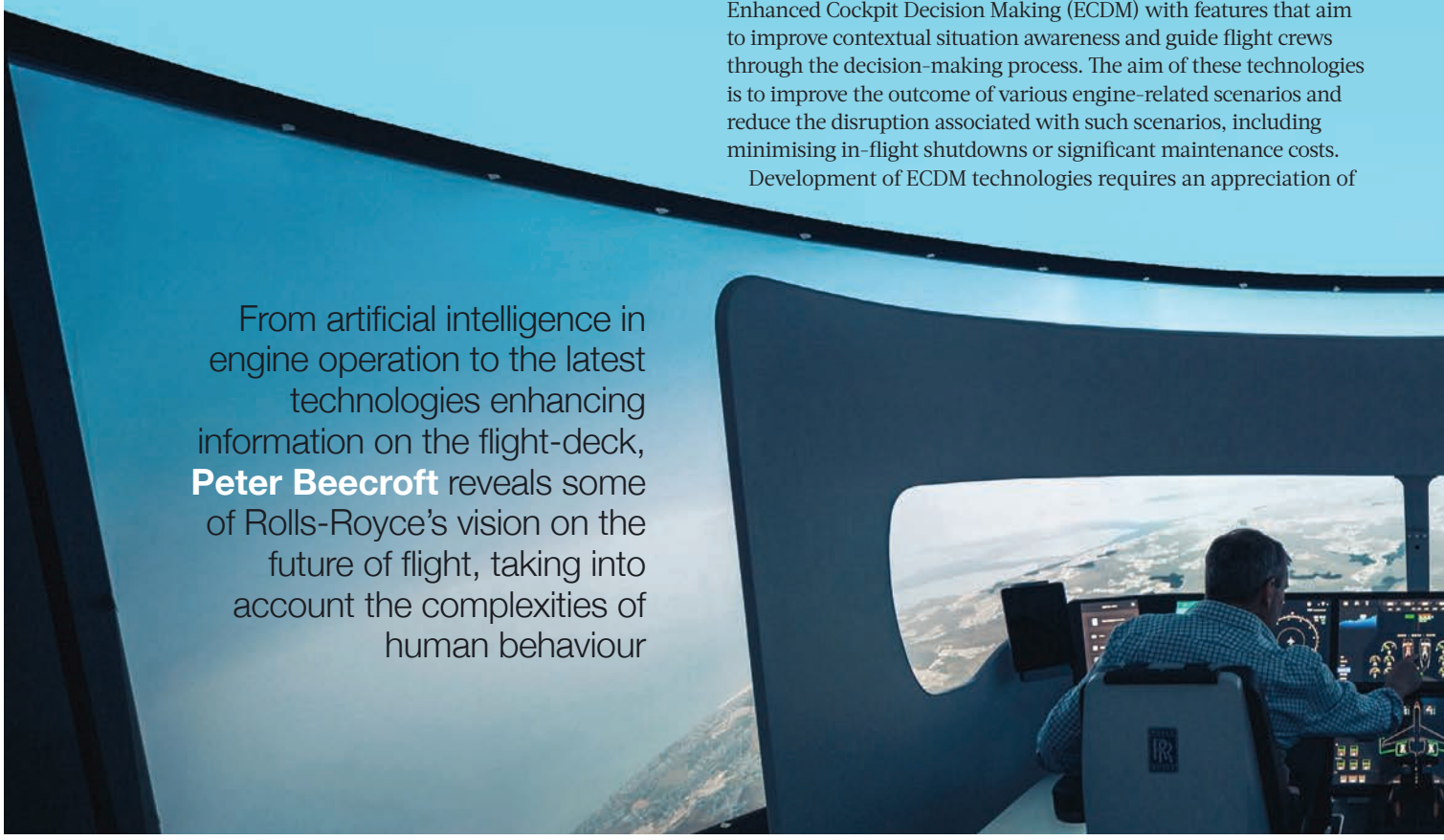
Aircraft flight-deck displays pertaining to engine parameters have changed relatively little since the early days of powered flight. Old analogue dials and gauges for parameters such as engine shaft speed and temperatures have often merely been replaced by digital equivalents displayed on screens in modern 'glass cockpits'. The aviation industry is naturally cautious, and any new technology is required to undergo rigorous testing and certification procedures, which can hamper innovation on the flight-deck. This slow progress has persisted despite the range of sensing equipment and capability of processing equipment on aircraft engines having evolved significantly.

The paucity of information presented by these indicators has resulted in some situations in which the flight crew have had insufficient contextual situation awareness of the condition of an aircraft's power plants. Ultimately, this means that they have been unable to make the most optimal decisions in some situations. Real-world examples of this include a bird strike on a GoAir A320 flight from Delhi on 21 June 2017, where a lack of information available to the flight crew resulted in the incorrect engine being shut down.

For many years Rolls-Royce has been at the forefront of 'IntelligentEngine' concepts, producing engines that are more connected, more contextually aware and more comprehending. To date, much of the 'intelligence' relates to on-board engine monitoring and advanced off-board data analytics. In the future however, Rolls-Royce is proposing to take advantage of their significant advances in on-board processing and artificial intelligence to enable engines to independently understand their own condition and autonomously request actions from the flight crew or maintenance crews.

Rolls-Royce is developing a suite of technologies known as Enhanced Cockpit Decision Making (ECDM) with features that aim to improve contextual situation awareness and guide flight crews through the decision-making process. The aim of these technologies is to improve the outcome of various engine-related scenarios and reduce the disruption associated with such scenarios, including minimising in-flight shutdowns or significant maintenance costs.

Development of ECDM technologies requires an appreciation of



the complexities of human behaviour in a flight-deck environment and requires careful design of the interfaces to ensure that they safely elicit the desired behaviours from the flight crew. As part of a programme known as 'Open Flight Deck', Rolls-Royce is partnering with human factors experts at the University of Southampton to develop user-centred flight-deck applications. This involves ensuring that the principles of human factors are implemented at the very beginning of, and throughout, the design lifecycle to ensure that the demands of the system match the cognitive processes and activities of the intended end users, in this case, commercial airline pilots.

The approach has meant that currently serving airline pilots are represented throughout the entirety of the design lifecycle, from concept generation through to prototyping, testing and certification. This is an important distinction because, in the context of aviation, there has been a tradition of relying upon the expertise of test pilots in technological developments. Relying on test pilots, who are not necessarily representative of airline pilots, brings with it the considerable risk that the expected benefits of a new technology may not be realised.

ECDM applications comprise two main interconnected elements: the 'engine condition application' and the 'user application'. The engine condition application consists of advanced diagnostic algorithms that determine the condition of the powerplant and how it's being operated. As these algorithms are aware of aircraft state and operation, they can determine what to tell the flight crew and when. The user application provides the human-machine interface for the flight crew. This is carefully designed for each specific ECDM feature using human factors methods which can help to ensure that pilots are correctly guided through the decision-making process.

Specifically, a toolkit called ***Design with Intent*** appears to hold much promise for the design and development of novel ECDM interfaces by providing an open forum in which key areas of discussion can be had between engineers, human factors practitioners and end-users. These discussions have meant it's possible to capture appropriate user requirements and deliver insights into the type of information that pilots may want access to in different operational scenarios.

Design with Intent was originally developed by Dr Dan Lockton, Professor David Harrison and Professor Neville Stanton in 2009 following the recognition that designers lack guidance on choosing appropriate design techniques that can influence end user interaction. It's a free online resource that has its roots within a sustainability context. However, Lockton and colleagues advocate its use as a tool for interaction designers more widely. Our research represents the first time in which *Design with Intent* has been used within an aviation context and it appears to work well.

To date, numerous design workshops have been hosted by the University of Southampton utilising the toolkit. The workshops, which comprise airline pilots, human factors experts and engineers, have culminated in the generation of numerous design concepts for multiple ECDM applications. These initial designs were then independently assessed by human factors experts using established usability guidelines available within the Human-Computer Interaction literature. The purpose of this was to identify potential areas of weakness within the interface concepts and provide recommendations on how the concepts could be further improved.

Formal testing will soon begin on of the first of these applications using Rolls-Royce's Future Systems Simulator (FSS) at the Aerospace Integration Research Centre (AIRC) at Cranfield University. Using pilot-facing video cameras, 'key-logging' →

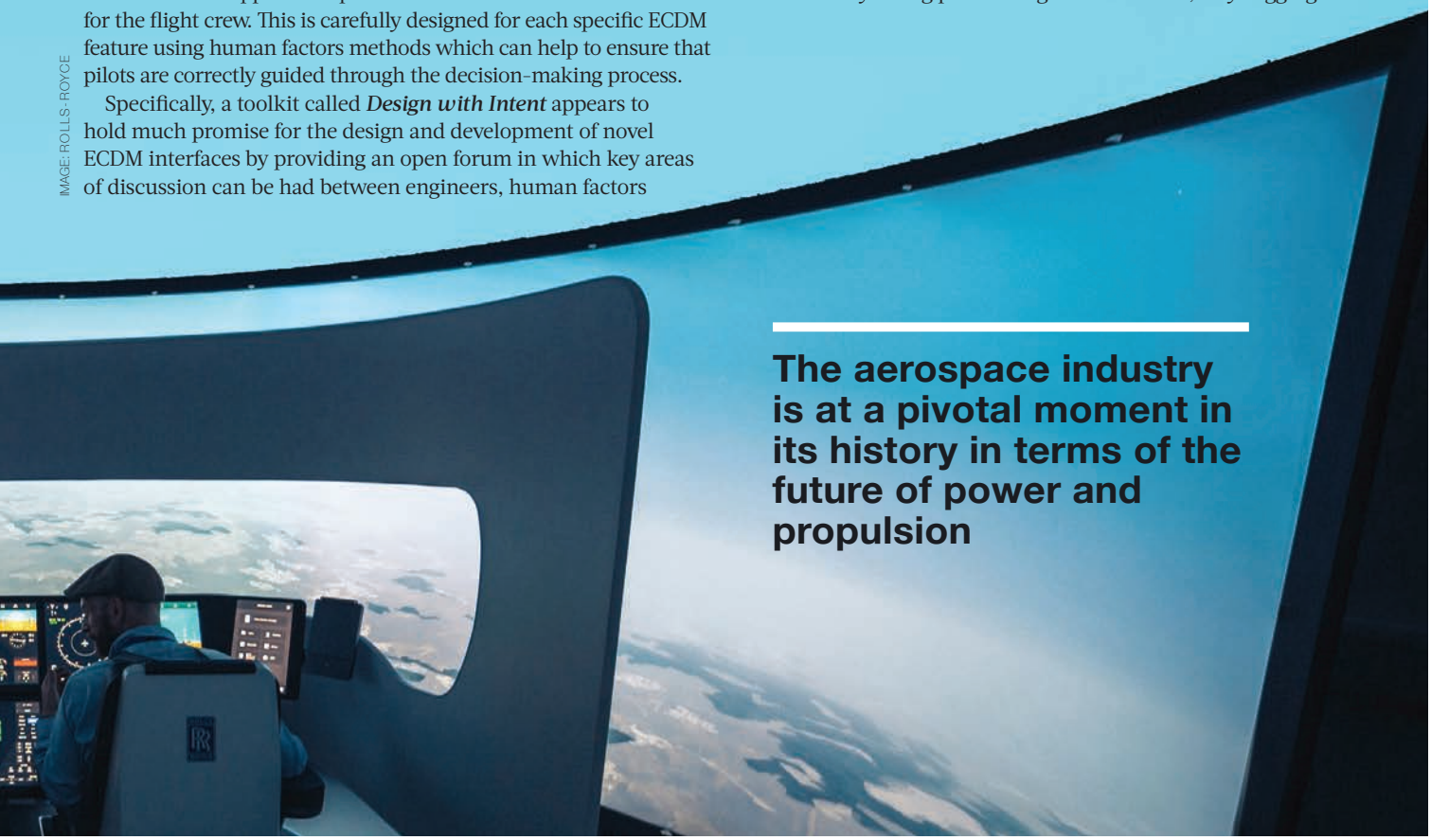


IMAGE: ROLLS-ROYCE

Rolls-Royce Future Systems Simulator at the AIRC at Cranfield University

The aerospace industry is at a pivotal moment in its history in terms of the future of power and propulsion

Cockpit layout hasn't changed much from early cockpit design

software and formal human factors interview techniques, the FSS will enable assessment of the performance of the user applications to understand whether they elicit the intended behaviours and anticipated benefits for aircraft operations. Such work is vital in capturing how end users interact with the applications and ensure that all the information and user requirements generated early in the design lifecycle have been met. Notably, the use of reconfigurable touchscreens also allows applications to be easily modified based on pilot feedback. The facility is therefore capable of being able to support the iterative design process in an efficient manner.

The aerospace industry is at a pivotal moment in its history in terms of the future of power and propulsion. Numerous traditional and start-up aerospace companies are looking into hybrid and all-electric aircraft concepts as well as developing increasing levels of automation and autonomy for more traditional aircraft. Such concepts are likely to require different methods of power management, and new human-machine interaction and interface designs will be needed to communicate to the pilot or operator the status of such power systems. Once again, integration of human factors approaches into the early phases of the design of such systems will be essential to ensure the success of these future products.

Rolls-Royce's learning from the development of ECDM in aggregating data and presenting guidance for decision-making will continue to feed into the development of future applications. The creation of such applications, enabling an engine to have greater contextual awareness, is part of the journey towards more autonomous aircraft. Initially, aircraft may employ the strategy of reduced crewing in cockpits, at least for some phases of flight, with ground-based 'remote assistants' monitoring and able to take control of the aircraft if necessary.

In the future, remote assistants may become 'fleet managers', responsible for monitoring a fleet of aircraft, only taking control of individual aircraft when human intervention is necessary. Solo pilots and remote assistants have the potential to experience extremely high workloads, especially under challenging 'non-normal' scenarios. Expecting these operators to rapidly become aware of the necessary conditions of the aircraft under such scenarios seems unrealistic.

The journey to autonomy and electrification provides Rolls-Royce with strategic direction, delivered whilst the company continues to develop and enhance fleets of more traditional gas turbine powered aircraft. It's clear that development of technologies such as ECDM, which embed human factors approaches in the design process, will become ever more essential during this journey. Through partnerships with academia and the wider human factors community, initially on programmes such as Open Flight Deck, Rolls-Royce can accelerate the development and deployment of such technologies. This will have an immediate positive impact on the operational disruption and safety of aerospace products, delivering significant benefit to its customers and the public at large.

Pete Beecroft is a Systems Design and Integration specialist for Rolls-Royce, one of the world's leading technology companies. He works primarily in research for whole engine and aircraft level technologies. Find out more at www.rolls-royce.com/innovation.aspx. The Open Flight Deck team includes Professor Neville Stanton, Dr Katie Plant, Dr Vicky Banks and Dr Craig Allison. For more information visit www.hfesoton.com

Further reading

Lockton, D, Harrison, D and Stanton, N A (2019) Design with Intent: 101 patterns for influencing behaviour through design. ISBN 978-0-9565421-0-6 www.designwithintent.co.uk

Stanton, N A et al (2019) Distributed Cognition in Aviation Operations: A gate-to-gate study with implications for distributed crewing. Ergonomics, 62 (2) 138-155.

Report on bird strike on GoAir A320 departing from Delhi on the 21 June 2017 www.flightglobal.com/news/articles/goair-a320-crew-shut-down-wrong-engine-after-birdstr-455529/

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For further information please scan the QR code or go to www.networkrail.co.uk/careers and search for 'ergonomics'.

Living and working in countries around the world widens your perspective and gives you a valuable understanding of different cultural and business norms, as **Kirsty Angerer** explains to Lou Boulden

Expanding your horizons

How did your career start?

I started my journey into ergonomics at Loughborough University where I studied ergonomics and human factors in the Design School. I had heard the term 'ergonomics' throughout my graphic design A-level, but honestly didn't really understand the subject until going to university. This is where I realised the magnitude of the subject and the different industries it could apply to. Ergonomics can have an impact on anybody in any environment and that's what makes it so exciting.

Following university, I found myself in London assisting organisations with the development and implementation of cost-effective ergonomics programmes. I conducted research-based training and assessment programmes to improve worker comfort while lowering injury risk and associated costs. I was part of a global team of 25 consultants from ergonomics, interior design, biomechanics, physical therapy and kinesiology. My role took me all over the UK, Europe, Middle East and the US. I then moved to Sydney to develop the consulting business in Australia and New Zealand. I spent two years there and loved the challenge of dealing with global contracts and developing programmes for that market.

I've since moved back to the UK to start my own consulting business known as 'The Travelling Ergonomist'. My day-to-day role involves implementing dynamic ergonomics programmes for a global client base. I can be doing anything from running ergonomics health check-ups, conducting seminars and workshops, or consulting on the design of future workplaces. And in today's professional world, with the prominence of agile and remote working, ergonomics is more important than ever. Every day we see people neglecting their bodies because of the changing demands of technology. My goal is to educate people on getting into neutral postures and to teach them how to navigate the changing workplace.

What are you working on now?

I've spent the last 12 months working with an international management consulting firm in London. I've been part of the project team responsible for the design and implementation of their new building which they move into this autumn. My initial involvement included assessing and commenting on furniture for the workplace. I joined meetings as an ergonomics expert and to collectively choose furniture that benefited employee wellbeing and came with a sustainability story. The business is going from a very traditional style to a more agile way of working where instead of dedicated desks there's now a multitude of work settings to choose from depending on the task at hand.

To do this, we assessed the products according to anthropometric data and UK regulations, alongside user trials over a period of two months. A whole floor was also dedicated solely for mock-ups of various work set ups, including sit-stand desks, chairs, task lights, monitor arms, storage and break-out areas. This was available for all employees to use at their leisure to experience different set ups and to comment on their favourites.

IMAGE: GETTY

Around 40 employees could use the space at any one time.

We've also spent one to two days per month conducting individual ergonomics assessments and workshops to educate employees on ergonomics and correct workstation set up. As they move into their new building, we'll be on site for two weeks conducting workshops and educating them on how to use the space and workstations effectively, with the goal being improved wellbeing and productivity.

To see a project through from start to finish is very rewarding as you see the impact that ergonomics can make on individuals and a business as a result of the sustainable buying decisions made. This means that hopefully we won't have to do too many retrofits. Whilst there is a start and end to building design, ergonomics remains a key feature within the business in accounting for new starters and injured employees. Hopefully though, the programme that we've put in place is proactive enough to reduce the number of employee issues.

Working abroad enables you to be more effective in developing global solutions to universal problems

How do you manage to work globally?

Whilst 'The Travelling Ergonomist' business is solely run by myself now, I have a team of sub-contractors all around the world that I work closely with. I remain in contact with them every month or connect with them when I'm travelling. Thank goodness for Skype, is all I can say!

Humans are the same in all countries and we suffer with the same issues, just in varying degrees. When you travel and work abroad you gain a strong understanding of cultural and business norms, which allows you to be more effective in developing global solutions to universal problems.

Of course, there are differences in terms of regulations with regards to ergonomics and then again depending on the industry you're working in. There are many factors that influence the safety, comfort and performance of workers. The underlying causes are usually economic, sociocultural or climatic in their origins, often combined with inappropriate technology. The methodology is essentially the same in all countries but sensitivity to economic and cultural differences may be needed.

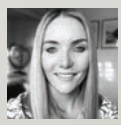
Having said that, when it comes to the corporate world and office environments, we can draw many similarities. Here, we're aiming to educate employees on neutral postures, create a culture of movement and implement appropriate work set ups. Contrary to popular belief, this doesn't need to cost a fortune.

How is ergonomics helping to improve wellness?

Absenteeism rates are on the rise generally and so is presenteeism as we feel even more pressure at work. We do, however, need to look beyond these figures alone and develop an understanding of the underlying risk factors in the workplace. In the medical world, screening for diseases is much more common as is a proactive approach to reducing diseases like cancer, diabetes and obesity. However, in the workplace we rarely see the same effort. We have become very reactive without truly screening our employees and understanding the issues.

I've been working with Professor Alan Hedge who has developed an ergonomic health check-up. Using state-of-the-art predictive analytics software, we run an ergonomics health check-up of employees which screens them for workplace risks such as musculoskeletal disorders and risks that can lower their productivity. A comprehensive report then summarises risks and suggests ergonomic interventions.

Ergonomists make it easier for people to do their jobs by observing human movement as it relates to the work environment. We apply our knowledge of musculoskeletal function and how humans interact with their environment to make the workplace safer and more efficient. If workplace wellbeing is a priority for a business, then working with an ergonomist is the obvious choice given our skill set that bridges the gap between many other disciplines. ●



Kirsty Angerer is 'The Travelling Ergonomist'. She gained a BSc in Ergonomics and Human Factors from Loughborough University in 2012. Find out more at thetravellingergonomist.com

Smart technology should improve services for resident communities and draw visitors in who can contribute to the local economy by being better informed about local attractions and amenities. **Barry Kirby** explains one project that looks at how we might achieve this

Smart town technology

Smart cities are generally seen as the next step in bringing technological solutions to some of the biggest issues facing large urban areas. Be it the ability for autonomous taxis to move us around, to intelligent parking, more direct and joined up health and social care, all the way to bins that tell the council when they need to be emptied, they're seen by both local and national government as a way of saving significant amounts of money by being able to tailor services and therefore cut costs. This makes greatest sense in cities where significant infrastructure is in place to install the technology and identify and automate services.

There are some great examples where different infrastructures are being developed but they all have one thing in common: in the broadest sense, technology comes first and then residents are brought along for the ride. Our current project takes this concept and turns it on its head, asking "how do we engage with residents in a meaningful way that means technology is being done with them, not to them?" This is significant if we're going to achieve maximum adoption.

Smart Llanelli

The Smart Llanelli project is a grassroots plan to determine how we can better engage with residents to determine what's needed, as well as getting buy-in to a technology-based way of revitalising town centres. Based in the Welsh town of Llanelli, just off the end of the M4, the project seeks to engage with technologies that are being developed for smart cities but puts them in the smaller town environment with a view to working as a catalyst for town centre revival, resident engagement and business collaboration. All of these are focused on a human-centric view to innovation.

Smart cities increase engagement through use of technology

IMAGE: GETTY

This project is a fascinating first for K Sharp, as it challenges us to engage culture and behaviour to develop local capability – and the means are just as important as the result. Indeed, without being careful and considerate of how we develop the approach, we will not get the end result. The model we've produced really does look at building relationships between local businesses, academia and government.

Smart business

Initial meetings with local businesses, the council and the Welsh Assembly are highlighting the significant challenges faced by simply networking between business, never mind full collaboration. However, we're looking at how we can engage better together and become more inward-looking to work in our own backyard. Coupled with this has been the running of an innovation workshop at our offices, which questions what innovation means and whether it has a place in local business. Fundamentally, these events treat every business as a stakeholder in the project to elicit user requirements and business needs that we could help deliver locally.

Smart resident

Resident engagement is a much harder topic. As human factors professionals, we have had experience in engaging with user communities or potential communities. However, in many ways our user community is selected and defined around a product or a service. In the reality of smart cities, user communities are defined by geographic location and there is no set way of engaging with them.

Resident engagement is often viewed by local and national government as a hoop to jump through, but we're keen to change this, using new strategies to help people interact and shape future services. The Smart Llanelli project uses techniques such as gamification to encourage residents to engage in a way that's more meaningful to them, encouraging them to pass on their views, whilst supporting the need for assurance of data security. Alongside this is the opportunity to improve outgoing communication to residents so everyone knows what's going on. This could be at a service level for all or a very geo-specific solution for planning applications or other areas of consultation.

Smart town

From a smart perspective, if we just focus on the cities then there's going to be a huge technological wedge between large urban areas and the rest of the country. This is currently recognised to an extent by the drive for rural broadband, although this is simply about giving rural communities connectivity not fully integrated, connected technologies. Existing city infrastructure is an advantage, being easy to build upon but we must not overlook the opportunity that towns could deliver in making us think about employing smart technologies in the more challenging areas and the step change in innovation that could bring.

The 'big win' for this project is true resident engagement and collaborative business driving the town's revival. We must acknowledge that the demise of town centres up and down the country is becoming more rapid and we need a catalyst or intervention to revive them. High street chains are moving to out of town retail parks where it's more convenient to park and shop, and the typical town centre during an average day is not what most people remember from days past. This is a mirror of what some cities are seeing with the move of large chains out to retail parks.

Smart route map

On our route map, there are two concepts being developed. Firstly, an app for the area developed using gamification techniques to encourage engagement from the residents and make it useful for everyone. Secondly, we're developing a cultural trail to encourage people to engage with the local area.

You could argue that our 'smart' theme is already breaking our own hypothesis because we're assuming that a technology-based solution is the way to go, and we hold our hands up and admit that. But that doesn't mean we're looking for a 'whizzbang' approach. In fact, part of the challenge will be to engage with the technology but if we want to retain the current cultural aspects of the town, then we need to make it transparent to those who may want to engage with it but who might not necessarily want to see it.

There is also a need for replication within this plan. In developing Llanelli, we must retain the understanding of what the key motivators and enablers are so we can engage with other similar communities. We aim to develop Llanelli as a model for the development of smart town technologies and their infrastructure, that look at people and what they need rather than just doing things to them and hoping they like it. The actual initiative may not be the same but by analysing our own progress and outputs, we can determine the common factors and what other communities can take away and re-use.

The 'big win' for this project is true resident engagement and collaborative business driving the town's revival

Once our initial elements are in development, we aim to engage with people to develop an outline framework that culminates in a conference or symposium that will look at practical projects and ideas for developing the town. This will be significant because it will be an example of what we're aiming to achieve, that is to motivate and inspire engagement.

This initiative is still very much in the first stages but already it's very exciting, blending business interaction, cultural development and technology innovation. The opportunities opened up by the development of a strong resident engagement ethos are boundless.

Barry Kirby is Managing Director at K Sharp and the CIEHF's Smart Cities Media Champion.

Delivered by design

Have you ever wondered how Amazon can deliver packages so quickly, taking less than 24 hours from the time you click to place an order on its website to the time it's delivered to your door? **Raz Osman** offers a glimpse into Amazon's world of people and technology working side by side

Without doubt, Amazon has changed the way that many of us think about shopping. Amazon uses the latest technology and the power of the internet to enable it to link millions of goods and services to huge numbers of individuals living around the globe within previously unheard-of delivery times. In order to do this, the company constantly refines the way that people and technology work together in its huge fulfilment centres, strategically located, fashioning orders for delivery at unimaginable pace and scale.

By the end of 2019, Amazon will employ nearly 30,000 people in the UK with a broad range of skills in software engineering, speech and linguistics, machine learning, supply chain and logistics, and of course in sorting and delivery. In its fulfilment centres, people are employed in a range of positions from operations managers to engineers, HR and IT roles to employees who handle customer orders. In the UK fulfilment centre network, employees work four ten-hour shifts per week with three days off.

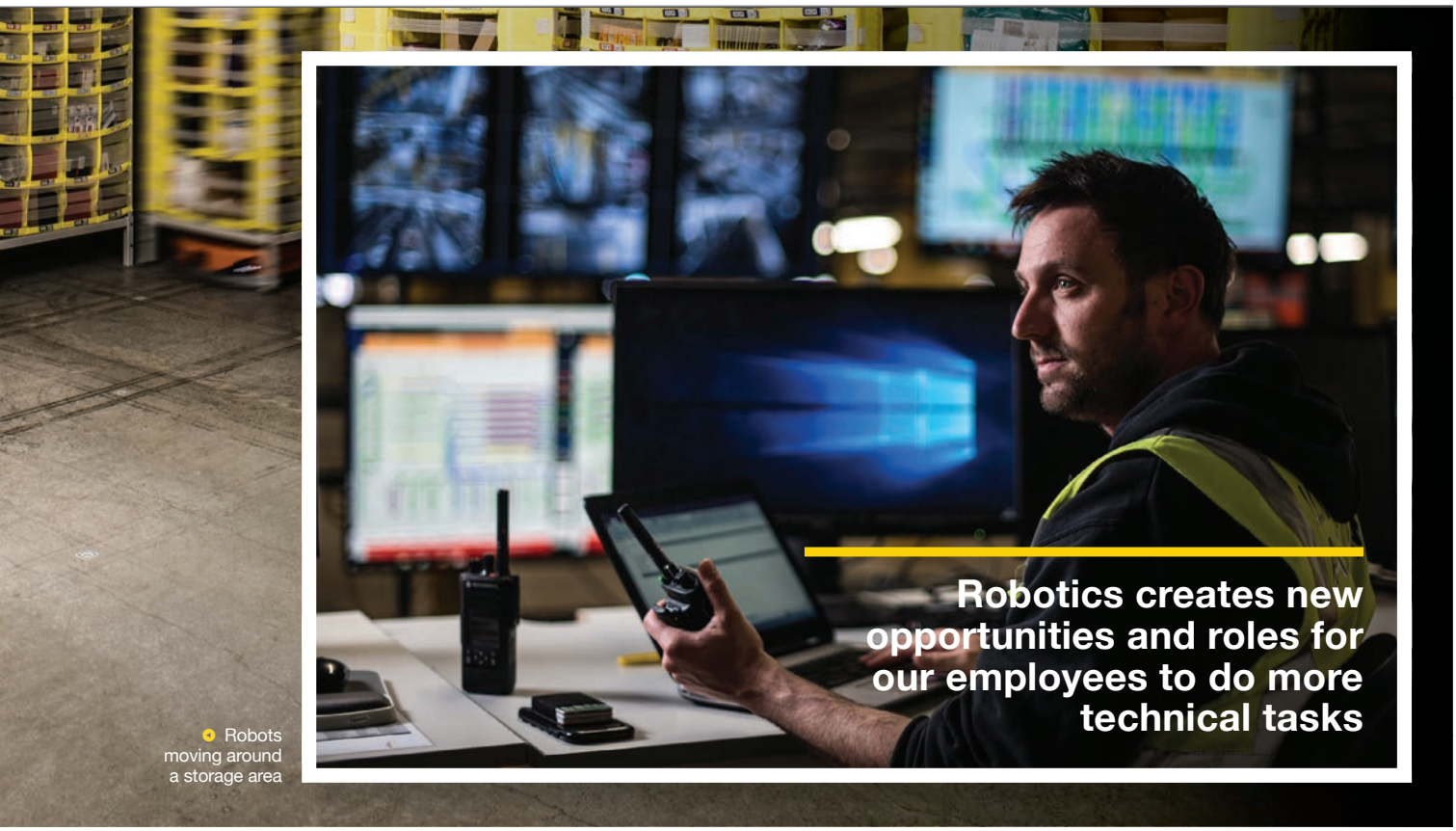
One of the first things I did on joining Amazon was to take part in launching a brand new, one million square foot fulfilment centre in the very centre of the UK in Leicestershire. The sheer scale of that kind of launch is both daunting and exciting at the same time, but the most exciting, and challenging, part of my role is the variety of work that I get involved in day-to-day. Having worked as a qualified Ergonomics and Health & Safety consultant, I would often impart the principles of the discipline. At Amazon I've been able to live and breathe the discipline and to put theory into practice.

The huge scale of a fulfilment building as you approach, the vast parking area, the innovative restaurant and facilities don't quite prepare you for the enormous, gleaming, concrete-and-steel interior. It's warm, busy without seeming frantic, humming without being noisy - in a word, purposeful. People are moving around along well-marked walkways and paths, some on bicycles due to the size of the building they need to navigate around during their shift. Seemingly everywhere you look, miles of conveyors move thousands of items each day from storage to packing areas to labelling then on to the distribution vehicles, in endless lines of plastic crates and cardboard packages.

Technology works out the most efficient packaging to use for any particular order, from the size of the box to the length of tape needed to seal it. But it can't yet deal with the huge variety of movements needed to pick up items and place them in a delivery box, ensuring they remain in perfect condition and are packed securely and efficiently. Those actions still needs the manual dexterity, manipulation and decision-making skills of people, working at stations designed specifically for the purpose. The next order arrives in a crate from the conveyor alongside their workstation and is pushed off the conveyor onto a short slide for ease of access to the items. A screen tells the worker which box type to use from the flatpack supply stored on a shelf above them and a machine on the workstation automatically dispenses the tape.

Transforming work through technology

Once an order has been placed, algorithms work out the most efficient route between any of its fulfilment centres where the goods are available, to the customer. At Amazon's Tilbury fulfilment centre, an army of orange robots on wheels, each the size of a suitcase and carrying, in a two metre high tower above it, a different array of items, bring ordered goods to one of many points where they meet human 'pickers'. The robots move around autonomously within a demarcated and dedicated human-free working area by detecting each other (and anything that



Robots moving around a storage area

Robotics creates new opportunities and roles for our employees to do more technical tasks

shouldn't be in their vicinity) and through sensors in the floor.

In traditional warehousing environments there have always been hazards in storing, locating and moving inventory. The growth of robotics has provided an opportunity for some of the hardest, most difficult or hazardous work to be done differently and to enable people to use unique skills differently. Manual tasks in Amazon's fulfilment centres thrive only where people bring advantage. Embracing automation and robotics can make processes more efficient while, at the same time, sustaining and creating new opportunities and roles enabling employees to carry out demanding and challenging technical tasks in areas like robotics engineering, maintenance and supporting day-to-day operations. This is positive for the people Amazon employ and provides career progression at every level through the business.

Using insights from workers, manager and specialists, the central safety team implemented a series of improvements by identifying human failure modes. The improvements included Electronic Fleet Management which allows electronic access control and maintenance, Anti Collision Sensors and Safe Distance Lighting. Solutions like these have made a huge difference as they protect people without having to rely on the individual. Procurement and safety teams then work together with suppliers of equipment to push the boundaries for improved and safer designs.

Continuous improvement

So, in an environment like this I might one day be reviewing noise or vibration levels, evaluating levels of lighting, undertaking Display Screen Equipment assessments, investigating thermal comfort or supporting usability testing, to name but a few activities I get involved in. Safety always comes first, so every shift and every meeting at Amazon starts with a safety tip. Safety is instilled in everything everyone does, and in every decision made. The aim is to apply ergonomics thinking to every aspect of this huge logistics operation, to optimise processes for each and every person, resulting in a smoother, more efficient and above all, safer, operation.

Any decision to implement a new or improved process or infrastructure is reviewed and assessed by multi-disciplinary teams containing Subject Matter Experts (SME). As the UK Ergonomics SME for Amazon, I'm regularly called on to assess new equipment and environments and provide recommendations. It really is important to everyone across the business and extremely satisfying and rewarding to see changes and modifications implemented based on my input.

Every day, through a device called the Safety Leadership Index, Amazon collects real-time feedback and insights from employees who are at work in the fulfilment centre, tapping into front-line ideas that can make a real difference. Using this feedback, Amazon looks to continually improve safety practices and enhance the working environments of all facilities. I'm constantly looking for ways in which we can lead industry improvements, for example, in areas such as the prevention of musculoskeletal issues. I'm currently leading a UK-wide project on this topic.

CIEHF member, **Raz Osman** joined Amazon as Ergonomics and Health & Safety Manager in 2016, after having worked for the company previously as a consultant.

For more details about Amazon's fulfilment centres, go to www.aboutamazon.co.uk/working-at-amazon/about-our-fulfilment-centres.

IMAGE: BLAKE EZRA PHOTOGRAPHY

JOURNAL EXTRACTS

Featuring research published in high impact ergonomics journals

Comfort and conversation

1 In the luxury car market and as driverless cars become a reality, seat design for supreme comfort is now a focus. For those with the budget, front seats are now designed to move away from the dashboard during driverless operation and rotate toward each other to increase occupant interactivity. However, for most of us, the requirement to become human contortionists, twisting our bodies to have in-car conversations, is still a reality, and so are the risks to our postural health.

As the percentage of us preferring to travel in groups is on the rise, researchers have been studying the effect of seat configuration on the (dis)comfort experience, conversation quality and posture we experience.

In most vehicles, passengers sit side by side and need to turn their body to be engaged in the conversation with their fellow travellers. However, rotating the body could lead to discomfort which influences conversation quality. In this latest series of experiments, participants were asked to talk to each other while sitting at the same, one metre distance in four seating arrangements with seat-belts on. Two seats were angled in four configurations: at 0° (side by side), 22.5°, 90° and 120° (almost opposite each other).

IMAGES: ISTOCK

Optical tracking was used and the collected data was analysed to acquire postural angles over time. Questionnaires were also used to evaluate the perceived (dis)comfort and the quality of the conversation.

Experimental results indicate that the 120° configuration scored the best in the overall comfort and the quality of conversation but only slightly better than the 90° configuration.

So, whilst research indicates a design re-think perhaps for comfort and conversation, these might need to take a back seat where situation awareness and control of the vehicle are concerned.

I Fiorillo et al (2019) Future vehicles: the effect of seat configuration on posture and quality of conversation, Ergonomics, *DOI: 10.1080/00140139.2019.1651904*

Seeing in a positive light

2 As the crisp British winter bestows us with a slim eight to ten hours of daylight, a swathe of media attention typically covers the associated ailments and deficiencies we suffer at the hands of insufficient light. However, proper lighting has an extraordinary ability to improve mood and energy levels and is being taken increasingly seriously in the modern workplace.

Based on the idea that positive feelings associated with light might influence social judgments in workplaces, researchers have recently proposed that satisfaction with light as a specific affective response to light can lead to positive judgments of other individuals.

In a laboratory experiment, participants assessed their satisfaction with light and rated other people's faces on warmth and competence. Results showed that satisfaction with light positively influenced judgement of others. They replicated the positive relation between satisfaction with light and social judgments in a field study with employees. This latest research opens interesting possibilities for the design of work settings that involve the evaluation of others.

O Kombeiz & E Dietl (2019) Light as a positive situational cue at work: Satisfaction with light relates to judgements of other's warmth and competence, Ergonomics, *62:8, 995-1007, DOI: 10.1080/00140139.2019.1608316*

Obituary

EDWARD LOVESEY

An influential researcher and teacher, always ready to take on a challenge, 1939 - 2019

Edward (Ted) James Lovesey was born in Hampshire in 1939 and went to school at Brockenhurst Grammar, where he became a member of the Air Training Corps and learned to glide. He took the Civil Service Exam and joined the Royal Aircraft Establishment (RAE) as a Student Apprentice. During his five years apprenticeship Ted's special brand of humour and creativity involved many dubious escapades (mostly fiery), but he completed training as an aeronautical engineer and became hooked on ergonomics at Cranfield University under Tom Singleton. In 1965 he returned to RAE to join Bob Thorne's Human Engineering Division to commence the rest of his career in research and teaching of ergonomics. It was also in this year that he joined the Ergonomics Society (as it was then).

Areas of research initially involved measurements of noise, vibration and climatic effects upon human performance. This involved Ted in trials from the Sahara to the Arctic and simulations from Concorde to hovercraft and helicopters. One such interesting interlude in 1969 was the Trans African Hovercraft Expedition up the river systems via Timbuktu to Lake Chad by SRN6 hovercraft, carrying out environmental measurements. This was an enterprise fraught with numerous hazardous and sometimes hilarious episodes, including partial dismantling of the hovercraft, travel by train and re-assembly.

Other areas of ergonomics research covered anthropometry and cognitive aspects of flying and crew workload. As part of this, Ted measured pilots' eye activity and stress using changes in voice spectrum during low level flight. A significant contribution to anthropometry was made by Ted's study of pilots' head size. As a practising ergonomist he felt it important always to experience ergonomics shortcomings first-hand. This led to completing a helicopter flying course - and some other life-threatening incidents! He was the UK member on the Commonwealth Aeronautical Advisory Research Council for Human Factors.

Ted was involved in trials from the Sahara to the Arctic and in simulations from Concorde to hovercraft

In 1992 Ted took early retirement from RAE and did some ergonomics consultancy work involving Army communications. After this he worked with Tom Leamon as Visiting Scholar at the Liberty Mutual Research Centre in Massachusetts before moving on to become Course Organiser for Health Ergonomics at the University of Surrey, where he taught basic ergonomics to MSc students and health and safety course graduates. Together with Professor David Stubbs, he restarted the CIEHF's Southern Regional Group, (known then as the Berkshire, Surrey and Hampshire Ergonomics Region or 'BASHER'). Also, around this time, Ted was awarded the contract to update parts of the MoD's Defence Standard on human factors. His previous research data became invaluable in preparing the sections on anthropometry and manual handling.

After Surrey University, Ted moved to Devon to provide ergonomics advice to a large international electro-optics company. During this time, following a request from Val Noble, he helped lead the South West Regional Group with her and later, Bernie Masters. He continued tutoring graduates for Barbara Haward at Portsmouth University and, for a short time, at London South Bank University.

Much of Ted's extensive work has been published in RAE reports, the *Applied Ergonomics* and *Ergonomics* journals and CIEHF's *Contemporary Ergonomics & Human Factors* series of conference proceedings. While serving on the Industrial Committee of the Ergonomics Society, Ted organised the first Military Ergonomics Research Conference in London. He later served on the Annual Meetings Committee in different positions such as Chairman and Proceedings Editor, and he served on Council and as an advisor to the Professional Affairs Board. He was a holder of both the Sir Frederic Bartlett Medal (1978) and the Paul Branton Meritorious Service Award (1998). More recently he continued spreading the ergonomics word to local groups and was awarded an Honorary Fellowship of the CIEHF (as well as trying to devise new Christmas cards for them). In his spare time Ted was also a gifted wood carver, especially of birds, with minute attention to detail.

Ted is survived by his wife Gillian, two daughters and five grandchildren.

Donald Anderson, an Honorary Fellow of the CIEHF, provided this obituary. It was was prepared using many of Edward's own words from his personal memoirs.

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Ways to get involved...

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Share your expertise

Masterclasses, which take place on the first day of this event, are interactive workshops that are perfect CPD opportunities for all involved. If you're an expert on a particular human factors tool or technique and are willing to share this with others, we'd like to hear from you.

Gain unique experience

As a student, you could be part of the team running this event, and get a behind-the-scenes look at how it all works, chat to presenters, and get valuable networking time. Your place will be fully funded, it's hard work but you'll get great experience for your CV. Apply for a place today.

Be first in line

Book early to guarantee your place at our flagship event, a unique forum for learning and exchange of ideas and information. With a day of Masterclasses, followed by two days of keynotes, talks, posters, discussions and workshops, as well as chances to relax and chat socially, make sure you register soon.

Find out more on our website...

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MEMBERSHIP

We welcome a new colleague to the CIEHF team

Towards a common goal

To join the CIEHF in the role of Marketing & Membership Manager was an easy decision for me to make and probably one of the best I've made for my career. Why? Because CIEHF is a vibrant community with lots of dedicated people working towards our common goal of making the world a better place. What's not to like?

I've worked in a variety of business-to-business settings and what I've enjoyed most has always been working with people; understanding their motivations and helping them to get what they want. In this position, one of my main tasks will be to make sure you too consider that joining the CIEHF was one of the best decisions you've made for your career. No matter if you've been a Fellow for many years or are just starting out with us, we want to ensure you're offered the professional benefits you expect and take advantage of the many opportunities that our network can provide. You can help me do my job by sharing your thoughts with me on what we're doing well and where we can improve.

Having worked internationally (and being an enthusiastic traveller), I'm keen to expand our network further and bring even more diversity to our community. Did you know we already have members in 49 countries? Please help us spread the word to any colleagues you may have that don't yet know about us and what membership offers. We'll be more than happy to extend our support and welcome them to our community. Perhaps this might lead to another of our much-liked international 'Perspectives' for a future edition of *The Ergonomist*.

I'll attend as many events as possible to chat with you in person, but also look forward to your input by phone or email.

Iris Mynott
CIEHF Marketing & Membership Manager
i.mynott@ergonomics.org.uk
07702 542166

Recognising excellence

Do you know someone who has made an impact through their achievements and hard work, demonstrating excellence in our discipline? If you do, you could help them get the recognition they deserve by nominating them for an award.

We've reviewed the CIEHF awards to ensure they cover a wide variety of skills, knowledge and experience of groups and individuals at all stages of their career. Aside from the President's Award, which continues to honour outstanding work carried out by a group, we've renamed our other awards and reviewed the criteria to make it more obvious as to their applicability. So, we now have Lifetime Achievement Awards, an Innovation Award, a Volunteer of the Year Award, a New Ergonomist Award and an award for Outstanding Communications.

If any of these have inspired you to think of someone that fits the bill, please take a look at our website for more details. The process is simple, requiring you to tell us the reasons for your nomination and to ask two others who know the nominee(s) and their work to act as referees and provide written support for the nomination.

The deadline, by which time we need to receive both the nomination and the referees' support, is 30 November. For more details, please visit **http://bit.ly/CIEHFawards**

Linking CPD to Chartered status

Continuous Professional Development (CPD) is vital if you're to enhance your knowledge and skills and demonstrate your commitment to your profession. It's also a requirement for Chartered status to log sufficient CPD online by 31 December each year. So, if you want to maintain your Chartered status, or to gain it for the first time, please don't leave it until the last minute; there's lots of information about CPD on our website and you can log your activities in your MyCIEHF account.

Our Professional Competency Checklist is a great place to start as it gives you an indication of your strengths and, importantly, where the gaps are so you can match them up to your development ideas. Check our webinar recordings, upcoming events and accredited training courses for potential CPD activities. And for more details about CPD, such as how to record it, tips for enhancing your CPD and a link to the Competency Checklist, please visit **http://bit.ly/CIEHFcpd**

Obituary
MIKE GRIFFIN

The leading authority on human response to vibration, 1946 - 2019

Michael James Griffin was Professor of Human Factors at the Institute of Sound and Vibration Research (ISVR) of the University of Southampton. He was universally recognised, in academia, government and industry as the leading expert on human response to vibration.

Mike was an outstanding academic and educator. He completed an undergraduate degree in physics at the University of Southampton before joining ISVR as a researcher in 1968. His PhD, completed in 1972, addressed the problem of helicopters flying into power lines as a result of vibration-induced reduction in the visual acuity of pilots. He was Head of the Institute's Human Factors Research Unit, rising through the academic ranks and achieving the position of Professor of Human Factors in 1991. Following his retirement in 2016, his association with the University continued as Emeritus Professor until a few months prior to his passing.

In the scientific and academic world, the name 'Mike Griffin' is synonymous with human response to vibration. There wasn't a single aspect of the subject that didn't interest him. His research, both in the laboratory as well as in marine, air, road and rail transport environments, produced new understanding of the physical factors responsible for motion sickness. His laboratory-based research on comfort and perception continue to form the basis of international standards for evaluating human response to whole-body vibration. He created a substantial body of knowledge on the effects of vibration on human performance in aircrew including not only visual performance but the design of helmet-coupled systems as well as effects of vibration on manual control, and even cognitive performance. His research on hand-transmitted vibration led to widely used objective tests and diagnostic instruments for the evaluation of signs and symptoms of hand-arm vibration syndrome. Vibration measures he developed that have been widely adopted include the 'vibration dose value' (VDV), a cumulative measure of vibration exposure, and the 'SEAT value', which describes the efficiency of a seat in isolating the body from vibration. The results of Mike's research can even predict vibration perception thresholds and when we might be disturbed in our homes by vibration caused by nearby transport and mining operations. As the leading authority on human vibration, he also acted as an expert witness on medicolegal and personal injury claims involving vibration exposure.

Mike's academic contribution included teaching and mentoring no less than 54 successful PhD students on top of innumerable undergraduate and Masters projects. With his reputation and standing nationally and internationally, he warmly welcomed researchers and collaborators from around the world. Much of the resulting research would be presented at the annual 'Human Response to Vibration' conference. Mike attended every conference since its inception in 1968 so it is poignant that the conference this year will be the first without his guiding presence.

Mike was a prolific author, contributing in excess of 700 publications ranging from book chapters, conference papers and reports, to papers of the highest quality in academic journals covering both medical and scientific aspects of human response to vibration. On one occasion, Mike was sent a 60-page report by one of his collaborators late one evening. He returned the email by 9am the following day with a comprehensive list of comments on all aspects of the report! His book, *Handbook of Human Vibration*, published in 1990, continues to be the definitive textbook on human response to vibration consulted by students, researchers and practitioners around the world.

His thirst for knowledge and enthusiasm to help his students was apparent through his teaching and research

Mike held numerous voluntary posts including memberships of the International Advisory Committees of conferences on Hand-arm Vibration and Whole-body Vibration, the CIEHF, the Human Factors and Ergonomics Society and the Aerospace Medical Association. He chaired the BSI sub-committee on 'Human exposure to mechanical vibration and shock' for about 40 years until his retirement in September 2018. At home, he advised UK Government via organisations such as the Health & Safety Executive,

the Ministry of Defence and the Engineering and Physical Sciences Research Council. Outside the UK, he was highly influential in both european and international standards committees, acting as advisor to the European Union and the European Commission, as well as to industrial and government organisations in Europe, the USA, Japan, Korea and China.

Mike's outstanding contribution to furthering scientific knowledge was acknowledged by his professional peers. The Ergonomics Society (as it was then) awarded him the Sir Frederic Bartlett Medal in 1984 for contributions to research, the highest honour bestowed by the Society. The following year he was made an Honorary Life Member of the Swedish Vibration Society. In 2007, he was awarded the RWB Stephens Medal for outstanding contributions to acoustical research and education by the Institute of Acoustics, and in 2011, the Taylor Award for advancing understanding and prevention of the effects of hand-arm vibration. In 2018, the Society of Occupational Medicine awarded him the Apothecaries Medal for his contributions to prevention and management of hand-arm vibration syndrome (HAVS).

Mike leaves a body of knowledge that will serve human sciences, engineering and design for many decades to come

Based on the kind sentiments received following his death, we're sure that all who knew Mike, whether personally or professionally, will have fond and lasting memories of his generosity and modest nature. He was a mentor to many of his students, at both undergraduate and postgraduate level and his advice was always thoughtful and carefully considered. His steady and methodical approach, based on clear thinking, a thirst for knowledge, deep understanding of the underlying scientific principles and an enthusiasm to help his students achieve their full potential, was apparent throughout his teaching and research.

Although Mike's vast knowledge of the subject of human response to vibration goes with him, he leaves a legacy of inspired and well-trained students, researchers and colleagues. He also leaves a body of knowledge and publications that will serve the fields of human sciences, engineering and design for many decades to come. Professor Michael J Griffin was a true giant in the world of science and education, and a world-leading contributor to the understanding and application of ergonomics and human factors.

Our profound sympathy goes to his wife Miyuki and his family ●

Co-written by **Gurmail S Paddan**, **Henrietta V C Howarth**, **Ken C Parsons** and **Ron McLeod**.

REGIONAL NEWS

SOUTHERN

Transport research revealed

TRL is a global centre for innovation in transport and mobility. It provides world-leading research, technology and software solutions for surface transport and related markets engaged in intelligent, new mobility innovations.

The CIEHF's Southern Regional Group had previously visited TRL in the early 1990s and witnessed crash dummy testing. The organisation has changed radically since those early days with the advent of digitisation and major changes in the automotive technologies and ecological environmental targets.

On 22 August 2019, a networking lunch at TRL's Crowthorne base enabled stimulating discussions between the 12 CIEHF attendees and the 10 TRL staff. Dr Richard Cuerden, Chief Scientist, welcomed the delegates to the TRL Academy and Dr Shaun Helman provided the background to the establishment of the Academy and the partnerships across a range of organisations. He explained how hazard perception is a fundamental requirement towards road safety and illustrated the hazard perception test that had been developed by TRL. The HelmUK project (HGV Platooning) examines the concepts of 'platooning' where up to three lorries travel in close convoy to reduce fuel emissions and fuel consumption. This challenges hazard

Jo Davies, Southern Regional Group Lead, tries out a simulated driving scenario

perception both of the platoon drivers and other road users. Significant research to gather evidence-based data from a range of scenarios in a series of simulated and road trials must be carried out to ensure that safety is not compromised and intuitive, effective communication is achieved.

Dr Kirsten Huysamen gave an overview of the breadth and depth of TRL's Behavioural Science and Human Factors team activities, citing over 150 projects. These include new safety regulations to tackle driver distraction, validations of new automated driving systems, guidance on road/rail infrastructures, modelling frameworks for assessment of electric vehicles and collision investigations.

Between 2012 and 2014, 200 people were killed in accidents involving buses. TRL outlined solution strategies to reduce this number to Transport for London's target of zero by 2030. Human factors examples included solutions to prevent pedal confusion and runaway bus incidents, as well as solutions to improve the visual conspicuity of buses and occupant safety. Many of these fatalities involve cyclists and Ceki Erginbas, Head of Roadside Safety, gave demonstrations of how their virtual reality environment was being used to identify improved visual conspicuity.

They also presented the ambitious digitisation of the Greenwich Borough as a test environment for electric and autonomous vehicles. This includes building information modelling and street digitisation. Their Digicar, MiniDigiSim and DigiTruck simulators are their key test environments to monitor and measure driver performance under variable controlled conditions. They are able to assess the impact of new road layouts, in-vehicle technologies, road signage and any factor that affects road user safety. All attendees had the opportunity to immerse themselves in the realistic simulated environments. It was pointed out that during the trials, participants would be given plenty of time to adjust to the virtual environments.

It was a real privilege to visit a world class organisation and the Southern Regional Group is very grateful for the outstanding hospitality received. Find out more about TRL at **trl.co.uk**

CIEHF events at a glance

For more details of all CIEHF events, see our website at **events.ergonomics.org.uk**

Eligible for CPD Lifelong Learning

EVENT	WHEN & WHERE	DETAILS
Global strategies for HF advancement	Wed, 13 November 2019	Webinar discussing the International Ergonomics Association's strategies for the advancement of human factors and ergonomics on the global stage.
Careers Day	Wed, 26 February 2020, Birmingham	Featuring the very best of careers insights, advice and inspiration from those already at work and from companies looking for new talent.
Doctoral Consortium	Mon, 27 April 2020, Stratford-upon-Avon	A chance for current PhD researchers to practise presenting to peers, to get feedback and to learn from other researchers and assessors.
Ergonomics & Human Factors 2020	Mon-Wed, 27-29 April 2020, Stratford-upon-Avon	Masterclasses, keynotes, talks, posters, workshops, discussions and lively social activities packed into a three-day showcase event.
AI in Aviation Safety	Mon-Tue, 9-10 November 2020, Manchester	Presentations, workshops and discussions about the latest advances in Artificial Intelligence in all areas of aviation safety.

Please note that some events details may be subject to change after publication. Please check the events website for up-to-date information.

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