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THE ERGONOMIST

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Designing the integration of people and future technology

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FROM THE PRESIDENT

A global community

Bob Bridger
CIEHF President

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The CIEHF's annual conference at Stratford-upon-Avon in 2020 will take place alongside the next Organisational Design and Management (ODAM) conference. ODAM is a Technical Committee of the IEA and its conference normally takes place alongside that of one the IEA's Federated Societies.

Our Institute has, for many years, been a Federated Society of the IEA and, in return for the subscription paid, obtains discounts at IEA conferences for our members and voting rights at IEA council meetings. Amongst other benefits, federation also gives our members access to the many Technical Committees and interest groups of the IEA and a global human factors community.

Notwithstanding these benefits, CIEHF's association with the IEA has come up for discussion at our Council meetings in recent years. One view is that the benefits of maintaining our links with the IEA do not satisfy the opportunity cost of maintaining CIEHF's status as a Federated Society (the funds might be put to better use elsewhere).

There is a danger in an organisation such as ours of 'institutional inertia' of "doing things because we always have"' without considering the benefits and whether and how the activities deliver value to our members (few of whom, seemingly, attend IEA conferences and benefit from the discount).

An alternative view of our association with the IEA is that perhaps CIEHF's approach has not been pro-active enough and that the benefits are there to be taken. As such, CIEHF's hosting of the ODAM conference next April is to be welcomed and I encourage all to attend the event to meet and hear from a global community of distinguished speakers.

I encourage all to attend ODAM and meet a global community

FROM THE EDITOR

Twenty twenty vision

We look forward to a new decade but what will it bring? No doubt we'll see major advances in use of technology and this is the main theme running throughout this issue.

Our cover article provides a sneak preview of some of the programme content for our upcoming Ergonomics & Human Factors conference in April. Topics include automation, artificial intelligence and resilient systems across sectors such as transport, healthcare, manufacturing and defence.

Bob Bridger and Amanda Widdowson share their views on the challenges and opportunities coming up, and Bob also reveals his thoughts on the future of work, including use of exoskeletons to reduce stresses on the human body. Noorzaman Rashid takes a look further into the future and sees cloud computing and advanced manufacturing as key trends.

Alina Graham describes her role in advanced manufacturing at JCB, including use of digital modelling. And an interesting piece by Corinne Parsons and Robin Ellis explains how technology has enabled progress in Royal Mail's operations throughout its history.

Although cybersecurity involves technology, it's fundamentally a people-based function say Neil Clark and Spencer Misstear, as they explore defence against cyber-attacks. Intriguingly, technology also has an important part to play in rugby training, as Dominic le Roux describes.

Dominic Furniss looks at administration of medication in care homes and Husam Muslim tells us about his research interests and career aspirations. And we remember John Ryder, who played such a large part in many people's lives.

Wishing you a peaceful and successful 2020.

Tina Worthy
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CHIEF EXECUTIVE'S PERSPECTIVE

Designing for the Future Human

In a blink of an eye another generation will have passed and we will be half way through the 21st century. At this point scientists, engineers, designers and psychologists will be referring to what we might expect to see in the 22nd century. The handheld mobile devices used by Captain James T Kirk, first seen in 1966, was pure science fiction to me, mostly because we were all still using public phone boxes. However, in less than a generation, in March 1984, the first commercial handheld mobile phones became available to the public. Since the launch of the first iPhone in 2007, over 2.2 billion units were sold worldwide by the 4th quarter of 2018.

Medical researchers continue to reveal evidence about the negative impact of mobile phones, from traffic accidents to the collection of germs from poor hygiene to the emission of radio frequency energy (a form of non-ionising electromagnetic radiation). The carcinogenicity associated with mobile phone use continues to be a topic for research; no doubt it will take at least a generation more until we might understand the impact more fully on our brain functions. However, this has not halted the human love for our mobile devices. We can now add Amazon's Alexa to the list and the many home devices being designed by competitor firms that enable Alexa.

The Chartered Institute of Ergonomics and Human Factors (CIEHF) is a learned society. Our vision is a world where integrated design improves life, wellbeing and performance. The people that will help us to achieve this are scientists, engineers and designers from every sphere of influence. Their work will include everything from medical devices using nanotechnology and synthetic human tissue to machine learning (the scientific study of algorithms and statistical models that computer systems use to perform specific tasks without using explicit instructions) to reduce human error, particularly in the fields of patient safety, aviation and transport.

The future of design is likely to centre around cloud computing, advanced manufacturing and Artificial Intelligence

"Designers should become what, in biology, is referred to as 'mutagen' - an agent that produces mutations in the artificial world. Interaction among disciplines and people is crucial", said Carlo Ratti, Director of MIT.

So how are humans evolving and how will it impact the work of ergonomists and human factors professionals? Well, modern medicine's ability to keep us alive may make you think that human evolution has ceased. Better healthcare (something we would all vote for) disrupts a key driving force of evolution by keeping some people alive for longer, making them more likely to pass on their genes. But there is plenty of evidence to illustrate that humans may be evolving faster than ever.

Humans are adapting to their environments, for example, gene mutations allowing humans to live at high altitudes have become more common in populations in Tibet, Ethiopia and the Andes. Unfortunately, humans are also evolving and adapting to unhealthy diets which contributes to health impairments such as osteoarthritis and type two

A future full of virtual assistants?

diabetes caused by obesity. Over 60% of the adult population in the United Kingdom is now overweight or classed as plus size. CIEHF President Bob Bridger's new book "A Guide to Active Working in the Modern Office" (CRC Press, 2019) covers a wide range of topics including the changing obesogenic workplace.

In the United Kingdom there have been several studies of anthropometric data over the last few decades. However, the changing nature of the population and in particular, the diversity of our citizens together with an ageing population, means that most data currently available is out of date. Maybe this is the reason why a size 12 dress in one high street store is so very different in fit to the same size in another store - a common complaint.

As the professional voice of ergonomists, the CIEHF will make strides to create more up-to-date anthropometric data and will campaign for more inclusive design. We will also collaborate with others to share learning and solve design problems of the future. Ergonomists and human factors practitioners will need to evolve additional inclusive systems thinking approaches just as designers, designing for the future, will need to do.

Whilst technology is beginning to reshape how we live our lives, the environment we live in is also influencing us as a result of climate change combined with socio-economic changes. This means that designers have the critical job of thinking about what our future will look like and how we will interact with it. Autonomous vehicles are a very good example, already challenging highway engineers and software designers. Psychologists are at the early stages of researching the relationship between people and autonomous vehicles or robots. I would highly recommend exploring 'anthropomorphism', the attribution of human traits, emotions or intentions to non-human entities. (Alexa is a good example of a non-human entity!)

The future of design is likely to centre around three trends. Mass availability of cloud computing, proliferation of advanced manufacturing capabilities and practical applications of Artificial Intelligence. We have not yet achieved the threshold where enough value from machine learning is available to the design community. More specifically the design community needs to embrace new technologies and manufacturing methods. Having said that, between 2010 and 2016 the design economy grew by 51%, employing 1.7 million people.

In our role as the professional body for ergonomists and human factors practitioners and specialists, the CIEHF will make strides to help our members make a significant contribution across all areas of design. As part of this journey, we will launch a Human Factors Roadshow across eight regions in 2020 and 2021.We will work closely with the Campaign for Science and Engineering (CaSE), the Design Council and allied professional bodies.

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noorzaman rashid

IMAGES: GETTY

Award for outstanding contribution

CIEHF President, Bob Bridger, has won the Ergonomics Practitioner of the Year Award from the Foundation for Professional Ergonomics (FPE). Established in 2004 as a non-profit organisation dedicated to advancing professionalism in ergonomics through educational activities and awards, the FPE initiated the annual award to recognise colleagues who have demonstrated outstanding contributions to the practice of ergonomics through their professional lifetime achievements or through specific implementation projects. The award was presented to Bob at the 2019 Human Factors and Ergonomics meeting in Seattle in October.

Take a governing role

If you'd like to influence how CIEHF is governed or are interested in setting standards for accreditation, we have places coming up on Council (as a Trustee) and on our Professional Affairs Board, for election at our AGM in April. It's a great chance to find out how the CIEHF is organised, how it functions and to meet and work with other members. Nominations open early February so if you're at all interested, please talk to us about what's involved to see if it would work for you. Find out more about the roles and what the nomination process involves at **www.ergonomics.org.uk** > **About us** > **Governance or email ciehf@ergonomics.org.uk**.

The human firewall

Human factors and cybersecurity aren't terms that are typically found in the same sentence. However, despite evolving technology, cybersecurity is, at its heart, a human factors issue, as **Neil Clark** and **Spencer Misstear** explain

Human factors, or more specifically, human failure, takes its fair share of the blame for accidents, incidents and organisational failings. Typically, this observation is made in High Reliability Organisations operating in sectors such as nuclear, aviation, oil and gas, rail and healthcare (in some regions). Reassuringly, this reference is almost always made in the absence of malice, and conversations evolve akin to: "We all know that more than 80% of accidents are attributed to human factors but we aren't for a second implying that anyone intended to cause harm, it's just people making mistakes". This recognises that we operate in systems in which the vast majority of people are trying to do good, they're working for the benefit of the organisation and those around them without malicious intent.

Sabotage is rare and recklessness is rarer still. It's also believed that most violations are made for 'good' reasons and most organisations are structured in a way that's pro-actively designed to prevent bad things from happening. James Reason's Swiss Cheese Model is an illustration of how such organisations are designed to work and where the human contribution and therefore vulnerabilities lie. IHF Cyber has produced a white paper that explores the dichotomy that the above argument does not apply in the world of cybersecurity. Within High Reliability Organisations it's a paradigm based on good intentions whereby there's no active and

malevolent opposition to its existence.

Cybersecurity is fundamentally a people-based function, but it involves some incredibly clever software, architecture and technology. However, it's the epitome of a non-technical issue attracting a technical solution and is a well-matched war between opposing sides; attacks will always occur, and the defence has an Achilles heel, which is us, an opportunity that can be exploited. Therefore, to call cybersecurity a 21st century 'technical issue' is fundamentally misleading; it's a non-technical issue in which ultra-advanced technologies are used to relentlessly try and expose human failures.

This active opposition tries to erode and penetrate barriers put in place to protect people, their assets and their processes. This is a shift from most organisational threats and certainly a dichotomy for human factors. There's a common misconception that in a system with ultra-advanced technology, the user's importance or status within the system is diminished. Not so in the world of cybersecurity. Enter our second dichotomy.

The technology on both 'sides' within a cybersecurity realm is advancing at a close-to-equal pace that's believed to largely cancel each side out. The continual chase across the electromagnetic spectrum never pauses for breath and it would appear that the most valuable and flexible part or our cyber defences, us, is also the most vulnerable; IBM's 2014 Cyber Security Intelligence Index reveals that 95% of all security incidents involve human error. The technology in cybersecurity is so advanced and actually so accessible (everybody's got it) that there has been a massive resurgence of the reliance placed on the human-in-the-loop. With that in mind, it's of the utmost importance that human factors should not be simply considered as a component of a technical system designed to prevent cyber-attacks, but rather it should be regarded as the primary and best defence against an ever-evolving technical foe! A human firewall, if you will.

IMAGE: GETTY

The problem is cybercrime or is it cyber-attacks? There's no doubt that a problem exists and it's a big one. In August 2016, Cybersecurity Ventures predicted that cybercrime would cost the world $6trillion annually by 2021, up from $3trillion in 2015. The world of cybercrime and cybersecurity blurs domains of advanced technology and human failures by way of polarity. In other words, advanced technology is pitched (in some cases directly) against human vulnerability. Society focuses typically on the technological aspect of the problem, not wrongly, but often at the exclusion of the human contribution, which is a vital and yet consistently overlooked aspect of effective cybersecurity measures.

Human factors should be regarded as the primary and best defence against an ever-evolving technical foe

IHF Cyber's white paper explores how human factors and human performance can be addressed so as to consistently and reliably defend against cyber-attacks. The purpose is to argue that people should not be shielded from cybersecurity systems but should be engaged as one of the most active and vigilant components; that way, we play to our strengths. But it's important to visualise the whole picture and that requires us to understand our vulnerabilities too.

The white paper makes the argument that cybersecurity has turned on its head the traditional model of technology helping humans. A typical style of multi-layered defence would be the preferred model for an effective cybersecurity system. A fit-for-purpose defence will not only provide the opportunity to prevent a successful attack, it must also recognise that attacks will be successful. Multi-layered defence systems, often referred to as barrier models, are commonplace within High Reliability Organisations and are being put to practical use all over the world.

We need cybersecurity to be cognisant of the approaches being employed elsewhere and to examine these various levels or barriers. While prevention is absolutely the priority of such a system, effective barriers must also exist to detect, control, mitigate and recover from a cyber-attack. In a sense, there is no silver bullet, just lots of brass ones.

To consider both the barrier approach and the human contribution, we must not only make a complete consideration of the threats, both technical (the technology) and non-technical (us) but also consider the complete lifecycle of an attack from prevention through to recovery in a proactive manner. An organisation must understand the spectrum of its vulnerabilities and where the human contribution is most prevalent. Given the high level of successful breaches that are due to human action or inaction, consideration of the human element is not simply a nicety as current perceptions and indeed actions may imply, but an absolute cyber essential.

The white paper describes, in detail, a method for assessing the human contribution when considering the vulnerability of an organisation, as well as the known technical threats. It's a fundamental shift in traditional assessment and testing and one that allows the entire lifecycle of cybersecurity to be focused, efficient and prioritised to the needs of a particular organisation.


IHF Cyber specialise in the human factors side of information and data security.

Neil Clark is CEO and specialises in process and procedural compliance, fatigue and safety design.

Spencer Misstear is Vice President and has 20 years of strategic business development experience.

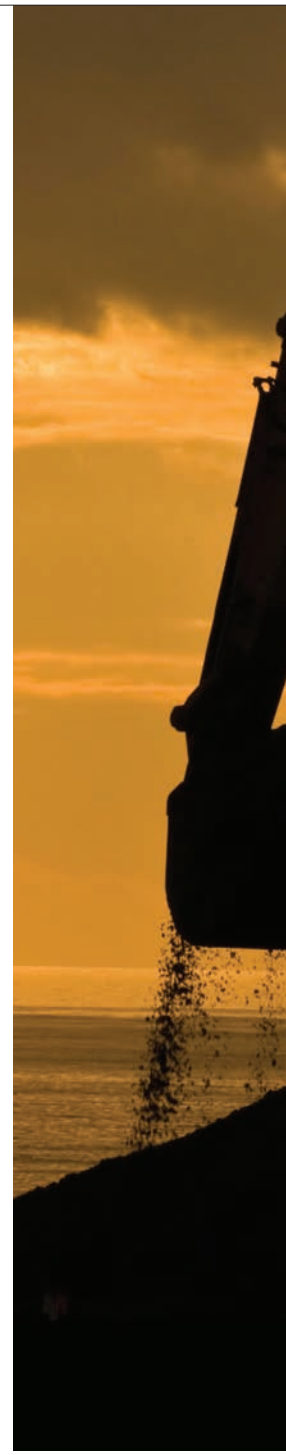
Further reading

IHF Cyber White Paper: www.ihfcyber.com/resources/

A DAY IN THE LIFE OF A...

CONSTRUCTION MACHINERY ERGONOMIST

Alina Graham, Principal Ergonomist at JCB



For the last nine months, my days have been very different, dealing with a much smaller human with contrasting needs than my normal customers. I gave birth to my daughter in January, and I truly believe that you never stop thinking as an ergonomist even when you're off work. It's opened a whole new area of design problems to me, from pushchairs to public changing facilities, but that's a whole story in itself.

As I finish maternity leave, I'm happy to be getting back into the swing of my job as Principal Ergonomist at JCB. JCB is a British multinational corporation that manufactures construction and agricultural plant equipment which is sold to customers and dealerships worldwide.

As with many in our industry, my days are often varied as my job involves aspects of research, user design and training. Since joining JCB over six years ago, one of the key accomplishments has been the inclusion of ergonomics as an independent section in the machine sign-off process. As a result, on a weekly basis I, alongside my colleague, sit on a committee to approve machines at various stages of development.

So, my day starts out like that of many parents, a rushed morning getting the children ready, dog walked, and everyone piled into the car to do the school and child-minders run. I then head into my office, which is the research department at JCB World Headquarters in Staffordshire.

On arrival, I catch up on any emails and review my day and week ahead. The morning is spent putting the finishing touches to a *Jack* (human digital modelling) assessment for one of our product teams and I then arrange a meeting to discuss the required changes. We use *Jack* software in the early stages of the design before any physical prototypes are available. This allows us to give the product teams scientific data behind our suggestions, as we know engineers need data like this.

I then sit down with my colleague to discuss some minor changes to our process which has been constantly improving over the six years since the ergonomics department was formed. These changes are then added to a presentation which I use to train our product teams and new employees. The presentation explains the importance of ergonomics, how we can support the product teams, and uses both good and bad case studies to further validate why ergonomics is a critical part of the design process. These communication sessions have been vital in the introduction of ergonomics to a well-established engineering company.

My next job is to arrange some user testing for the following week. This particular project is at a high-fidelity stage, and the users are some of our key customers. We use a variety of customers together with our test site operators - expert operators who evaluate our machines but are also JCB employees.

In the afternoon, I head over to one of our product teams situated at a different site. Although part of one company, we work as consultants to these product teams and so I spend quite a bit of my time working at these sites. This meeting is

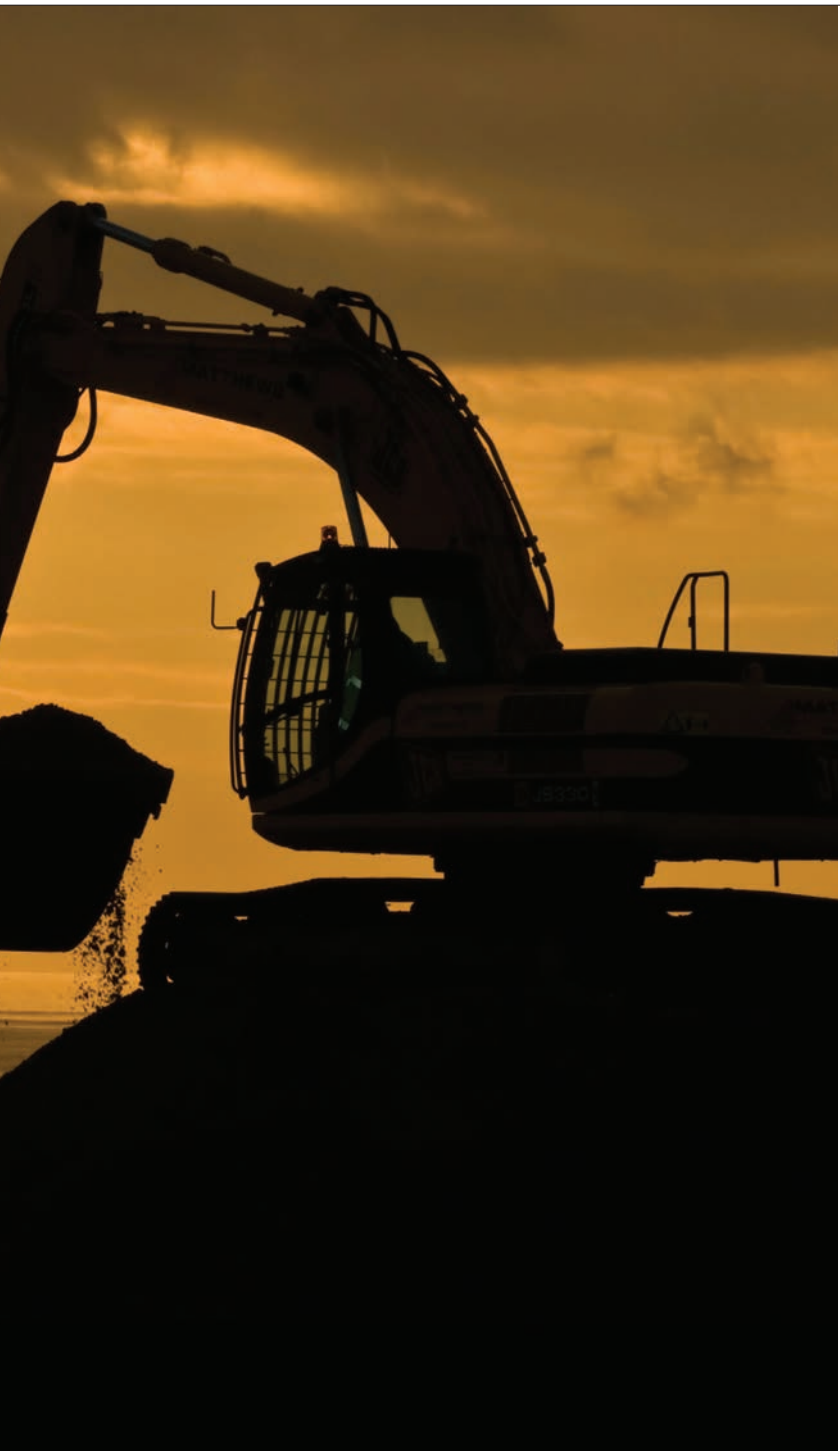


IMAGE: ALAMY

A JCB excavator in action

to discuss the development of a new product range. Having worked with this team on another project, ergonomics has been involved early on in the design phase but that's not always the case. Late involvement can mean less scope to make changes or extra cost if late changes are made.

Last on today's agenda is a Professional Recognition Forum which happens twice a year. This is a gathering of all chartered professionals in JCB, an area that the company are really pushing. As a Chartered Ergonomist, this puts me in the same category as the Chartered Engineers and I believe it has really helped the engineers to take the discipline seriously.

Another big area of my work is customer visits which could be UK based or overseas. These visits are project specific and visits are carried out to the key regions that the machine is being sold into. Much of this has been Europe but one of the most interesting regions I've been to is India. We visit the country regularly as we have engineering facilities there, but the customer visits are really eye-opening and have a huge impact on my thoughts about the design of our machines. There is so much I could discuss on this subject but a key example is that it's not uncommon for excavator operators in India to be barefooted, even in a quarry environment. Foot pedals are traditionally made of steel so you can only imagine the temperature these can reach in the Indian climate. This was one of many areas of the cab that we changed to ensure inclusion of different cultures.

Once my work day is over, I then head back home via the childminders. My amazing husband cooks tea (he's a much better cook than me!) and then, once the children are in bed, I sit down at my home desk and work on my MSc project. Although I did a BSc in ergonomics at Loughborough, I recently felt the need to further my education. As one of a two-person team, I'm aware I need to continually expand my knowledge and to increase the skillset in JCB. This need resulted in the company sponsoring me to complete a Masters part time, and it's been just what I needed. It kept my mind working through maternity leave, and whilst it can be hard to fit into my life, I'm still glad I decided to take the course.

One of my key accomplishments has been the inclusion of ergonomics in the machine sign-off process

The thing I was most worried about in coming back to work, was picking up where I left off. In this case, it has felt a very smooth transition and I'm already feeling back to normal. Both my maternity cover Charlotte, and my colleague Rebecca, have done a fantastic job in covering my work and made my return much easier than anticipated.

My job is always varied and full of new challenges, working with all disciplines. One day I'm looking at a diesel fill point, the next a display screen and another day its engine and emissions regulations. This keeps me very busy, and alongside my Masters and family life, I'm glad I'm someone who doesn't like to stand still for long.

Alina Graham is studying for an MSc in Applied Ergonomics with the University of Nottingham. JCB produces over 300 types of machines including diggers, excavators, tractors and diesel engines and has 22 factories across Asia, Europe and America.

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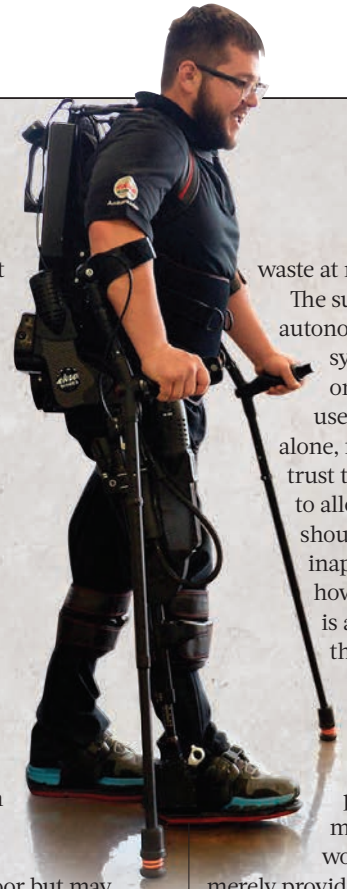
Chartered Institute of Ergonomics & Human Factors

The future of work

How we work has changed remarkably in a relatively short time and our discipline is well placed to explore the effect this will have on us as humans in the future. **Bob Bridger** discusses the challenges he sees on the horizon



Walking with a battery-powered robotic exoskeleton

There's no time like the present to talk about the future. As I write this piece, I'm aware that my working life and that of many of my colleagues, has changed dramatically in the last 40 years. I can still recall the sound of a copy typist typing a letter I'd written by hand 40 years ago, but it's a faint and very distant memory. I'm no longer a desk-bound 'knowledge worker' but a 'digital nomad' with mobile devices providing me the affordances to work almost anywhere. The relationship between work, working conditions and the work environment has undergone a dramatic shift, making many of our scientific and legislative responses to work design either inadequate, inapplicable or obsolete, while introducing many new challenges.

Digital platforms now control many existing jobs and make new work roles possible; the gig economy being an example with food delivery and taxis, but extending to other areas such as logistics and distribution. New technologies like smart glasses can augment human performance in applications such as stock picking but the long-term effects of using these and many new devices are poorly understood.

A renewed emphasis on mental wellbeing at work is to be welcomed, taking into account as it does what makes work fun and rewarding, but this more holistic approach should not replace the traditional focus on the identification and amelioration of psychosocial risks, including newer risks such as 'technostress'. Workers may no longer be 'tied to a machine' on the factory floor but may be tied to the internet by mobile devices with little control over work demands or scheduling.

Much of our knowledge about human factors is based on the assumption that most people work full time in one job or career, possibly for many years. Will the rise of a new generation of 'slashers' (one person/multiple roles) where individuals combine different jobs and alternate between them constantly, render many of our ideas obsolete?

Will exoskeletons and robots bring an end to the 'epidemic' of work-related musculoskeletal disorders in manual work, eliminating the very risks which many of our risk assessment tools are designed to assess and forcing some of our consultancies to seek new areas of business? Or will they introduce new risks of their own, such as long-term changes in muscle recruitment patterns in exoskeleton users or new disorders where the load is merely transferred lower down the kinetic chain. While making effortful exertions easier, will exoskeletons make effortless exertions more difficult, introducing new risks when complex movements are needed in a job?

Increased emphasis on sustainability, recycling and remediation of obsolete material and work sites may give rise to a new generation of hazardous jobs as workers are employed to do the work that can't be mechanised or automated easily, such as sorting through conveyor belts of waste at recycling centres.

The success and safety of autonomous vehicles and transport systems may depend more on how they are perceived by users than on the technology alone, for example, whether users trust the system and are willing to allow it to operate when it should or whether they have inappropriate expectations about how capable the system really is and fail to take action when they should.

With little sign that the 'epidemic' of overweight and obesity is in decline, the digital environment provides opportunities to make traditional sedentary work more active. However, merely providing office workers with more adjustable desks is likely to be inadequate and there is scope for developing new approaches to integrate increased physical activity with traditional office work.

With a shift of focus from office workers sitting at desks to teams communicating via networks, designers and facilities managers may start to question whether offices with desks and chairs are needed at all and will consider the requirements for designing the offices of the future. Perhaps in 40 years' time, nobody will work in offices and the QWERTY keyboard, like the mechanical typewriters it was originally designed for, will be a distant memory in the minds of none but the oldest members of our Institute.

Many of the these and other matters are already being researched by CIEHF members. There's never been a better time to be involved in human factors.

Bob Bridger is President of the CIEHF and a researcher, consultant and teacher in ergonomics.

Further reading

HesaMag#16. 2019. The Future of Work in the Digital Era. The European Trade Union Institute's Health and Safety at Work Magazine, Autumn/Winter 2017.
Bridger, R S, 2020. A Guide to Active Work in the Modern Office: Homo Sedens in the 21st Century. CRC Press, Boca Raton, Fl, pp138.

Ergonomics & Human Factors

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The challenges of medical packaging

Recently, the CIEHF's Pharmaceutical Sector Group held its first event where systematic challenges that are associated with the current approaches towards the labelling and packaging of medicines were discussed. The key drivers for the event, held on 23 October in Birmingham, were to look afresh at these challenges from a multiple stakeholders' perspective and to start to identify human factors approaches towards optimising packaging and labelling of medicines.

The day started with two excellent presentations, the first a keynote address from Professor Jamie Coleman of Birmingham University, followed by a moving and inspiring presentation from Lisa Richards-Everton, a Patient Safety Campaigner. An interactive workshop session followed which looked at several historical case studies where labelling challenges had been identified. The Systems Engineering Initiative for Patient Safety (SEIPS) model of work system and patient safety was adopted, which provides a framework for understanding the structures, processes and outcomes in healthcare and their relationships.

After lunch, parallel syndicate workshops focused on two important labelling issues, namely training and education, and label design. Both topics took a human factors approach to define solutions, and recommendations and actions were proposed.

From a training perspective, these included:

- **Clinicians:** Thinking about interlinking systems and labelling designed for the ideal environment. How does that differ from your everyday working environment?
- **Technology:** Considering maximising use of technology making human interactions more dynamic and stimulating.
- **Product redesign:** Being more imaginative with product design. For example, designing a wraparound label on a vial so that as it's unpeeled it reveals different types of information at each stage such as dosing, side effects, etc.
- **System components:** Finding specific examples such as frontline medical staff understanding what the drivers are in procurement, as no one group actually sees the system throughout.
- **Education and communication:** Enhancing education and communication between drug manufacturers, the Medicines and Healthcare products Regulatory Agency (MHRA) and the NHS.
- **Moving trusts:** Realising that differing working environments require stratified education and awareness raising of implications.
- **Raising issues:** Raising issues about labelling without casting blame.

From a labelling perspective, recommendations and actions included:

- **Ethnographic exploration:** Understanding how patients use medicines within their own homes.
- **Review and exploration of regulations and guidelines:** Focusing on storage and administration of medicines packaging and information.
- **Guide development:** Focusing on critical information required on medicines packaging and labelling.

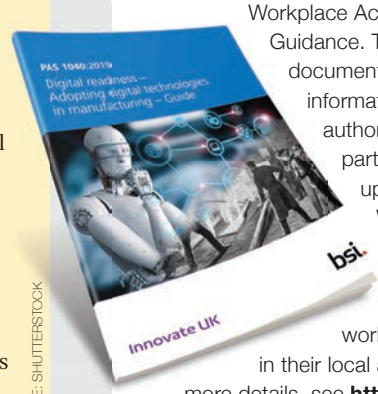
At the conclusion of the event several delegates volunteered to be involved in a steering group whose remit would be to address these challenges. This may involve designing stratified user support programmes to manage medication errors based on labelling. More news on this will follow.

IMAGE: SHUTTERSTOCK

New guides published

The UK's Industrial Strategy sets out to boost productivity and create new businesses, jobs and export opportunities through innovation and the adoption of industrial digital technologies in manufacturing. Supporting this Strategy, BSI have released a new publication which sets out practical guidance for UK manufacturers wanting to adopt technology such as artificial intelligence, robotics and the internet of things. PAS 1040:2019 Digital readiness – Adopting digital technologies in manufacturing – Guide provides help to organisations in identifying and understanding the business factors including leadership, culture, integration and processes that should be taken into consideration in planning and implementing the digital journey. The guide is intended for all manufacturers, suppliers, and related service providers who are looking to increase business efficiencies and competitiveness. It can also benefit developers and providers of digital readiness diagnostic tools. Further details about PAS 1040:2019, which is free to download, can be found at **http://bit.ly/BSIPAS1040**.

Public Health England, in collaboration with the Local Government Association and Association of Directors for Public Health, has published Local Healthy Workplace Accreditation Guidance. The 44-page document provides information for local authorities and their partners on setting up a Local Workplace Health Accreditation Scheme and promoting workplace health in their local area. For more details, see **http://bit.ly/PHEhealthyworkplace.**



THE PRESIDENT

What's the top challenge for the Institute?

The main challenge will be to achieve its targets for membership and income growth. A number of initiatives are already in place, for example we're actively trying to engage with colleagues in related areas and are working on new learning pathways for Technical Membership. In some ways this represents a change of focus from 'selecting-out' to 'qualifying-in'; practising what we preach in the sense of fitting the membership category to the person.

What industry development will impact our discipline?

Human factors and safety. We've already seen robust growth in safety in a number of areas and we expect to see further growth in 2020. The Institute is working actively in this area and is finalising a new white paper on learning from incidents, and later in 2020, there will be an event on AI and aviation safety. This is not to say there aren't many other new developments that we need to be aware of; automation and AI, exoskeletons and new ways of working are examples. However, safety is the main area I expect to deliver against the key performance indicators of the Institute's strategic plan in 2020.

Where do you see opportunity?

We've moved away from trying to 'sell' ergonomics, instead focusing on the issues and letting the benefits speak for themselves. The Institute aims to produce more commercially viable content that will appeal to a wider audience, and so increase our impact.

Bob Bridger is a researcher, consultant and teacher in ergonomics.

A new decade

As we enter a new decade, Lou Boulden talks to **President Bob Bridger** and **President Elect Amanda Widdowson** about their thoughts on human factors challenges, impact and aspirations in 2020

We need to capitalise on our contribution to enhanced usability and showcase our capabilities

PRESIDENT ELECT

What's the top challenge for human factors?

Product design and engineering procurement requirements do not always include human factors considerations, making it difficult for competitive organisations to justify spend on human factors effort. Why is this? In some cases, budget constraints drive ready-made, Commercial-Off-The-Shelf products which afford little opportunity for human factors intervention. In others, lack of awareness is a contributory factor.

Our work directly supports the current public appetite for enhanced usability and diversity in design, as well as industry challenges such as digital transformation. We need to capitalise on this and showcase our capabilities. Ergonomists and human factors specialists hold the solution to these challenges. How do we do this? By seeking to understand our client's needs and by sharing our success stories, for example in the form of cost-efficient, quality case studies and through tried and tested methods, and then by holding webinars and other events to promote them.

How will technology affect our discipline?

Digital transformation programmes are likely to continue. Organisations are seeking to optimise new technologies such as Artificial Intelligence and data analytics to more efficiently capture and utilise the 'big data' available to them. This technology could help doctors assimilate complex medical histories and predict future patient risk, for example. In the transport sector, it supports asset failure prediction and travel information for passengers. These initiatives depend on the successful integration of human factors. The design, selection and introduction of new technology and applications should be accompanied by proper user consultation and Human Computer Interaction design principles, otherwise they are unlikely to be utilised to their full potential.

Where do you see opportunity?

We're a relatively broad discipline; anything that involves a human at some stage arguably requires human factors input. In the short-term, I feel we need to focus our target area of influence. In my Presidential year, I'm keen to promote diversity in design, so I'm planning a campaign to collect a broader range of anthropometric data from members of the public. This campaign would serve two main objectives. Firstly, it should provide human factors professionals with a more diverse source of anthropometric data to enhance design projects. Secondly, it would raise public awareness of the CIEHF and some of the benefits of our discipline.

I'm also keen to work with the growing user experience community as their aims align with some of ours. I, along with other members of the CIEHF's Executive Committee, have met with the President of the User Experience Professionals' Association (UXPA) with this in mind. So far, two joint events have been held and more are planned. The CIEHF is the only organisation in the UK that can offer Chartership for human factors, so this, coupled with our experience and tried and tested approaches, means we have a lot to offer.

What's your top aspiration for human factors?

I would love to see an increase in the demand for human factors in all sectors. To achieve this, we need to work together to raise awareness of the benefits of the discipline and the strengths of our members. Increased knowledge sharing, including cost effective, best practice case studies with demonstrable benefits, should facilitate this. Knowledge sharing could take the form of remote and face-to-face presentations, as well as written publications. Joint events with target partner organisations, including the UXPA, could also contribute. These activities rely on the promotional efforts of our members and professional marketing team. We all need to take responsibility for driving our own success.

Amanda Widdowson is Human Factors Capability Lead at Thales.

Researchers have studied whether AI systems and humans make similar decisions given the same set of data

Tech, tools and trends

Through previews of work that will be presented at a major conference, **Tina Worthy** explains how a deep understanding of human factors underpins and links vital aspects of our interactions with each other and with technology

Imagine, if you can, that you need to deploy a reserve parachute because your main chute has just failed to open. You'd hope that the deployment mechanism for the reserve chute would be obvious and easy to use, and to hand. But, according to researchers, reserve parachute deployment systems have evolved haphazardly so this might not always be the case. To understand more about human reactions in such scenarios and to feed into design recommendations, a study was carried out using a zipline and test conditions designed for body, hand and gaze positions, cognitive loading and switching, and physical disorientation that would all be experienced in a real deployment. The results have led to recommendations which are being incorporated into the latest draft of the European Norm for harness design.

Human reactions are also under intense scrutiny in work associated with development of automated vehicles. A survey found that in most people's minds, autonomous cars will provide an exciting opportunity for drivers and passengers to disengage from the task of driving and instead, rest or socialise whilst being whisked away to their destination. But is this really how it will be? The current partially automated Level 2 vehicles on the market require constant monitoring from drivers. Although the monitoring process may increase workload, interactions associated with the process have rarely been explored in a complex real environment but it's clear that a sufficient level of situation awareness will be needed prior to humans taking back some level of control from the automation. As might be expected, studies show that the transfer of control from vehicle to human is more natural and smoother for experienced drivers who understand the limits of autonomy, but how quickly can this transfer take place?

In Level 3 cars, where there is conditional automation, if systems fail or limitations are exceeded the human driver must be ready, possibly at a moment's notice, to take over control of the vehicle. In these cases, understanding what, why and how to design and build the environment around the human to optimise communication will be a major factor in preventing collisions. In-car information systems are becoming more varied and complex and feedback can now be given to the driver in a wide variety of ways. These include text, graphics and changing colours across multiple screens and through a Head Up Display, with vocal or other audio alerts, ambient lighting and haptics. A study showed that feedback modes participants relied on varied widely and gender can also influence the results.

Other studies have shown that drivers exhibit complacency in their behaviour when interacting with automated vehicles. They may become overly confident in the automation so this needs to be further explored and clearly understood so as to select appropriate mitigation strategies within system design or driver training. Extended automated journeys where there's no need for human intervention can lead to boredom with the potential to induce sleepiness and sleep episodes. This can decrease cognitive and psychomotor functions and jeopardise safety if manual control is suddenly needed. A study has looked into sleep inertia in work, shift work and machine operations in order to provide evidence that this condition should be treated as a new risk in semi-automated driving.

At a more basic level, since vehicles first took to the road, drivers have used mirrors to obtain information about the dynamic changing environment around them. But of course, mirrors present a reflection which we then need to interpret and add to our mental model of our surroundings to ensure we manoeuvre our vehicles without incident. Cameras and sensors can help enhance our view of the outside of a vehicle and are already used for checking the rear of lorries for obstructions when reversing, for example. But researchers have been exploring the use of digital mirrors that give overhead views of a vehicle and the immediate surroundings to determine whether they allow hazards to be located more quickly and easily and their position determined more accurately in relation to the vehicle.

In a similar way, exterior visual data can now be gathered from inside submarines. For more than a century, submariners have been dependent on periscopes for views of their surroundings above water while submerged. Periscopes evolved to include improved optics, electrical drives and image stabilisation but they still need to be physically manoeuvred to give direct line of sight to the operator. More recently, multi-sensor optronic mast systems have been developed that no longer need to penetrate the hull, requiring instead just a cable to link them into the submarine's interior. Where this type of system occurs, the traditional constraints in locating the control room and taking account of requirements for maintenance no longer exist. A study has looked into whether designers are taking full advantage of this with the layouts of new submarines.

A toolkit for improving quality and safety through resilient systems has been developed

When operating below periscope depth, sonar has been used to build situational awareness but classifying vessels using sonar relies on the analysis of sound to build up an understanding of the vessel's motion. This carries inherent uncertainty with potentially fatal consequences for misclassification, resulting in collisions between vessels and submarines. Researchers now suggest that artificially intelligent support could be created and provided through analysing historic information about vessels transmitted via satellite.

Artificial Intelligence (AI) and machine learning systems are dependent initially on knowledge from human experts. But if we trained these systems to perform and think in the same way as humans, some decisions made by machines might be unacceptable because people consider many additional, often personal, parameters that might be inappropriate for a machine to use. Making sense of a given set of data depends on selection of an appropriate frame of reference and this selection can depend on the prior experience of the 'sensemaker' as much as on the availability of data. Researchers have studied whether AI systems and humans make similar decisions given the same set of data and have come to some interesting conclusions.

Artificial Intelligence has enabled, in the last decade, an exponential growth in the number of clinical decision support →

IMAGE: GETTY

Graphical user interface concept

systems (CDSS). But while the vast majority of algorithms used are tested for efficiency on specific datasets or against humans as reference standards, very few are evaluated for their benefits when used to supplement a clinician's decision-making. Amongst others, trust in the system, interpretability of the results and the seamless integration into hospital workflow play crucial roles in bridging the software outputs to actual effects on patient outcomes. A systematic review has been carried out to determine the impact of AI-based CDSS on physicians' performance, one of the outcomes of which will be a list of metrics used to measure human performance when supported by computers.

Even with the assistance of AI, healthcare remains a complex system in which it's often impossible to fully anticipate what might happen and therefore fully specify all potential courses of action. Clinicians must take action to solve problems and challenges, based on the information available to them combined with their knowledge and skills. This helps to build a resilient system that leads to quality improvement. A new toolkit for improving quality and safety through such resilient systems has been developed and shows much promise.

Even the most resilient systems can suffer from disruptions, which can have far-reaching negative consequences. The extent to which a system can anticipate, absorb and adapt to a disruption is a characteristic of its resilience. As people are often fundamental to system resilience, an improved understanding of the people-related factors that underpin system resilience helps in predicting system vulnerability and the response to a disruptive event. Researchers have developed a framework to help identify relevant people-related factors within a system and predict the system's resilience and the likely dominant response from key personnel.

A new framework provides a simple process for incorporating cognitive requirements into military systems development

In today's high-tech world, we need resilient systems to deliver power, water and communication but these may rely on physical connections between source and outlet, often located underground. And that can be a major source of disruptions. The construction industry damages thousands of services each year through service strikes, when workers accidentally dig through underground utilities, leading to a significant cost and risk to human life. Training is an established aspect of safety management but many training sessions are delivered via traditional presentations which lack interaction and engagement and can be ineffective. However, an alternative method of training is becoming more commonplace, using Virtual Reality technology, which has been shown to have a major impact on cognitive ability to retain safety information. One construction company saw a 32% reduction of service strikes in 12 months, following this method of training.

Cognitive ability has been classified in a study undertaken to provide the UK Ministry of Defence with a generic process to allow them to determine the cognitive capabilities required for accurate system operation. Through analysis of literature and an understanding of military tasks, a framework has been created, which, when combined with guidance and best practice, provides a simple process for deriving and incorporating cognitive requirements into military systems development. This will help to maximise system performance.

One measure of system performance is sustainable productivity, often used to assess effectiveness of manufacturing processes. Increasing levels of automation and robotics in manufacturing are transforming manual work but often the technology does not fulfil expected performance and benefits because there is little or no understanding of how a system will impact operators. Work is currently being undertaken to identify factors relevant to the success of new industrial technologies and in particular, automation and robotics. Results will be used to create a self-assessment tool for organisations to independently evaluate and improve their current state of readiness for new implementations. In another study, a digital toolkit has been developed which helps provide new systems-led understanding of future manufacturing workplaces, and the ability to predict the impact of introducing new technology into this sector.

Details of all these topics, and many more, will be presented and discussed at CIEHF's flagship event, Ergonomics & Human Factors 2020 in conjunction with ODAM2020, next April. For more details, including the programme and how to book, visit events.ergonomics.org.uk.

IMAGE: ALAMY

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rps MAKING COMPLEX EASY

Royal Mail introduced and developed automation to enable increasing amounts of mail to be sorted and delivered rapidly. An early understanding of the importance of ergonomics ensured human operators were properly accommodated, recognising that people would continue to play a vital role, as **Corinne Parsons** and **Robin Ellis** explain

Moving the mail

During the late twentieth century more than 16 billion letters were delivered annually by Royal Mail to 30 million addresses throughout the UK. Founded over 500 years ago, the company provides mail collection, sorting and delivery services and owns and maintains the UK's distinctive red pillar boxes, first introduced in 1852, many of which bear the initials of the reigning monarch at the time. All mail was originally sorted by hand, bundled and transported around the country in mail bags that were individually loaded onto the most effective transport of the day.

In the 1950s and 60s, Royal Mail started to develop letter sorting machines and while they were an improvement, enabling mail to be sorted more quickly, they were not designed around the human operators. The machines tended to cause reach and posture problems and were difficult to use.

However, although most mail was still sorted and bundled by hand, these early machines paved the way for a major letter sorting automation programme in the 1990s, with larger, faster machines. In recognition of the fact that people would continue to play a major part in Royal Mail operations, the organisation set up an ergonomics team in the mid-1980s

Employees sort deliveries at Royal Mail's Mount Pleasant Mail Centre

Manual letter sorting

1990s letter sorting machines

Looking out over a modern mail sorting centre

and since then ergonomists have been involved as a core part of the project teams developing and deploying the automated systems. This included involvement in benchmarking visits and requirements analysis, concept testing, development of specifications for tenders, tender adjudications, user testing of pilot machines, development of workstations, operating systems and maintenance routines, training and deployment.

At the start of the 1990s there were more than 80 mail processing centres often with multi-floor working. The bigger machines led to a smaller number of much larger single-floor processing centres, and there are now 37 such centres. The machines developed at this time could segregate mail into letters, large letters and parcels, into first and second class, cancel the stamps, automatically read the addresses and sort to 180 destinations at a rate of 30,000 letters each hour. Optical character recognition has allowed most addresses to be read and sorted automatically. For those that can't be read, an image is captured, sent electronically and is coded by a human operator, so that it can then be sorted by the machine.

There was a recognition in Royal Mail that designing and commissioning machines that could sort many thousands of letters an hour would be pointless if the tasks to operate these machines at the required rate were beyond their users. Ergonomics involvement at an early stage and throughout the project lifecycles has resulted in working systems that are designed around the human operators and their capabilities and requirements. Ergonomics input typically involves gathering user requirements, developing concepts, reviewing drawings, building and testing mock-ups and carrying out user trials. The findings shape the design of the workstations, control systems, working methods, ancillary equipment and maintenance.

The automation programme continued to include large letters and more recently, small parcels, so the proportion of mail sorted by hand has steadily decreased and today 90% is sorted by machine, mostly into the final order in which it will be delivered.

In addition to the new machines, a new system of containerising mail in trolleys and trays was also developed in the 1990s to support the automation. Bundled mail in bags was replaced with letters carried in order in letter trays. The trays are now transported in containers which are wheeled directly to and from the machines and into lorries and trains on to delivery offices and regional hubs. This has greatly reduced the manual handling requirements of the work.

The trays and wheeled containers were specifically developed with input from the ergonomics team. The ergonomics involvement in the design of these systems influenced the size and weight of the containers, the design of the handles, brakes and their handling characteristics. Looking over a modern mail centre today, it's encouraging to see that all the equipment in view has been improved by ergonomics input during its design.

A modern mail sorting centre is very different to those of 30 years ago. The hustle and bustle of a physically intense manual operation in many relatively small offices has been replaced by a much smaller number of large buildings with big sorting machines. There are fewer people but they have improved working conditions and less physically demanding work. This has allowed a more diverse working population to develop with over 45% of the workforce now being over the age of 50.

The development of new and upgraded automation for sorting mail has continued to the present day. Ergonomics has remained integrated within the project teams to ensure usable systems are developed that can be operated and maintained efficiently by people, without detriment to their health and wellbeing

Dr Corinne Parsons is the Occupational Health & Ergonomics Manager at Royal Mail and **Robin Ellis** runs RED Design Ergonomics. This article was written in celebration of the 70th anniversary of ergonomics in 2019.

IMAGE: GETTY

Safer drug dispensing

Different bottles, packets, faded labels, new dosages, new colours means there's a myriad of factors to be scrutinised by care workers every day as they administer vital medication. **Dominic Furniss** explores how human factors can improve the safety of medication administration for care home residents

IMAGE: JOHN HOLCROFT / IKON

Thousands of elderly and less-abled people each year make the emotive and life-changing decision to seek greater support from the social care system. One critical area of care and resident safety is the administration of medication, with residents prescribed an average of seven medicines a day, and many taking ten or more. Unsafe pharmaceutical packaging, together with look-alike labelling, have both been identified as major contributing factors to medication incidents, which are one of the biggest causes of patient harm. However, labelling is only one aspect of the process for ensuring safe use. Feedback about reports of medication incidents and errors indicate that a systems-wide approach to how the label is developed, used and amended is needed.

However, there is no real consensus about the definition of a medication error. A recent systematic literature review found 26 different terminologies employed for a medication error. And many studies have described medication error rates in hospital settings but data for primary care is relatively scarce.

In a recent report called the 'State of Care', from the Care Quality Commission (CQC), a strong focus has been placed upon the role of technology in the delivery of future person-centred care. The challenge set out to providers and the wider local health and social care communities is to consider technology in a broader strategic sense, as an enabler of high-quality care.

But technology may not be the simple answer to medication administration as we have witnessed in the last few months, as a new Healthcare Safety Investigation Branch report highlighted a significant safety risk with electronic prescribing. A patient was left with internal bleeding by being given two types of blood-thinning medications at the same time.

Sadly, the term 'human error' is frequently scribbled on case notes across the social care system, isolating thousands of carers every day as the sole reason behind patient medication administration incidents. So, while the current National Institute for Health and Care Excellence guidance states that care home providers "should ensure that a robust process is in place for identifying, reporting, reviewing and learning from medicines errors involving residents", there is far more that can be done to support staff.

As humans, we're fallible and we make mistakes. However, as hugely adaptable creatures, we're also heavily influenced, for good or bad, by the systems and environments we operate in. The majority, if not all of medication administration incidents, are multi-causal, meaning there are different factors that contribute to the end outcome. Essentially safety needs to understand systems, not blame individuals.

We tend to have a bias for the simple story where the blame lands in the lap of individuals (the first order story). For example, when top Formula 1 driver Lewis Hamilton wins a race, we attribute that win to him and don't think about the team of people, equipment, funding, etc. that's put him on the podium (this is the second order story). It's similar for medication incidents, and even normal performance at work; we think of training people, when really there might be improvements to be made in their working conditions, the forms and procedures they use, the technology they operate or the way their environment is organised (the second story). The second story is where deeper systemic changes can be made for lasting improvements: draining the swamp rather than swatting gnats.

In the case of medication incidents, we might investigate whether the care worker concerned was fatigued from a long shift, or whether the lighting conditions in the dispensary were adequate, or whether measurement vessels were clear enough to read, or whether the resident was in an unfit mental state at the time of administration. Taking a step back can reveal some often very simple changes that care homes can make to support the performance of their staff and the safety of residents.

To better understand this, consider commuting to work every day and safely arriving at the destination. It's easy in fine weather and on a clear day but change that to a dark winter's night and torrential rain after a long night shift, and we begin to feel the impact of the environmental influences surrounding us.

Reducing medication errors and improving medication safety requires a systems approach

Social care, as a safety-critical industry, does have proactive approaches to safety. To enhance this from a human factors point of view, a detailed task analysis could be conducted to understand work-as-done, identify the potential for deviations, and try to redesign the system (how work is organised) so it's easier for frontline staff to work efficiently, effectively and safely, and manage other performance-influencing factors that could affect safety.

In a recent paper published in the *British Medical Journal*, researchers looking at the management of risk in hazardous conditions concluded that improvisation is not enough. One of the main messages is that the idea of zero harm hinders safety improvement. They say we need a more mature approach to risk in healthcare to recognise where standards of care cannot be achieved, identifying hazards, and practical strategies and approaches to managing safety. The researchers drew out the following underpinning principles to frame their approach to managing pressures and crises.

"First, we must in a sense, give up waiting for things 'return to normal' although we can, of course, continue to innovate and improve the system. However, we must face the fact that unsafe practice exists and ask how risk can be minimised in essentially dangerous conditions.

Second, we must accept that we can never eliminate all risks and hazards. There is nothing wrong with eliminating risks where this is feasible, but we need to balance these preventative actions with a wider portfolio of safety strategies that are explicitly aimed at managing dynamic threats and pressures.

Third, although most of the literature on adaptation focuses on the management of surprises and unexpected problems, →

A nurse giving medicine to an elderly man

the principal focus should be on expected problems and hazards. Pressures of beds, staffing, equipment and sick patients are unexpected in that it's hard to know when they will happen but they are entirely familiar. These situations are quite different from sudden, unexpected and unusual crises that are the focus of much of the literature.

Finally, we must acknowledge from the start that the management of risk when an entire unit or organisation is stressed necessarily requires engagement and action at all managerial levels. Negotiating new priorities, comprehensive training and strategies in a stressed organisation requires coordinated action between executives, middle management and frontline staff."

Several studies have explored ways to improve the quality of prescribing in primary care. However, outcomes are mixed and few studies have specifically focused on medication errors. Reducing medication errors and improving medication safety requires a systems approach.

The elderly population may also encounter special issues related to medication errors. For example, people living in care homes are often frail with multiple health conditions and take multiple medications. The administration of medication in this environment often differs to patients' own homes as it's provided by nursing staff or other personnel, raising issues around dispensing, administration and monitoring problems, as well as staff training.

According to work conducted by the Care Quality Commission, there's an increased risk of poorer experiences and outcomes when a patient's care is transferred between services. At this critical time, communication can break down around prescribing and supplying medicines, which means people may not always get the right medicines quickly enough, and this may lead to harm.

NHS England reported the positive news this year that, as part of the NHS' 'Long Term Plan', extra medical and clinical experts are being put in place, including 200 new clinical pharmacists and pharmacy technicians, to support care home residents to improve quality of life, cut hospital stays and reduce over-medication. There is a hugely beneficial role that human factors can play to support this work.

It was also good to hear Health Education England, on behalf of NHS England, initiating the 'Medicines optimisation in care homes' training pathway for 600 pharmacy professionals from April 2018 to March 2021. However, often there can be too much focus on training, competences and individuals and not enough on human factors that can target system risks and issues. A little bit of human factors knowledge and systems thinking could go a long way.

Another key area where human factors can support social care, is in the development of a medication safety management system. So, as part of the CQC's rating of homes, this would question what they have in place to monitor, report and learn from incidents and manage safety in the future. Specialist human factors training for care home managers could be an interesting avenue to explore.

Social care would benefit too from learning from other safety-critical industries. The petrochemical and medical device design sectors now use the Systematic Human Error Reduction and Prediction Approach (SHERPA) to risk for managing human performance.

There is growing human factors input across social care but it's crucial that care homes come together to share their experiences and learning. With initiatives to increase the role of pharmacists in care homes there could be an opportunity for a stronger presence of Medication Safety Officer networks across the social care system.

No machine in the world is up to the job of providing the love, care and empathy our care workers provide every day but advances in technology and greater knowledge around the challenges they face in their line of work could help transform the lives of care workers today. ●

Dr Dominic Furniss is Pharmaceuticals and Patient Safety Champion for the CIEHF.

Further reading

LHSIB report into electronic prescribing: www.hsib.org.uk/investigations-cases/epma-systems-and-safe-discharge/

Amalberti R, & Vincent C, Managing risk in hazardous conditions: improvisation is not enough. *BMJ Quality & Safety*. First published online: 09 July 2019. doi: 10.1136/bmjqs-2019-009443

NHS England news report on NHS Long Term Plan: www.england.nhs.uk/2019/05/army-of-nhs-experts-to-tackle-over-medication/

NHS England article on medicines optimisation: www.england.nhs.uk/primary-care/pharmacy/medicines-optimisation-in-care-homes/

IMAGE: GETTY

JOURNAL EXTRACTS

Featuring research published in high impact ergonomics journals

The psychology of spam

1 Could you categorically recognise every spam email lingering in your inbox? The number of phishing attacks is on the rise. Tech platform *ZDNet* recently reported that one in 61 emails in your inbox now contains a malicious link. Analysis by security provider Mimecast found that between August to November 2018 and December to February 2019, the number of emails delivered, despite featuring a malicious website address, increased by 126%. So how can we better educate and support workers in the war against spam? A group of human factors researchers believe the answer lies in the psychological interaction of spam email features.

Whilst many of us may make the quick-fire 'delete' judgement based on an email title or sender address, the reality is, in our busy lives, spam continues to plague and trick us. This study took things a step further, exploring distinct perceptual and decisional contributions to spam email mental understanding. Participants classified spam emails according to pairings of three stimulus features: presence or absence of awkward prose, abnormal message structure, and implausible premise.

Applying general recognition theory, researchers found that the accuracy of spam classification was highest for categories containing either two non-normal dimensions, such as awkward prose and implausible premise, or two normal dimensions, such as normal prose and plausible premise. Testing for dimensional interactions at perceptual and decisional levels with these categories provides insight into how people mentally construe threat cues in email. Such information could inform personalised training emphasising features that need particular attention. This might be particularly valuable for embedded training systems that present phishing emails periodically in a real-world setting.

S Williams et al (2019) The psychological interaction of spam email features, Ergonomics, 62:8, 983-994, DOI: 10.1080/00140139.2019.1614681

The trend to unfriend

2 Ever walked down a supermarket aisle and taken a side-swerve to avoid an awkward conversation with a Facebook 'acquaintance'? We may know what a person had for breakfast, the name of their new-born child or where they are holidaying this year but becoming friends on Facebook does not guarantee long-term meaningful friendships.

Have you ever been subjected to the cutthroat act of being 'unfriended' on Facebook? Now an official term in the Oxford English Dictionary, unfriending is the instant removal of a person from your friends list, rendering them unable to view your online activities. Maybe not the same as cutting someone out of your 'real life', but what emotional impact can a contact suddenly and mysteriously disappearing have on our social psyche?

Unfriending is becoming a large social trend and might have negative consequences for both parties. To gain insight into the factors influencing adolescents' unfriending, researchers have made use of an extended version of the theory of planned behaviour. To enrich the theoretical framework, the researchers included antecedents related to adolescents' friendship management on Facebook, namely their number of friends, their friendship acceptance threshold and their degree of public communication.

A cross-sectional survey was conducted among a group of adolescents and analyses of the results indicated that both subjective norm and attitude were related to behavioural intention, which in turn was related to adolescents' unfriending behaviour. The size of adolescents' friend networks was positively related to their confidence in the ability to unfriend others. Adolescents' friendship acceptance threshold was negatively related to their attitude, whereas adolescents' degree of public communication was positively associated with their perceived behavioural control and the experienced social pressure to unfriend.

IMAGE: SHUTTERSTOCK

K Verswijvel, W Heirman, M Walrave & K Hardies (2019) Understanding adolescents' unfriending on Facebook by applying an extended theory of planned behaviour, Behaviour & Information Technology, 38:8, 807-819, DOI: 10.1080/0144929X.2018.1557255

Dominic le Roux is one of the few ergonomists in the world who works for a national rugby team. Here she explains how her background helped her team to prepare for their biggest challenge at this year's Rugby World Cup

Training above the game

With England's immense achievement of reaching the final of the Rugby World Cup in early November, let's think about what level of investment and participation in the sport it takes to do that. The Rugby Football Union (RFU) is the governing body for rugby union in England, and according to their 2018 annual report, they invested £107.7m in the previous year in their 2000 rugby union clubs and in operating the game at all levels. They estimate around 2.5 million people in England participate in rugby in some way, from playing to watching. That's more than the entire population of one nation that's taken part in all the Rugby World Cup tournaments since 1999 – Namibia. They've qualified six times, have gone on to score a total of 27 tries and are currently ranked 22nd in the world.

However, Namibia's biggest challenge is still to win a match in the World Cup competition and since 2016, this has been the primary aim. After qualifying for Japan 2019 in August of last year, the only purpose of preparation was to win a match. The philosophy introduced by coaching staff to obtain this goal was to train 'above the game'. When Canada qualified in our Pool in November 2018, we realised that this was Namibia's target team

Namibia players react after Italy's try during the Rugby World Cup 2019

to beat. Other teams in our Pool were Italy, South Africa and New Zealand which, shall we say, we were less likely to be able to beat.

As part of the preparations for qualification and ultimately, for taking part in the World Cup in Japan, we decided to take a more robust, scientific approach to training and preparation, something which we had not done before. Funding was raised and supported Namibia Rugby in renting a GPS system so that we could collect objective data about the players and the effectiveness of our training. The system included heart rate monitors and data collection software so, with a sports science background and an understanding of the importance of human factors methods in the process of introducing new systems, it became part of my job.

Initially understanding the hardware, software and interface of the GPS units was crucial. As with physiological measurement techniques, physical measurements should also not interfere with the task at hand. Familiarisation was one of the challenges when the system was first introduced. Not only was it important for the players to become familiar with the units themselves, they had to get used to the process of putting on the GPS vests, placing the heart rate belt in the vest, placing the GPS unit in the pouch created in the vest on the upper back, then putting their shirts over the top and being mentally ready for training. At first, some players' behaviours changed on the field and they sometimes tried to cheat the system by running extra metres during a session, in addition to the actual drills. But once they understood the system was there to improve their game, they became more receptive to the ideas we were trying to introduce.

To prevent errors, a checklist system was used to be sure all heart rate belts and units were on and placed at the same position, at around the same time prior to training sessions and were allocated to the same players each time. This helped players trust the system and the results obtained from training sessions and matches.

The second major challenge was standardisation, not only the data collection but also the reporting metrics and structures. As part of the collection methods, each drill was recorded as a timed period allocated to players involved and only during the time the drill was executed. This was the only way we could standardise and compare our metrics to match data. During a match, the statistics are derived from the time spent from whistle to whistle, or 'ball in play' time. This meant that training statistics for 15 vs 15 contact training drills could be compared to match data.

Once the metrics were agreed between myself and all the coaching staff, these were the only metrics we reported on. The layout of the reports were also adapted to suit the understanding and needs of coaching staff to contribute to their planning strategies.

The data we collected soon started to dictate training intensities and durations but the subjective aspect of human perception on factors affecting performance was also critical. Player welfare is an important concept in rugby and by collecting daily subjective data on perceptions of muscle soreness, fatigue, sleep quality, stress and mood, it provides valuable information about each player's physical and mental wellbeing.

Comparing the training volumes, intensities and physiological reactions of a session with the subjective data collected the following day, may provide information, in the longer term, on efficiency of recovery methods, fatigue and state of mind. It's important to evaluate this throughout the year but also prior to a match. Match day readiness should reveal a well-rested athlete with a positive mind set. High levels of stress can pose a challenge to processing information, which is detrimental to a team sport, as situational awareness is crucial for good decision-making opportunities.

When athletes are prepared to compete at a higher level of physical demand than the match may require, it supports the injury prevention strategies of load management. Introducing players to sudden increases in high speed loads during a match, for example, exposes them to a greater risk of soft tissue injury such as hamstring strains. Load monitoring is important throughout the year. Different teams quantify their training load differently. Some look at arbitrary units (AU) by collecting session rate of perceived exertion (sRPE) data by multiplying the session's RPE with the time trained in minutes. Other teams break the training session down into segments and calculate the AU for each segment. The majority of teams use sRPE in combination with other physiological measures to monitor training load. Another aspect of load management which we applied looked at absolute figures, as well as acute-to-chronic work ratios. This may include looking not only at training volume (distances) but also at high speed volumes, training intensities, heart rates and total number of acceleration efforts.

We took on a more robust, scientific approach to training and preparation

On Sunday morning, 13 October 2019, team Namibia were as ready as they'd ever been to win a match at the Rugby World Cup. However, nature had contrived against us! Typhoon Hagibis hit the area the night before and the match was cancelled. So, we'll have to wait until the next tournament to see if the preparation and training regime were good enough to bring about a win. Whilst we were devastated that we didn't have the chance to prove ourselves, we now have the advantage of a greater understanding of training regimes and will hopefully qualify again next time. See you in France!

Dominic le Roux is a Sports Science and Monitoring Specialist at Namibia Rugby. She has an MSc in Sports Science and was in private practice for seven years as a physical therapist prior to her MSc in Ergonomics at Loughborough. She started working for Namibia Rugby in November 2016.

Further reading

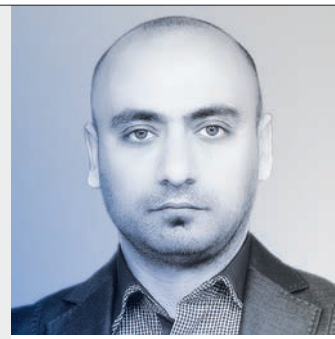
D Le Roux, 2017. A human factors perspective from Namibia, *The Ergonomist*, issue 561

IMAGE: GETTY

Q&A

MEMBER PROFILE

Following presentation of his award-winning paper, **Husam Muslim** talks to Lou Boulden about his research interests and career aspirations



Tell us about your research interests

I'm a PhD candidate working in the Laboratory for Cognitive Systems Science at the University of Tsukuba in Japan. I received my Master's degree in engineering from the University in 2017. My research interests include ergonomics in automated human-machine systems, human-automation interactions, and human factors, particularly in automotive automation. I was awarded the CIEHF's John Wilson Student Travel Bursary to participate in a symposium, held in Tallinn in September, on Analysis Design and Evaluation of Human Machine Systems (HMS 2019). At that event, I received the International Federation of Automatic Control Young Author Award for my research paper entitled *Trust and Acceptance of Adaptive and Conventional Collision Avoidance Systems*.

Why that symposium?

During the last 25 years Estonia has experienced rapid technological development and is now one of the leading countries in areas like e-government, cybersecurity and e-medicine. All these areas rely heavily on human-machine interaction technologies so it was fitting that this symposium was held there, and it seemed like a highly relevant event at which to present my work.

What's the background for your research?

Advances in technology have enabled automation to be applied in all aspects of human-machine systems, including car driving. Automated driving systems are assumed to reduce driving workload and enhance road traffic safety and capacity. However, human drivers have to monitor and interact with the automation in a highly dynamic environment. Although driving automation systems are designed to improve safety, there may be unintended negative consequences of excessive and long-term use. For example, there may be a loss of arousal and situation awareness, as well as automation-induced complacency, which occurs when people become overly satisfied with their abilities. Drivers are also more likely to engage in non-driving related activities, impairing their ability to respond in critical situations. Drivers may become overly dependent on a system that may not always work as they expect. In critical situations, these factors will all impede performance when drivers need to resume manual control of the vehicle. While such problems may be partially addressed by appropriate instructions and/or training for drivers, there's also an obvious need to take into account the root cause of the problems when designing human-machine interactions.

My goal is to be a leading scientist in an academic research laboratory or institution

What are your future goals?

My goal is to be a leading scientist in an academic research laboratory or non-profit research institution, focusing on ergonomics. My short-term research interests involve design and implementation of automated vehicles capable of performing specific tasks on predefined roads to help older people and those with special needs. I'm also looking at development of automated life-saving vehicles to aid people during disasters and accidents in dangerous places. Longer term, I'm interested in the development and implementation of fully automated vehicles for everyone. My goal for the upcoming two years is to gain the skills and knowledge necessary for conducting systematic

IMAGE: GETTY

investigations, understanding real-world problems from a broader perspective, setting out solutions and leading scientific projects in ergonomics and human factors.

What advice do you have for aspiring researchers?

I recommend honing your data analysis and computational skills through research experience, attending conferences and meetings, and reading scientific literature. I'd also advise you to deepen your background knowledge in ergonomics and human-machine systems to become more familiar with topics in information systems and engineering science disciplines. It's also really valuable to supervise other students, either undergraduate or graduate, by providing them with the necessary advice, new ideas and experience and help them understand real-world problems and how to design their research work. This will help and train the next generation of ergonomists. I'd also say to improve your scientific writing, academic communication and presentation skills through preparing and submitting manuscripts to top peer-reviewed journals, take part in lab and technical meetings, and attend local and international conferences. I look forward to a future where I can establish a successful, long-standing research group of active PhD and post-doctoral researchers in ergonomics. ●

Husam Muslim is a third-year, multi-award winning, Doctoral course researcher majoring in risk engineering at the University of Tsukuba in Japan. He is a member of the CIEHF and the US Human Factors and Ergonomics Society

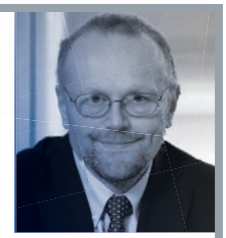
Exploring latent error conditions

Undetected human error in aircraft maintenance creates a latent error condition that can contribute to undesirable outcomes. Individual Latent Error Detection acts as an additional system safety control that helps an engineer recall past errors through environmental cues.

A new book, by CIEHF members Justin Saward and Neville Stanton called *Individual Latent Error Detection (I-LED): Making Systems Safer*, addresses a gap in the human factors research and current safety strategies by exploring the nature and extent of I-LED and its benefit to safety resilience.

For more details, visit **http://bit.ly/I-LED**. If you'd like a free copy in return for a 700-word written review to be published in a future issue of *The Ergonomist*, please email **ciehf@ergonomics.org.uk**.●

Designer elected as President



Fellow of the CIEHF, Chris Ramsden, who is an industrial designer, bioengineer and ergonomist, has recently been appointed to serve a second term as President of the world's largest internationally recognised body for the design profession, the Chartered Society of Designers (CSD). 2020 will mark the 90th Anniversary of the CSD which accredits over 60 courses and awards Chartered Designer Status.

Chris said that he was very honoured to have been asked to serve for a second term and looked forward to developing even closer links with the CIEHF. Chris also assists the CIEHF as Healthcare Sector Group co-leader for Medical Devices and is involved with the Trailblazer Group on developing a Human Factors Apprenticeship. ●

Chartered Institute of Ergonomics & Human Factors

Notice of Annual General Meeting

The AGM will take place at 17:15 on Tuesday 28 April 2020 at the Crowne Plaza, Stratford-Upon-Avon for the following purposes:

- To receive the minutes of the 2019 Annual General Meeting.
- To present the Annual Report and approve the year end accounts.

Nominations are sought from Registered Members or Fellows (or Retired, or Honorary Fellows) for the following positions:

- President Elect
- Treasurer
- Council Members
- Professional Affairs Board Members
- Plus one Graduate Member Representative on Council

Nomination procedure

Nominations must be made following the method that will be set out at www.ergonomics.org.uk > About us > Governance and must be received and seconded by 13 March 2020.

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 20 February 2020.

The current General Regulations can be found at www.ergonomics.org.uk > About us > CIEHF Documents.

Noorzaman Rashid
Chief Executive of the CIEHF
Noorzaman.rashid@ergonomics.org.uk

MEMBERSHIP

Our latest accreditations

Congratulations to the following members and organisations whose applications for accreditation by the CIEHF over the past few months have been successful. Registered Members and Fellows also have Chartered status.

Technical Membership

- Pete McCarthy
- Varun Sarpangal

Registered Membership

- Mark Sujan
- Zoe Cooper
- Richard Marshall
- Ian Harryman
- Rachel Fowler
- Byron Edwards
- Darren Doyle
- Mike Bromfield
- Joanne Knight-Smith

Fellowship

- Vincent Duffy

Registered Consultancy status

- Lorraine Braben Consulting Ltd

Training Courses

- Human Factors Foundation by the Energy Institute
- DSE Workstation Assessor by Ergonix
- Introduction to Human Factors in Healthcare by Atrainability
- DSE Workstation Assessor's Training by WorksOut
- Introduction to Ergonomics and Human Factors by Robert Gordon University, Aberdeen
- DSE Assessor by Ergonomic Options

IMAGE: ISTOCK

Making the most of membership

Members of the CIEHF will be accustomed to receiving their own personal printed copy of *The Ergonomist* but if you've passed your copy on to a colleague and haven't seen it again, no need to worry. You can access past issues online by simply logging in to your MyCIEHF account and navigating to 'The Ergonomist' drop-down menu item.

Whilst you're logged in, please take a look at the newly named 'Research' page (this used to be 'My Journals'). Here you'll find not only the two major journals we've always made available to you, *Applied Ergonomics* and *Ergonomics*, but also a relatively new addition called the Research Gateway. It offers searchable access to curated full-text journal items, and articles from magazines, trade publications from top publishers plus critical news content with ongoing updates. Use it to find citations for papers you're writing, ideas for future work or simply interesting material to read. You can access the Research Gateway through your MyCIEHF account and get started straight away, or, if you'd like to watch a quick tutorial on how to find exactly what you need, just click on 'Help' in the top right corner once you're in the Gateway.

If you'd like to exchange ideas, discuss a specific topic or ask a question, then go to our online discussion forum called Communities which allows you to do just that. Again, you can access it via your MyCIEHF drop-down menu and, as a member, you have access to all discussion forums. Recent topics include manufacturing practice in pharmaceuticals and musculoskeletal disorders in healthcare workers. Why not start your own discussion on a topic that matters to you or join a sector group community? If you're new to participating in online forums, the 'Communities' menu item takes you to a page explaining how it all works and what to do to make the most of it.

We'd also like to highlight your access to recordings of past webinars, which are available through a new menu item called 'Webinars'. (We moved the links to here to make it more obvious how to find them following feedback from members.) Recent topics include medication packaging, cybersecurity, global strategies for advancing human factors and mentoring. All great topics for CPD and all about an hour long – just right for a train journey perhaps!

We urge you to make the most of your membership and take advantage of these resources whenever you want, from wherever you are. Through analysis of access statistics, we regularly review member benefits to ensure we offer those that we think are of the most value to the majority of members. This has recently resulted in the discontinuation of the My Discounts programme in order to concentrate our resources on investment in the more popular benefits. So if you find a particular benefit of real value, please use it often and tell other CIEHF members about it so they can help to keep it going too.

We hope you'll appreciate the changes but we'd be very happy to hear your feedback.

Iris Mynott
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07702 542166

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
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 in conjunction with ODAM2020	Mon-Wed, 27-29 April 2020, Stratford-upon-Avon	Masterclasses, keynotes, talks, posters, workshops, discussions and lively social activities, together with an in-depth look at work systems design, technological change, complex systems and much more, all packed into a three-day showcase event.
Human Factors in Rail	Wed-Fri, 24-26 June 2020, London	An exploration of in-cab signalling, traffic management, non-technical skills, the platform-train interface, safety culture and more.
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.

Obituary
JOHN RYDER

A true people person who helped others realise their potential, 1951 - 2019

It is with great sadness that we announce the passing of CIEHF Fellow, John Ryder.

John studied at the Royal College of Art gaining a BA in Interior Design and was awarded an MA in Environmental Design & Architecture in 1976. It was later in his career that he found ergonomics, and with a background in art, it's safe to say that he approached the world of ergonomics and human factors from a design perspective. It's been said by many who had the pleasure of working with John, that design and people, and designing *for* people were truly his forte.

His entrance into ergonomics came via control centre design; an area that he helped to pioneer for clients as varied as the Metropolitan Police, Sellafield, London Underground and Shell, during a career spanning more than 40 years.

Over the years, first as director of Townend Ryder design, then at Vectra, Arcadis and, for the past seven years, Atkins, John turned his hand to most areas of physical ergonomics. He was well experienced in working within multi-discipline design teams across high hazard industries including rail, nuclear and oil and gas. He established a track record in conceptual design, master planning, preparation of specifications, analysis of requirements and assessment of design compliance within complex engineering and design projects. With projects as varied as the design of security systems for oil and gas clients in the United Arab Emirates to design consultation on London Underground Stations including Bond Street and Farringdon, together with control centre design for Crossrail and HS2, John's knowledgeable and calm approach was invaluable to many clients.

Whilst it could never be said that John was a whizz with word processing and document formatting, or that he enjoyed the expense processes, machinations and procedures of big business, you could always rely on him if people were involved. Wherever he went, in whatever business, John made friends. And during such a long career, there were many projects, clients and engineering teams within which he made friends.

John's honest and open approach helped to build strong, supportive and successful teams. To those outside the team it could appear to be a clique but for those of us who have had the privilege of working in one of these teams, we know it to be a family.

Above all, John's greatest strength was his ability to spot talent in individuals. He was a true people person and central to his everyday work was supporting and developing junior colleagues. He was extremely generous with his time and would always be the first to offer support and guidance to help colleagues through challenges, and to help them realise their potential. Over the years, John encouraged and supported no less than 13 individuals to successfully become Registered Members of the CIEHF. He was a Fellow of the Institute and strong supporter of the work done by the organisation, and in recent years was a member of the Professional Affairs Board.

Aside from his work and colleagues, John's family was central to his life; his wife of over 40 years, Joy, his son Tom and his wife Sarah, daughter Lucy and her husband Charles, and granddaughters Harriet and Amelie, and another granddaughter due very soon. John was immensely proud of them all and their many achievements. Since 2017, John had taken advantage of reduced working hours and flexible working to allow him to spend more valuable and cherished time with his family, and also to pursue his hobbies especially as an artist, true to his early training, creating many striking works in drawing, painting photography and woodwork.

Central to John's everyday work was supporting and developing junior colleagues

The funeral service was held on Friday 6th December at Crewe Crematorium, and was well attended by many family, friends and colleagues with standing room only. The service was followed by food and drinks at John's favourite pub, the Cholmondeley Arms, for a celebration of John's life and achievements, and above all for his love, care and support for others.

John's colleagues and clients will remember him as a warm-hearted man, quick to joke and see the good side of a situation and as a great friend and mentor to many. He will be sadly missed.


Emily Thorne and **Alex Morley** work as Principal Human Factors Consultants at Atkins.

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					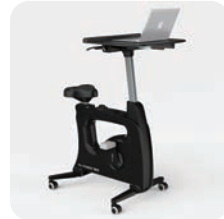
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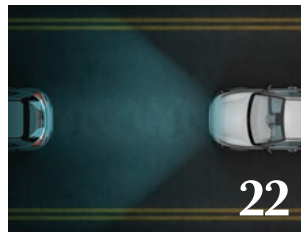

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FROM THE PRESIDENT

The productivity paradox

Bob Bridger
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Many of us have an interest in the future of work and how the changes currently taking place in the economy will affect our own working lives and professional practice. With this in mind, I was interested to read the other day about the vision of Sanna Marin, the Prime Minister of Finland, for a four-day working week combined with a six-hour work day. Finland also recently experimented giving 2000 people a basic income of 560 euros/month.

The call for a shorter working week is not new. The first person to propose that nobody should have to work for more than six hours per day, was the philosopher Francis Bacon (in *New Atlantis*). His utopian view was that, properly organised, this was all the time needed to do what needed to be done in the agricultural and craft production systems of the time. Working hours have been shortened several times since then; during the First World War, the working week of munitions workers was reduced without ill-effects on output.

One of the main counter-arguments against a shorter working week or workday is the concern that shorter hours will lower output. However, this will only apply if productivity remains the same or is lower. What happens to output if productivity goes up when the hours are shortened?

What, exactly, is productivity in a post-industrial workforce where much of the activity involves sharing, re-shaping and processing information? When offices were first automated in the 1970s and 80s, the expected improvements in productivity were not realised, and the 'Productivity Paradox' of 'information technology' became a matter of debate. At least part of the apparent paradox was due to use of outdated and inappropriate parameters to assess productivity. Key Performance Indicators from the days of the typewriter were not sensitive to the real benefits of office automation. A shorter working week may also call for revision of many of our current conceptions of workplace health risks, based, as they are, on models and data from employees working the traditional 40-hour week.

With these thoughts in mind, I look forward to hearing what the international speakers at our forthcoming CIEHF/ODAM conference have to say.

A shorter working week may call for revision of conceptions of workplace health risks

FROM THE EDITOR

Strategy and insights

In this issue, we're pleased to reveal our new five-year strategy, as outlined by our Chief Executive, and the launch of our first Learning Pathway is celebrated with an article explaining how it aims to provide a standard for human factors learning and practice in the energy sector.

Our cover article by Tracey Herlihey explains the vital work of the Healthcare Safety Investigation Branch, with a fascinating look at the jobs of three of its analysts and investigators. Stef Cormack reveals research aimed at understanding the non-technical skills needed for paramedics dealing with cardiac arrests. And we take a look at how wearable tech has helped decrease hazardous movements and how it can help reduce musculoskeletal injuries.

Mark Young discusses how we can successfully integrate people and technology in our complex multi-user road systems. Complexity features heavily in a preview of many of the interesting presentations that will feature at our upcoming Organisational Design & Management conference.

There's an encouraging insight into ergonomics in China from Professor Wei Zhang, while Alawi Almajid is on a personal crusade to improve the situation in Saudi Arabia.

I hope you enjoy reading it all.

Tina Worthy
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China's booming economy has driven up the standard of living. Now ergonomists are playing catch-up as **Professor Wei Zhang**, President of the Chinese Ergonomics Society, explains

An ergonomics perspective from China

China is undergoing huge change, both domestically and in its relationships with the rest of the world. In recent decades, the market expansion of the world's most populous country has been nothing short of remarkable. It now has the second largest economy on Earth, with growth currently at 6% annually. This economic awakening has raised the standard of living across our country but at the same time, it's created higher market, consumer and workplace expectations. This is true of health and safety in general, and ergonomics in particular.

Discussion around these topics is exciting, but it isn't new. The Chinese Ergonomics Society, of which I'm President, was founded more than 30 years ago and over that time its membership has grown from less than 100 to more than 1400. As the economy has developed and transformed, so the issue of human factors and ergonomics has attracted increasing interest from both academic researchers and industrial practitioners.

China is still a little way behind some countries in the West; on a scale which put the United Kingdom and United States on 100, I would place us at perhaps 70 or so. On the same benchmark, I would say that a few years ago we were at about 30, and that shows the scale of advance as production has been upgraded.

As China's consumer society expands, people care more and more about design and quality, though this remains an area where ergonomics still has to make progress. But again, there are signs of a raised consciousness here. More and more people have started to realise the importance of ergonomics for reasons not only of health and safety but also of cost and efficiency, along with the role these play in developing and launching new products and improving market success and service quality.

One of the reasons ergonomics has taken time to gain due recognition here is because of the high profile in China of other occupational safety and health issues such as industrial accidents and illnesses. Pneumoconiosis, which is caused by the inhaling of hazardous dust and is a condition often faced by miners, is still the country's most commonly notified occupational disease. However, demand for manufactured goods that take account of ergonomic factors will continue to increase, particularly as employees become more aware of issues surrounding their own health.

There is nothing unique about workplace ergonomics challenges in China; they are much the same as in other countries. Problems such as neck, shoulder, back or wrist pain do not stop at borders. Neither do fatigue or eyestrain resulting from prolonged sitting, standing, repetitive tasks or heavy lifting, or indeed psychological impediments including tension and anxiety caused by intensive working. We're seeing ergonomics emerge as an important factor in areas such as the design and manufacture of furniture, and it's expanding in other, less consumer-focused sections of Chinese society and the economy.

The military, for instance, is adopting ergonomics and it's being introduced in the area of complex industrial equipment and systems as well as in computer software. Healthcare, too, is an important sector, particularly in the sphere of public health. Education – and especially universities – is an important area of activity. The Chinese government is supportive of moves to improve ergonomics and training in this area, and teaching staff now have much of the knowledge to be able to carry out improvements.

The one problem we do have is that of training resource. The increase in demand for learning means that the pipeline of educated professionals is not currently large enough to meet this, leading to some delays in knowledge transfer. Only a limited number of universities so far have PhD or Master's

degree programmes and many don't yet have the necessary background in ergonomics research training.

In a bid to take things forward, the Chinese Ergonomics Society has supervised four cohorts of young faculty research programmes in the last four years, benefiting more than 170 university teachers. We have also sponsored more than 20 selected research programmes submitted by over 50 education professionals. The key education and research institutions that have been involved in working to build awareness of the subject from the start include the School of Management at Tongji University, the Research Institute of Psychology at the Chinese Academy of Sciences, the School of Public Health at Peking University, the China National Institute of Standardisation and the Department of Psychology at Zhejiang University.

Unsurprisingly, the use and promotion of ergonomics is being driven mainly by China's global enterprises and high technology operations, such as the electronics company Huawei. These businesses have seen best practice in action in other countries and are enthusiastic about its deployment at home. Along with their competitors and others, multinational companies have an awareness of the value of highly skilled and innovative employees and the importance of looking after their wellbeing.

Having healthy staff in a secure and safe workplace is obviously a laudable objective in itself but there are also powerful economic reasons to place ergonomics at the heart of an organisation; the consequences of poor practice can mean reduced wellbeing, a lowering of morale and a loss of productivity. Wider impacts on Chinese society include the potential for ongoing disability and higher social security costs. There is a general recognition that adjusting the jobs to fit the workers, rather than the workers to fit the jobs, represents an investment not just in their futures but in that of the entire country.

In time, we will see a greater use of ergonomics rolled out across China's 42 million small and medium sized enterprises. To stimulate this process, the International Labour Organisation has developed its own programme manual, called *Ergonomic Checkpoints*. This contains suggestions that are practical, easy to implement and low cost.

The growth of the internet is also encouraging discussion about ergonomics issues by allowing professionals, designers and others to talk to each other through forums such as WeChat groups, stimulating debate and a common understanding of the issues. One exciting development in particular will help to put China at the centre of the global ergonomics stage. The Chinese Ergonomics Society has won support from the International Ergonomics Association (IEA) in hosting the latter's council meeting in Beijing in August this year. This follows on from our successful hosting of the IEA 2009 Congress, again in Beijing. We hope and anticipate that our Society members will invite their colleagues from the council to take part in additional events such as lectures and research seminars.

Female workers in a textile clothes factory in Huaibe

In another joint initiative, two Chinese Ergonomics Society member organisations – Tsinghua University and Beijing Kingfar Inc – worked alongside the IEA to establish two new annual awards. These are the Human Factors & Ergonomics (HFE) Education Award and the IEA/Kingfar HFE Research Award. These prizes are intended to be global, and ergonomics colleagues worldwide are both welcome and encouraged to apply for them according to the terms defined by the IEA.

The benefits of raising awareness about ergonomics and wider occupational safety and health issues, both in China and across the world, are widespread. A proactive approach impacts positively on health outcomes, addresses risk and makes the workplace a better environment for everyone. No matter where you are on the planet, that can only be a good thing. I look forward to seeing even more advances in China and elsewhere in the future.

Workers at the new Dongfeng Citroen factory in Wuhan

IMAGES: GETTY

Wei Zhang is a Professor in Human Factors and Ergonomics, Department of Industrial Engineering at Tsinghua University, China

Wellbeing focus boosts productivity

The wellbeing of employees has become a key objective in the UK manufacturing sector. A new study shows that more than 90% of companies investing in employee health and wellbeing have seen an increase in workforce productivity and an improvement in workforce relations. Manufacturing companies also saw a reduction in absenteeism alongside a strengthening of staff retention as a return for wellbeing investment on staff.

These are the findings of a report into the UK's health and safety landscape entitled *"Health, wealth and wellbeing for Manufacturers"*, published by Make UK and Howden Employee Benefits & Wellbeing. The report also shows that the manufacturing sector is "ahead of the curve" when it comes to supporting workers returning after sickness, with more than 60% already offering flexible working arrangements and around half providing professional occupational health support. With 90% of manufacturers having workers who are sick, long-term, more than 80% are providing voluntary sick pay, and another 80% easing the way back into work with phased and flexible working.

The last official numbers from the UK's Office for National Statistics showed 141 million days lost to sickness absence in 2018, and more than 17 million working days lost to mental health related conditions. Across the whole of the UK economy, sickness absence costs companies £15 billion a year.

Tim Thomas, Make UK's Director of Labour Market and Skills Policy, said: "Employers have recognised that jobs within their businesses should be flexible and include career development and flexible working pathways in order to retain staff. With 10% of the manufacturing workforce due to retire in the next three years and the pressures of new immigration rules post-Brexit, skilled workers have never been more important."

Make UK, the manufacturers' organisation, collectively represents 20,000 companies across engineering, manufacturing, technology and the wider industrial sector.

The value of occupational health

A new report examines how occupational health practitioners and providers can add value to workplace wellbeing initiatives by focusing on the knowledge, skills and competences required to introduce workplace health and wellbeing programmes.

A report, "The Value of Occupational Health to Workplace Wellbeing", published by the Society of Occupational Medicine (SOM) and Cohort, looks at current thinking and research on the attributes required by practitioners to contribute to successful workplace wellbeing initiatives. Led by a team from the University of East Anglia, the study analysed SOM survey data, scientific literature and interviews with 11 experts. It identified four major areas that practitioners need to develop: building the business case for health and wellbeing; acquiring and using evidence; knowledge of health and wellbeing; and building and sustaining a programme of activities.

The report concluded that the benefits of programmes may be seen through employee engagement and retention or employer attractiveness in the labour market. For more information, visit **http://bit.ly/SOMvaluereport**

IMAGES: ISTOCK / SHUTTERSTOCK

Support for science

In the run up to the UK election in December, the Campaign for Science and Engineering (CaSE) – of which CIEHF is a member – called on all political parties to make commitments to support science and engineering by supporting three main aims:

- A long-term plan to reach 3% of GDP invested in R&D by the end of the next decade, with planned annual increases for public investment in R&D.
- To make the UK a partner of choice for international collaborations, including with the EU.
- To provide an immigration system that works for science and engineering.

Following the Queen's Speech after the election, CaSE Executive Director Dr Sarah Main said: "We welcome the Government's renewed commitment to science and innovation, placing it at the heart of its agenda to "improve daily life for communities across the country". We look forward to working with the Government and science community to develop its proposals, including new approaches to funding 'high risk' research in emerging fields."

Dr Main noted that the background briefing to the speech said that the UK "will continue to collaborate internationally and with the EU on scientific research, including with the EU through Horizon".

She added: "CaSE will continue to work with the Home Office, BEIS and other stakeholders to make sure the proposed new fast-track visa for science meets the needs of the UK's science and research community. In particular, that it reflects the interdisciplinary nature of modern, cutting-edge research and the various individuals, including technicians and early career researchers, that make up successful research teams."

CHIEF EXECUTIVE'S PERSPECTIVE

The future human

"Integrated design to improve life, wellbeing and performance" is the ambition and vision for the CIEHF. Our new five-year strategy, just launched, is ambitious; we aim to become the pre-eminent professional home and voice for human factors. To help us achieve this we'll focus on how our work impacts society and citizens and we'll seek to influence the evolution of our discipline and practice in industry, commerce and business.

Four overarching themes will bring together our activities over the next five years. The first is creating a world-class membership body fit-for-purpose today and in the future. This will mean creating an agile entity, financially fit, generating our own income with increased member focus. I'm completely committed to improving further the member experience. What we do should be memorable and outstanding otherwise why do it at all? Amanda Widdowson, our incoming President, will launch an impactful initiative this year that aims to influence other professions and highlight the need for more inclusive design.

To help define our brand we've started the process of redesigning our logo to reflect science, engineering and technology. We will, within our limited resources, create a modern, more engaging website improving the user experience and user interface. You may have already seen a notable difference in the marketing of our Ergonomics and Human Factors Conference this year, which will run in conjunction with the 13th Organisational Design and Management symposium. Thanks to Patrick Waterson we have an excellent number of submissions.

The second theme of our strategy is supporting members. We'll support members through more personal development activity to help hone skills. Learning activities will include consultancy skills especially for those setting up their own businesses, selling and client management workshops, effective presentations and social media training. There will also be masterclasses on how to influence human factors activity within a corporate environment led by some of our own very experienced and successful members. Over time we hope to create an e-learning platform to support CPD activity.

Our discipline and profession will make a difference in a rapidly environmentally, demographically and technologically changing world

The launch of our Energy Learning Pathway has been extremely successful with one company enrolling 50 participants. This year we'll begin developing a Healthcare and a UX Learning Pathway. UX is very much part of the human factors competency framework and so we expect more people with a UX background to begin joining the Institute.

Our strategy uses the concept of the Future Human; our third overarching theme. This theme will drive the content of our magazine, *The Ergonomist*, to show how our discipline and profession will make a difference in a rapidly environmentally, demographically and technologically changing world. We're revitalising our Sector Groups and encouraging the leaders to think about the future and how we influence the evolution of the profession.

Paul Bowie, Mark Sujan and Chris Ramsden are good examples of three co-leaders creating a new agenda for our focus on healthcare, building on the work undertaken by members Alex Lang and Sue Hignett. Mark will also be setting up a Special Interest Group (SIG) focused on Digital Healthcare and AI. Brian Edwards will continue to lead the Pharmaceutical SIG, which is now a Sector Group in its own right. Kirsty Angerer ('The Travelling Ergonomist') will help to establish a Sector Group focused on the office environment, and a new Defence Sector Group is being established by Steve Harmer and Laird Evans which no doubt will have a very forward-looking agenda.

Collaboration with 'Partners of Choice' is our last overarching theme. In effect we will, in everything that we do, look to collaborate with others to ensure our thinking is inclusive and outward focused. Later this year we'll launch a Human Factors Roadshow to take place in eight regions, with the aim of promoting the role and contribution of human factors to business leaders. We'll partner with other organisations and our Registered Consultancies within the regions providing an opportunity for them to engage with local businesses.

Any members who want to be involved in helping to deliver our strategy should contact me directly or arrange to meet me at our Conference in April.

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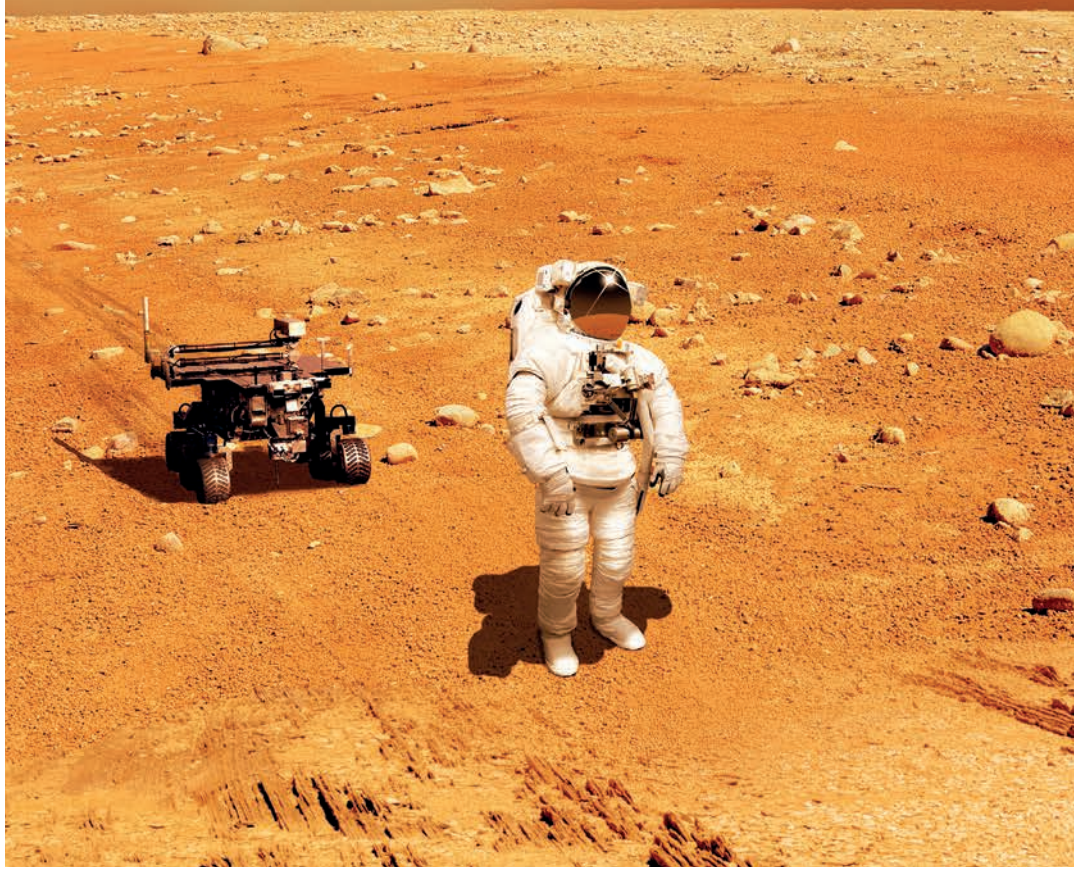
noorzaman rashid

IMAGE: ISTOCK

Making complex connections

Complex socio-technical systems are evident in every aspect of our lives, from our connected devices to public transport, and from healthcare to aeronautics, and all benefit from human factors research, as **Tina Worthy** explains through previews of presentations that will be given at a major upcoming conference



Imagine a manned mission to Mars to explore, settle and perhaps terraform the planet. It's been the subject of science fiction, aerospace engineering and scientific research for decades. Surviving the journey and being able to spend significant time on the planet requires faultless human-centred design of technological systems. Mission success and the welfare of those involved are both critically important for long duration and sustainable performance. Successful human exploration will be highly dependent upon the design of human-machine interfaces so human factors and other disciplines will need to combine to create a living, working and recreational space that supports astronaut health, wellbeing and performance. Permanent communication between Earth and Mars will be critical.

Already, communication via the internet and the proliferation of connected devices has completely revolutionised almost every aspect of our lives. For many of us, the way that we work, move around, shop and even socialise has changed dramatically in the last 25 years. But we're only part way through this 'connected revolution' as advances in communication technologies are making it possible to connect more 'things'. While connectivity brings great opportunities, it also brings a number of challenges. We're used to providing input to a device and the device providing information back to us, but as we migrate towards a world that now has a connected variant of almost every product imaginable, the challenge for practitioners is how to design these devices.

Connecting devices is one thing but digitally connecting people brings its own set of challenges. The Fyre Festival was marketed as a luxury music festival in the Bahamas, promoted heavily through social media, and attracting over 4000 attendees. But the event, in 2017, was cancelled one day into its inaugural weekend amid chaos and acrimony as problems arose related to security, food, accommodation, medical services and artist relations. It resulted in million-dollar losses for the organisers and subsequent law suits. Researchers carried out a socio-technical analysis of archival materials, corporate

IMAGE: GETTY

websites, leaked internal documents and documentary accounts to understand why the event failed so spectacularly. Almost 60 thousand tweets about the event were collected enabling researchers to draw out socio-technical factors and interdependencies that contributed to the failure and to understand the potential to apply socio-technical frameworks to diverse business events, situations and problems.

A complex socio-technical system that affects hundreds of thousands of people every day is public transport. With an infrastructure operating at full capacity, a testing political climate, and a mix of government, regulatory and public pressures, Britain's railway is in a constant state of flux, continually evolving to meet the ever-changing demands of today, whilst anticipating the myriad needs of tomorrow. Even minor disruptions frequently lead to congestion and delays, and result in losses to public satisfaction and confidence. Technological interventions to optimise system performance require a robust and coordinated approach from ergonomists in collaboration with front-line rail staff, engineers, system architects and policy makers. One example is the Digital Railway project which is focused on deploying new technology to maximise train capacity on the existing infrastructure. To do this requires a comprehensive programme of human factors integration to effect the necessary cultural and organisational changes.

Socio-technical systems were also at the centre of investigations by researchers following a severe water shortage in South Africa. In 2018 the city of Cape Town was literally days away from shutting off the municipal water supply to four million residents. Persistent drought, exacerbated by climate change, had led the city to announce 'day zero'; the day when the potable water supplies would be shut off and water would only be available from tankers at designated safe zones. However, the day never came as the rains started falling and the water supplies were replenished. Was this near miss just luck or the result of concerted efforts by city officials and residents, engineers, scientists, local and national government? Researchers examined the human/systems interactions as they unfolded over time.

Fire safety managers know all too well about complex unfolding situations. Today's fire safety management is mainly focused on technical installations, construction and building measures, control plans and evacuation routines. Fire safety installations could meet all regulatory requirements and still create problems, sometimes to the point where fire safety routines or installations are bypassed. Researchers applied a systems perspective to work and safety to examine the preconditions for a well-functioning fire safety system from two case studies, one on land and one at sea.

Failure to control safety is driven, in part, by significant gaps in contemporary incident and accident causation models and analysis methods which leave practitioners ill-equipped to fully understand, forecast and prevent accidents. Research has revealed that there may be a common causal network

Surviving a journey to Mars requires faultless human-centred design of technological systems

of contributory factors involved in accidents regardless of domain, and that there are a set of systemic conditions that are present when major catastrophes occur. But accident analysis methods often fail to reveal the role of normal performance in accidents, migration of work practices, feedback loops, and emergent behaviours. Researchers have looked at developments that need to be made to improve the situation.

Traditional safety approaches have focused on identifying and preventing errors and have explained safety in relation to the absence of errors. Efforts to reduce errors can increase the complexity of the work system and introduce unexpected consequences. In healthcare, an emerging approach, called Resilient Healthcare, proposes understanding the variability in healthcare practitioners' everyday work by comparing Work As Imagined with Work As Done.

Safety management relies on avoiding serious incidents by the identification of hazards and the development of safety barriers such as technological barriers, procedures, regulation and laws, to prevent and mitigate risks, together with the strict compliance of operators with these safety barriers. But does this traditional view of safety management still hold true in today's dynamic, complex and changing environments? Two serious healthcare incidents that occurred ten years apart have benefited from extensive investigations to identify their root causes and add to the discussion.

The performance of any healthcare organisation is dependent on their continuous ability to have a sufficient number of carefully deployed qualified workers. Shortage of personnel leads the nursing managers to readjust the organisation of their teams which could influence the quality of care and the health of caregivers. Researchers have explored the different types of flexible practices used to organise hospital nursing staffing and their consequences on the activity of caregivers with the aim of helping decision makers find ways to improve the organisation of nursing staff.

Focusing on why things go right is the focus of Safety-II. It can be argued though that most of the work has been conceptual and it's often thought of as being difficult to administer and complicated to understand. One way forward is to understand adaptations that occur in normal everyday work. This can be achieved by contrasting Work As Imagined and Work As Done in the context of the work environment. One understanding of this is to capture and analyse such adaptations and demonstrate value by sharing good practice. Researchers have studied the jobs of nuclear plant operators, more specifically the adaptations they made, to successfully carry out their work. The adaptations were classified and provided new insights into how and why the adaptations occurred.

For more information on all these presentations, and many more, visit https://conference.ergonomics.org.uk

A DAY IN THE LIFE OF A...

SAFETY SPECIALIST

Alawi Almajid, Safety Specialist at Halliburton Energy Services

Ergonomics is a widely known discipline around the world, but in my country of Saudi Arabia, it still tends to be seen and not heard. There is a recognition of its important role both in society and the workplace but at present it's not widely used. However, as an evangelist for the ergonomics cause, I'm working to drive things forward.

Many Saudi employers see ergonomics as a burden. There is a strong perception that a lot of effort is needed to implement it efficiently, and that a redesign of jobs and workplaces may be needed to reduce the risk of musculoskeletal disorders. My own job involves working as a safety professional in the oil and gas sector. By its very nature, the energy industry tends to focus on what's directly in front of it. However, I've developed an interest in issues that could indirectly affect employees, with ergonomics being the main focus. I've been studying this closely for the past five years, and I'm currently undertaking a Master's degree in the subject.

It's been a memorable journey for me. I originally went to Australia to study mechanical engineering but really didn't get on with it because I disliked mathematics. So, I looked around to try and find something I would really enjoy doing for the rest of my life. I was interested in health and hygiene – my wife is a laboratory specialist – so went on to study occupational hygiene in London and discovered ergonomics, which I found to be both interesting and scary at the same time.

The work was difficult and stressful but I pressed on, reading the research and realising the important part ergonomics had to play in the workplace. At the same time, it became clear to me that nothing was happening with the development of this in Saudi Arabia. That gave me a lifetime goal: to educate the people, organisations and government in Saudi about the importance of ergonomics, and how it can impact on health and wellbeing as well as on productivity and quality within the workplace. Many of the discussions we're having and the issues we're working through here are similar to those in other parts of the world. Broadly, the approach to ergonomics for many individual organisations or people can be summarised under two headings: manual materials handling training and office ergonomics.

There's been a discussion stretching over years about the benefits of manual handling training in industrial environments, in areas including whether stoop or squat lifting is safest. Squat lifting is favoured by many and, in all honesty, I think this debate is now over. I'm trying to drive employers towards the need to redesign tasks or tools and materials rather than invest in manual handling training, and my efforts in this area continue.

Office ergonomics should play a big role within organisations but the training on this can be superficial; it often seems that the only thing that managers teach their employees is how to adjust their chairs and screens. At present, there does not seem to be any real investment in teaching staff about why the workstation should be set up in a certain way, for instance, or how they may be at risk of developing a musculoskeletal disorder.

Most of my work on ergonomics is undertaken outside my consultancy job. My employers have been extremely supportive and my working rotation of 14 days on and then 14 days off allows me the flexibility I need. My manager has also been helpful and encouraging. One example of how I have been able to suggest real improvements was in 2016 when I was involved in assessing a task where a worker did bolt torqueing on an expander machine.

The organisation involved back then did not have any idea about ergonomics. After seeing the medical diagnosis indicating an inflammation of the employee's ligaments – he had been doing the same job for about eight years – I volunteered to run the assessment. The result was then presented to HR, the production manager and the

Delegates listen to a presentation in Riyadh Chamber

factory manager. We didn't have to change the design of the equipment but we did have to involve the employee in deciding better ways to improve his work as well as purchasing tools that helped him to do his task safely with little to no risk of musculoskeletal disorder.

Saudi Aramco, a client, has also made progress with adoption of ergonomics over the last two or three years. It's carried out research into reducing physical discomfort such as neck pain and shoulder pain affecting its staff at computer workstations, though it has still to change things for employees out in the field. It went to the effort of bringing in human design researchers from the UK to help and give presentations.

Another case involved a manufacturing company that had no idea about ergonomics or how to implement it. I did an assessment and spoke to the employees, including one who had worked in a similar posture for about nine years and had problems with joints and ligaments. The changes we made to improve things were small and cost virtually nothing.

Worker adjusting a bolt torque on an expander machine

The Saudi Vision 2030 national economic development programme means there are going to be advancements in technology, and workplaces will change. As a result, ergonomics should and will be embedded in the transition to make working safer for everybody. As part of this, organisations in the kingdom are focusing on manual handling and office ergonomics but they're encouraged to do more than that, such as looking at organisational ergonomics and worker health.

One of my own responses to this has been to start a series on WhatsApp and other social media that I've called *Almajidnomics*. This focuses on spreading knowledge about ergonomics in Arabic, summarising research in simple yet understandable language for everybody. This is important because we currently have essentially nothing in our own language; all our resources are in English and where necessary have to be translated. I've now reached the second phase of this personal project, and the new season will include infographics, diagrams and a book. I'm self-funding this work and hopefully it will turn out to be a really useful addition to the debate.

Stimulating discussion about taking ergonomics forward and building knowledge of the subject is also critical. Last October I carried out a presentation at a health and safety forum In Riyadh organised by the Occupational Safety, Health Association and Security and Riyadh Chamber of Commerce. More than 1000 people came along and there was a real interest in this whole area. Encouragingly, I have two further seminars booked for April where I will be able to discuss the work I've done on ergonomics further and make the case for its application.

Ergonomics will be embedded in the transition to make working safer for everybody

There is a compelling argument that Saudi Arabia should have caught up with the US and Europe on all this by now. Yes, we are late to the party but better late than never. Things are changing, and I'm proud to play my part in that.

Alawi Almajid is a safety professional working for Halliburton Energy Services.

The pursuit of energy supplies has brought great benefits, tested human ingenuity and provided a catalyst for technological innovation but how do we ensure people aren't pushed too far in this safety-critical industry when the pressure is on? Human performance has its limits but, as **Tina Worthy** explains to Tim Power, a new learning initiative could provide the answer

Pathway to high performance

No industry has a larger impact on our world than the energy sector. Energy is needed for light, heat and transport and is used to manufacture the products we rely on for an increasing quality of life on a daily basis. It's a multi-trillion dollar industry that employs millions of people around the world and encompasses everything from oil and gas extraction to nuclear power, in addition to harnessing the power of the sun, wind and tide to help us transition away from our current reliance on fossil fuels and address climate change.

The demand for energy is relentless. According to BP's 2019 Statistical Review of World Energy, consumption grew at a rate of 2.9% in 2018 – almost double its 10-year average of 1.5% per year, and the fastest since 2010. This puts pressure on the industry to find and develop more energy resources as quickly and efficiently as possible... and that pressure could increase the risk of something going wrong.

Despite the success of the industry developing new technologies and expertise, incidents such as the Deepwater Horizon disaster in the Gulf of Mexico in 2010 illustrate the far-reaching implications of what happens when things do go wrong, not only for human life but also for the environment.

Human performance plays a critical role in the energy industry (and in any industry) to ensure competent people can work in safe, efficient, well-designed systems. Human factors gives people the tools to achieve this by designing fit-for-purpose systems where the potential for error is recognised and designed out wherever possible. Applying knowledge and principles of human factors sets people up for success so they can work together effectively.

Many energy organisations have recognised the value of human factors in improving human performance and have welcomed an initiative from the CIEHF that provides highly structured education and training aimed at all levels of an organisation. In December 2019, CIEHF launched *Human Performance for the Energy Sector*, the first of its 'Learning Pathways'.

Developed in partnership with the Energy Institute and I-CAB, the Pathway includes a free e-learning introductory course which highlights the concepts of human performance. This knowledge is developed through three further levels of study, which leads to the successful learner being eligible to apply for recognition as a Technical Specialist of the CIEHF.

Who's the Learning Pathway specifically aimed at?

In high-hazard industries like the energy sector, good human performance makes the difference between success and failure. We believe that everyone has a role to play in managing human performance – and the good news is you don't have to be an expert to make a difference. Being able to recognise situations that will lead to poor human performance, and then being able to do something about it, is in everyone's power.

The Pathway is aimed at anyone who needs to apply human factors in their organisation and will particularly appeal to engineers with responsibility for safety or process, or specialists working in operations.

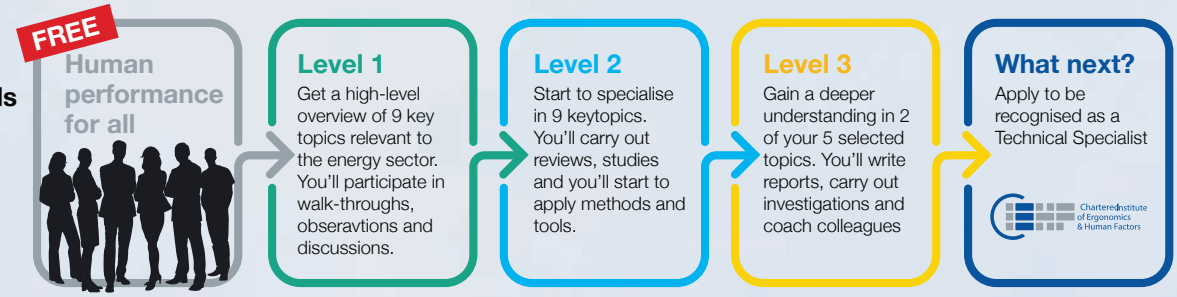
What are the benefits of undertaking the Pathway?

It's great for individual professional development and career progression, and invaluable for any business wanting to increase their resilience by improving human factors competence and capability across their workforce. Human factors is a vital component of any business, but people knowledgeable and skilled in the discipline are in short supply, so this Pathway offers a valuable route to attaining those much sought-after competencies.

Human Performance for the Energy Sector is fully supported and will lead learners through a structured, multi-level, self-paced, on-the-job programme. It provides them with valuable learning resources and

Who?

Anyone who needs to apply human factors in their organisation e.g. an engineer or operations specialist



KEY PATHWAY TOPICS

- Task analysis
- Designing for people
- Incident investigation
- Procedures
- Safety critical communication
- Workload, stress and fatigue
- Human factors in projects
- Control room design and alarm management
- Leadership, supervision and safety culture

question sets to test their understanding and gives detailed real-world activities that will allow people to put the theory into practice, helping them to build up their skills and confidence. This approach allows people to gradually create and hone a pragmatic, flexible and transferable skill set in human factors so they'll become a valuable asset within their organisation.

What does the Pathway involve?

The first part includes a free e-learning course that can be completed in one to two hours, which gives a general introduction to human performance. It's designed for everyone, from front line operators to senior managers, and includes practical guidance on how to improve human performance with video case studies and simple-to-use tools. People can obtain a certificate by successfully completing an optional quiz at the end of it.

We hope people will be keen to learn more as we've developed a further three levels of study to increase knowledge and understanding of the techniques and concepts used step-by-step.

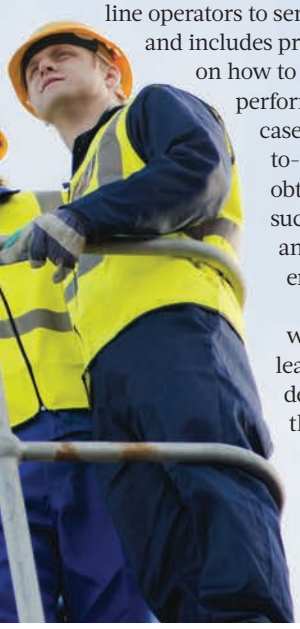


IMAGE: GETTY

What will people learn in the three levels?

Level 1 provides a high-level overview of the individual topics with activities such as walk-throughs, observations and discussions, while Level 2 allows the learner to specialise in five selected topics relevant to the needs of their business and their role. They will also carry out reviews, participate in studies and apply methods and tools, all supported by a mentor. The mentor could be a Chartered Member of CIEHF or someone with Competence Assessment Training.

Level 3 is designed to advance understanding of human factors with a choice of two of the five selected topics and professional development will again be supported by a mentor. Activities at this level include writing reports, carrying out investigations and coaching colleagues.

The learners have Activity Reports to complete for each level and will need to provide documented evidence of their learning and activities in the online Learning Management System provided by I-CAB, which will be reviewed by CIEHF assessors on completion of the course.

How long will the Pathway take?

It's expected it can be completed in around two years and has been designed to be flexible enough to be accommodated within people's normal working duties and to take place as part of their on-the-job professional development. To be eligible to apply for Technical Specialist, learners must have completed a minimum of 200 days of human factors-related activity by the end of the Pathway.

How much does the full Pathway cost?

The e-learning introductory course is free, while the full three level Learning Pathway, which includes access to the online learning resources, a comprehensive handbook and certificates of completion, is £750 plus VAT. In order to access the Pathway, learners will need to become an Associate Member of the CIEHF, which costs £99 for the first two years. As a member, they'll receive all the CIEHF benefits such as news and information about the profession and human factors applications, access to our on-line communities to discuss topics and ask questions, as well as a 25% discount off CIEHF events.

We're also offering substantial discounts for organisations interested in signing up multiple people to the Learning Pathway.

Do you have plans for more Pathways?

Yes, we've deliberately designed the framework behind the Pathway and the key topics so we can use them consistently across different sectors. We'll be taking the feedback we're getting from energy and using it to begin formulating further Pathways in other sectors, initially healthcare and User Experience.

More information, including how to get onto the Pathway, is available on our website at **www.ergonomics.org.uk/hpenergy**.

Tina Worthy is CIEHF's Chief Operating Officer.

ADVERTORIAL

Using data to assess workers' manual handling techniques provides an invaluable insight

Being actively safe at work is more effective when risks can be tracked, compared and shared. Learning can be adapted into everyday behaviour and workers can manage their own musculoskeletal wellbeing. **Amy Hope** and **Toni-Louise Gianatti** discuss how wearable tech has helped decrease hazardous movements and reduce musculoskeletal injuries

Making wearable tech work

New technology aimed at improving worker safety – such as wearables to track hand arm vibration and cognitive fatigue, and GPS trackers for distributed workforces – is being adopted within industrial workplaces. Combining objective assessment data, real-time biofeedback and self-managed microlearning is an effective training method. A recent study published in the *Journal of Biomechanics* notes that real-time feedback in the form of an auditory alert when a hazardous movement is executed elicits a negative reinforcement which promotes a change in movement behaviour.

Workplace injuries are costly. A paper, published in October 2019 by the Health & Safety Executive taken from the Labour Force Survey, states that during 2018/19, an estimated 6.9 million working days were lost due to work-related musculoskeletal disorders, that's an average of 14 days lost for each case. Of these, back disorders accounted for 2.8 million days lost.

Fitting the task to the human is not always possible owing to environmental limitations, or lack of appropriate equipment. Risk assessors may find it difficult to truly understand the task as they lack expertise in the work. The worker understands the task but often lacks the awareness of the risks involved. The ideal scenario of engineering out hazards or eliminating them is the ultimate goal, but many industries remain reliant on manual workers to do their job in ways that do not risk their musculoskeletal health. Equipping workers with the learning tools and capacity to feel responsible

for their own bodies and movement can help bridge the gap between limitations in task design and musculoskeletal safety.

The insecurities once felt about employee tracking in industrial workplaces have quelled. General acceptance and union buy-in arises from the understanding that wearable tech is not aimed at providing new methods for 'Digital Taylorism' but keeping the focus of wearable programmes on safety, allowing workers to engage with their own learning, avoiding unnecessary tracking methods and providing the option to anonymise data. Using data to assess workers' manual handling techniques provides an invaluable insight for change implementation.

Using wearable tech

Soter Analytics provides companies with a ten-day manual handling training programme using a wearable device and in-app tutorial providing results from the individual worker to the upper management via a web-based dashboard, and back to the worker in an engaging mobile app. The *SoterSpine* device is a 2 x 4cm lightweight sensor which attaches to the back of a shirt neck, providing real-time biofeedback risk alerts. The individual movement data is then available to the worker in the *SoterSpine* app providing insight on hazardous movements they make and recommendations on what could be done differently.

The intervention of in situ micro-learning - bite size chunks of daily information - with personalised coaching encourages the likelihood of behavioural change due to workers being able to self-pace their training at a time that suits them. Machine learning algorithms allow filtering of the complex data noise to really see what's going on, giving the ability to predict the movement patterns of workers and profiling of hazardous tasks.

The sensor identifies hazardous movements such as twisting and poor technique flexion, and the compounders for predisposition to injury, for example, repetition, intensity and static postures. Acceptable intensity of lifting has previously been defined using the NIOSH lifting equation, however this standard generalises capability of genders and does not take into account individual body capabilities or previous injury status. Using many characteristics of lifting movement within the sensor algorithm, actual individual lifting capability can be assessed and if a lift is too heavy, and/or the technique is poor, this data will be gathered. If the movement is deemed to be hazardous by the sensor, the worker will get immediate auditory and vibrotactile feedback. Biofeedback risk alerts promote increased proprioception and movement development opportunities, aiding behavioural change.

The case study presented is strong evidence for the use of wearable technology and analytics in industry, when used by health and safety professionals in collaboration with industrial workers to identify risky tasks or environments and elicit data-driven reasons for making investment into automations or engineered solutions. This is an update on out-dated and inaccurate ergonomic assessments, combined with a consistent approach to manual handling without the loss of time to a classroom, and allowing on-site ergonomists to deploy their time to solving problems rather than trying to find them.

Amy Hope is the principal ergonomist at Soter Analytics, and a practicing osteopath. She has 10 years of clinical practice and an MSc in human factors from the University of Nottingham.

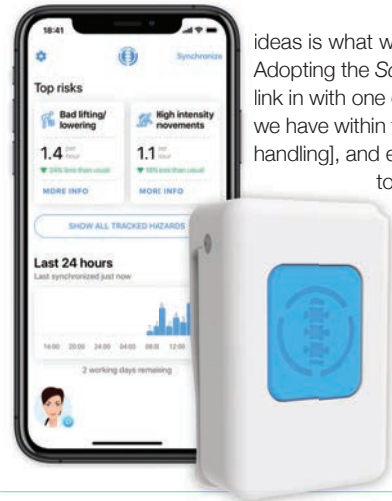
Toni-Louise Gianatti is Product Manager and Training Content Developer for Soter Analytics (www.soteranalytics.com). She has over 20 years of integrative movement coaching experience.

Further reading

Punt, M et al (2019). Real-time feedback to reduce low-back load in lifting and lowering. *Journal of Biomechanics*, 109513.

AN INDUSTRIAL CASE STUDY

The *SoterSpine* was implemented within Travis Perkins Group's specialist businesses, BSS, CCF and Keyline. BSS was the first to adopt the technical solution. Travis Perkins prides itself on 'Keeping People Safe' which is a core value within their health and safety culture. The first longitudinal outcome data of impact of *SoterSpine* on musculoskeletal disorders revealed a 55% drop in musculoskeletal injuries. Vimel Budhdev, Head of Health, Safety and Environment at Travis Perkins Specialist Businesses, said: "Using innovative ideas is what we strive to do. Adopting the *SoterSpine* solution to link in with one of the problems that we have within the business, [manual handling], and employing this device to help eliminate, reduce and also teach people the right way of doing manual handling has been the perfect marriage."



The solution was implemented across a large and diversely located workforce. Each worker managed their own progress through the programme via the app. As the *SoterSpine* solution is scalable across on-site and delivery workers who do not spend time on site, a large number of workers achieved their goal of reducing injury risk. All data was made available to management and was used for debriefing sessions.

Mr Budhdev noted the reduction of high-risk movements. "In one simple instance, the device highlighted that one of our colleagues was bending at a low level roughly around 100 times a day so by easily moving some things around we have saved around 26,000 high-risk bending movements in a year."

In April 2017, the NHS in England became one of the first healthcare systems in the world to have a specialist agency dedicated to investigating and sharing learning across the entire healthcare system. That agency is the Healthcare Safety Investigation Branch (HSIB) and its purpose is to "improve patient safety through effective and independent investigations that do not apportion blame or liability".

To help decide when to launch a safety investigation, HSIB use three criteria: systemic risk, outcome impact and learning potential. The criteria help identify where an HSIB investigation will be of most benefit and to generate a judgement of how much impact an HSIB investigation is likely to have on patient safety across England. At the time of writing, since its inception in 2017, HSIB's 12 National Investigators have published 20 independent investigations, all of which, including investigation reports, recommendations and responses to recommendations are accessible from the HSIB's website. Recommendations focus on the healthcare system and can also target organisations which provide services or products to the healthcare system, including regulators and policy makers. →

Investigating patient safety incidents

Approximately 60,000 patient safety incidents resulting in moderate to severe harm or death are reported annually across England's NHS. **Tracey Herlihey** explains how investigation into these incidents by a unique specialist body is revealing the underlying contributory factors and creating an invaluable shared learning resource that will bring positive change to how care is delivered

Taking a systems perspective is integral to extracting learning and making meaningful recommendations

IMAGE: SHUTTERSTOCK

MAIRI ALEXANDER

Intelligence Analyst

As an Intelligence Unit Analyst, I work across different parts of the organisation throughout the entire investigation process from selecting to launching investigations, to recommending and evaluating investigation methodology, to analysing findings after report completion.

I work as part of HSIB's Intelligence Unit to analyse and prioritise healthcare safety intelligence from a wide variety of sources to gain insight and define safety issues for potential HSIB national investigations. The Unit is a small team with a varied background, from academia and human factors to practicing clinicians, and a solid understanding of the complexity of a healthcare system, that was never purposefully designed but has grown organically and often haphazardly.

HSIB considers a risk-based approach to selecting incidents with a focus on systems, processes, design and culture, not on individuals. A safety issue can be referred to HSIB by individuals, groups or organisations or it could emerge from analysis of data captured or generated by the Unit. The decision to start an investigation could relate to a single event, a series of events or an issue discovered through current, ongoing investigations. Launching a national investigation is a decision debated and informed by a diverse group with vast knowledge of safety investigations. We're unable to investigate every incident that's shared with us, but every patient safety issue we receive is reviewed and stored in our database. This helps us to identify patterns related to safety issues over time.

Now that the maternity programme has completed hundreds of local incident reports, work is underway to analyse the findings. Common themes that we find recurring in multiple trusts are being considered for further work at a national level so that learning can be shared as widely as possible. As a healthcare professional who has been investigated and undertaken investigations, I find this new approach to patient safety incidents very refreshing. If HSIB recommendations are enacted, it fills me with great hope that there will be meaningful change for patients and staff, one not reliant on the latest checklist, or a protocol update or on increased vigilance by staff.

SASKIA FURSLAND

National Investigator

As a national investigator I could be investigating any patient safety issue that has occurred since our launch in April 2017. Each national investigation is formed of a small team consisting of a Principal National Investigator, a Lead Investigator, a Support Investigator and an Intelligence Analyst. The investigation team come from a variety of backgrounds, some with extensive experience working in healthcare, and others with experience of safety critical industries, human factors, safety science and the design of safety management systems. We also use subject matter advisors to provide relevant expertise in the area we're investigating.

I can be leading and supporting up to five national investigations at any one time and so each day tends to be a bit of a juggling act! My day-to-day activities are based upon three key stages to national investigations.

The first is a scoping investigation. During this stage we establish the facts and circumstances surrounding the event we're investigating. This helps us understand if it meets the criteria to progress to a national investigation. We engage with the provider, staff, the patient and family to gain their perspectives on what happened and to understand the context and circumstances which led to the event. We also conduct observations of the work environment to gain further insight and consider any other relevant evidence.

The second stage is a full national investigation. If the investigation meets our criteria, we broaden out to look at the systemic factors that are contributing to the patient safety risks we identified at the scoping stage. We use a variety of human factors methods and analysis tools to inform our investigations such as AcciMaps, Functional Resonance Analysis Method (FRAM), the ATSB investigation analysis model and SEIPS, a human factors framework for studying and improving health and healthcare.

The final stage is developing recommendations and publishing the report. We work closely with national bodies and organisations that we propose to make recommendations to. By doing this we aim to influence change and make improvements at a systems level.

Happy parents celebrate the birth of their baby

In April 2018, HSIB launched its maternity investigation programme. Maternity investigations replace those conducted locally by individual hospital trusts and cover all incidents that meet specific criteria: intrapartum stillbirth, early neonatal death or suspected brain injury. In April 2019, HSIB's Maternity Investigators, of which there are currently over 100, had full national coverage across the NHS in England. As of November 2019, the maternity team had received more than 900 referrals and progressed nearly 700 investigations. Investigation reports are shared with the family, hospital trust and the individuals involved in the investigation. In 2020, HSIB anticipates publishing thematic and national investigation reports based on the learning from individual maternity investigations.

All HSIB investigations examine the full range of factors that underlie patient safety incidents. Most harm in healthcare results from problems within the systems and processes that influence how care is delivered. Taking a systems perspective and incorporating human factors into HSIB's investigation methodology is integral to extracting learning and making meaningful recommendations for system change.

Three colleagues give their perspectives of working at HSIB.

Tracey Herlihey is the Head of Safety Intelligence at the HSIB. She is a Chartered Ergonomist and Chartered Psychologist. Tracey has a PhD in Applied Psychology from Cardiff University specialising in human perception and performance.

Saskia Fursland has a total of nine years' experience in applying human factors in incident investigations and has been working for HSIB since its launch in 2017. Prior to that, Saskia worked as an Aviation Psychologist with the UK military.

Mairi Alexander has worked, studied or taught in healthcare for 15 years. She's been a qualified midwife since 2009, providing care during the antenatal, labour and postnatal period, including supporting bereaved parents and those with safeguarding needs. She's contributed to guidelines, audits and investigations.

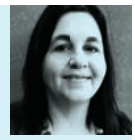
Clare Pagett has worked in the NHS since 1991 as both a nurse and a midwife. Latterly, she's worked in management and clinical governance roles, joining HSIB in June 2018.

Further reading

For further information and reports, see the HSIB website: www.hsib.org.uk
NRLS national patient safety incident reports: commentary, March 2019 http://bit.ly/NRLScommentary

CLARE PAGETT

Maternity Investigator



As a Maternity Investigator I look into maternity incidents which meet the HSIB maternity programme criteria. My background is in nursing and midwifery but the team of maternity investigators come from a wide range of professional backgrounds and sectors. This helps to ensure we have a strong mix of people with clinical experience and knowledge as well as those who can bring fresh thinking and insight which makes for a much more dynamic workforce. There are 14 regional teams across England and I work in the West Midlands team.

In my first three weeks with HSIB I attended an intensive training programme provided by North Bristol NHS Trust and Cranfield University. The training includes all aspects of conducting a patient safety investigation, especially in human factors so we could develop an understanding and take a systems approach when analysing evidence. We also learnt to use bespoke investigation and analysis tools and approaches.

In any investigation we only proceed if the family are happy for us to investigate; including the families in our work is vital. I travel to meet with families and hear about their experiences from their perspective. When meeting staff our approach is not about finding or apportioning blame but developing an understanding of what it's like for them to work within the maternity and neonatal services as well as establishing the facts for our investigation.

When it comes to evidence analysis and report writing, like the national team, we consult subject matter advisors to provide relevant expertise in the area we're investigating. Every case will usually have input from obstetric, maternity and neonatal expertise but we also access other specialist advisors when needed such as cardiology. Our report is shared with the family and the trust.

Our overall aim is to conduct an independent safety investigation to identify common themes and improve safety within maternity services. As part of this we hope to work closely with other national maternity improvement programmes to influence system change.

IMAGE: GETTY

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NEVILLE STANTON
Professor of Human Factors Engineering at the University of Southhampton, UK

For more details of all the speakers and to book tickets visit:

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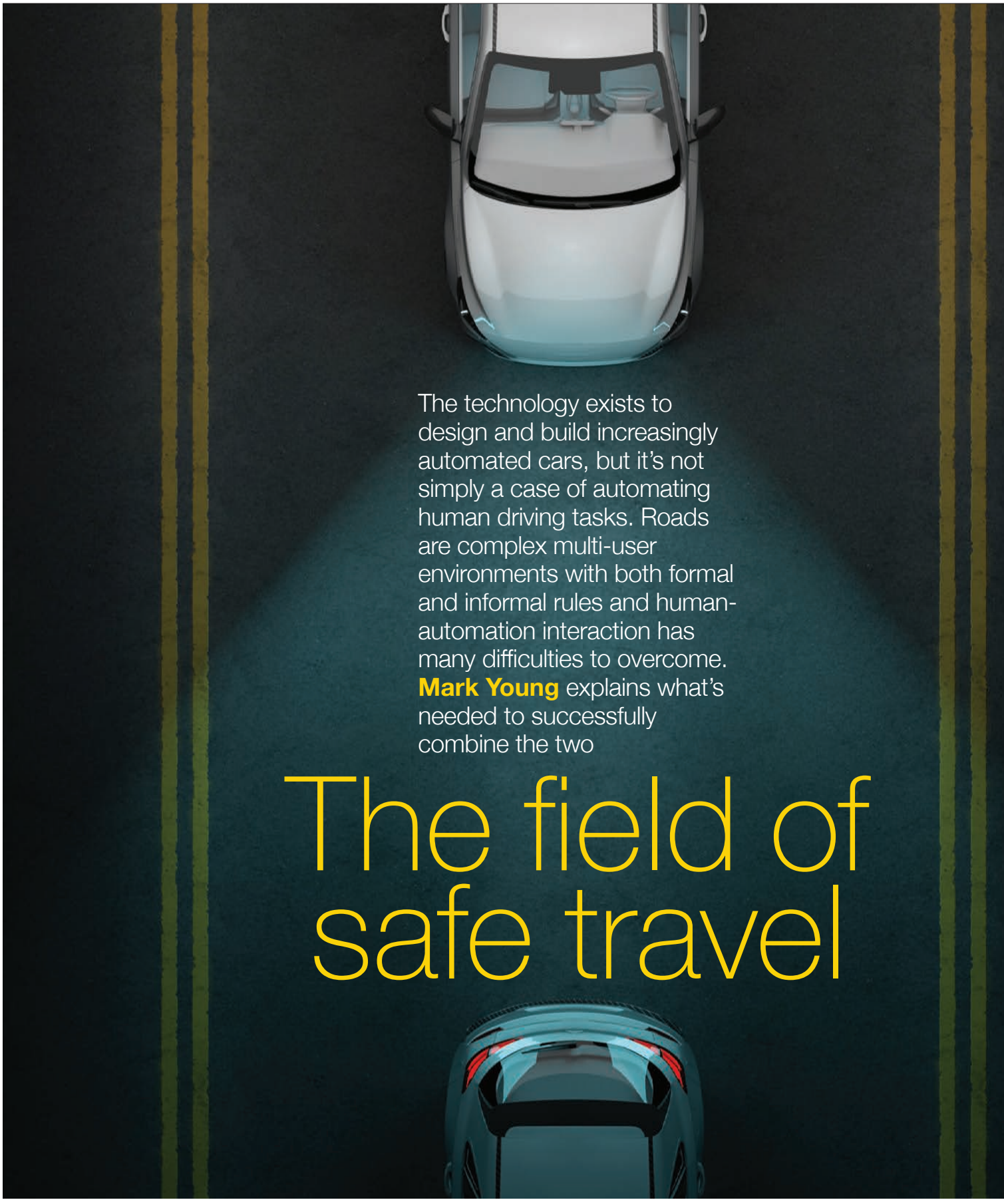

The technology exists to design and build increasingly automated cars, but it's not simply a case of automating human driving tasks. Roads are complex multi-user environments with both formal and informal rules and human-automation interaction has many difficulties to overcome. **Mark Young** explains what's needed to successfully combine the two

The field of safe travel

Picture the scene: the year is 2057, the setting is a farm where Jake, a mechanic, cares for automated vehicles ('automatics') that have been retired from service. Jake recalls how it all started:

"We take it all for granted now, but I can remember the days when the first laws came out forcing the old machines off the highways and limiting travel to the automatics. Lord, what a fuss. They called it everything from communism to fascism. But it emptied the highways and stopped the killing and still more people get around more easily the new way."

"Of course, the automatics were ten to a hundred times as expensive as the hand-driven ones, and there weren't that many that could afford a private vehicle. The industry specialised in turning out omnibus-automatics. You could always call a company and have one stop at your door in a matter of minutes and take you where you wanted to go. Usually, you had to drive with others who were going your way, but what's wrong with that?"

With all the fuss about self-driving cars in recent years, you would be forgiven for thinking that these words come from some contemporary sci-fi story. But they were written in 1953, only a few years after the formation of the CIEHF, in a short story called *Sally* by Isaac Asimov. Still, the story is prescient, predicting as it does concepts such as Connected and Autonomous Vehicles (CAVs), ride sharing and Mobility as a Service (MaaS). In fact, probably the only aspect that Asimov got wrong was the timescales, with the technology developing rapidly and expected to be available in the next five to ten years.

Technology has been the real push towards CAVs coming to market, with advances in image recognition, sensors, mapping and machine learning all enabling the self-driving car towards becoming a reality. Meanwhile, the pull has been from safety and economic fronts. Self-driving cars could meet the desire for more comfort and productivity, rather than thinking of travelling as wasted time. Future vehicles cannot be simply treated as living rooms or offices on wheels, though. Human factors research has explored how well people can complete basic in-vehicle tasks, not to mention their susceptibility to motion sickness when engaging in non-driving activities.

As for safety, the populist assumption is that automated cars will more or less eliminate the majority of crashes that are attributed to 'human error'. Ironically, one of the pioneers of human factors, Kenneth Craik, died tragically in 1945 at the age of 31 when a car struck his bicycle in Cambridge – just the kind of accident that an automated vehicle should be able to avoid. But a big part of that assumption is based on the technology being capable of passing a driving test in the real world.

On the face of it, the core task of making a vehicle drive for itself is easy, reducible to two dimensions: longitudinal (acceleration and braking) and lateral (steering). However, the decisions that a human driver makes, in amongst the uncertainty of other road users, are much more complex. In 1938, psychologists James Gibson and Laurence Crooks described a *field of safe travel* representing an area in front of a driven vehicle that is dynamically shaped by infrastructure and other vehicles. This is illustrated by a figure from their paper shown on the next page.

This field of safe travel – which an automated vehicle must compute using its sensors and software – is also mediated by formal and informal rules of the road. Back in the 1960s, Jock Kinneir and Margaret Calvert pioneered the iconography and typography of modern British road signs, in one of the most powerful demonstrations of designing information for human use that there has ever been. The clarity and consistency of signage makes it much easier for people to read at speed. Current technology in automated vehicles equally relies on machine vision. Similarly, lane markings have various meanings according to the rules of the road but serve a crucial purpose for camera-based automatic steering systems, as they use the white lines to 'see' the edges of the lane. This can cause problems where lane markings are unclear as control must pass back to the human, who can cope much better with the variability. Nevertheless, as the technology develops, automated vehicles will incorporate high definition 3D maps and machine learning to overcome such weaknesses, although the optimal recipe for automated driving has yet to be perfected.

Human factors will play a pivotal role in designing acceptable alternatives to private cars

Meanwhile, people interact on a human level with myriad informal rules, the classic example being a flash of headlights to signal some courtesy, such as letting another driver out of a junction. How will technology cope with these unstructured, often inconsistent, behaviours?

The interim solution is that humans and technology work together until automation is capable of taking over the complete driving task. That means automation of only some parts of driving, or in only some circumstances. For instance, many cars today are available with Autonomous Emergency Braking (AEB), blind spot assist or park assist – technologies which support specific aspects of the driving task. Elsewhere, adaptive cruise control, lane keeping assistance and other self-driving technology is largely, at the moment, restricted to operating in traffic jams and on highways, where the complexity of the driving task is reduced.

But such partial automation raises some of the biggest human factors concerns of all, as a multitude of studies have shown that human-automation interaction is fraught with difficulty. One of the key issues is trust in automation, in particular, over-trust in a system, when a driver perceives →

IMAGE: ISTOCK

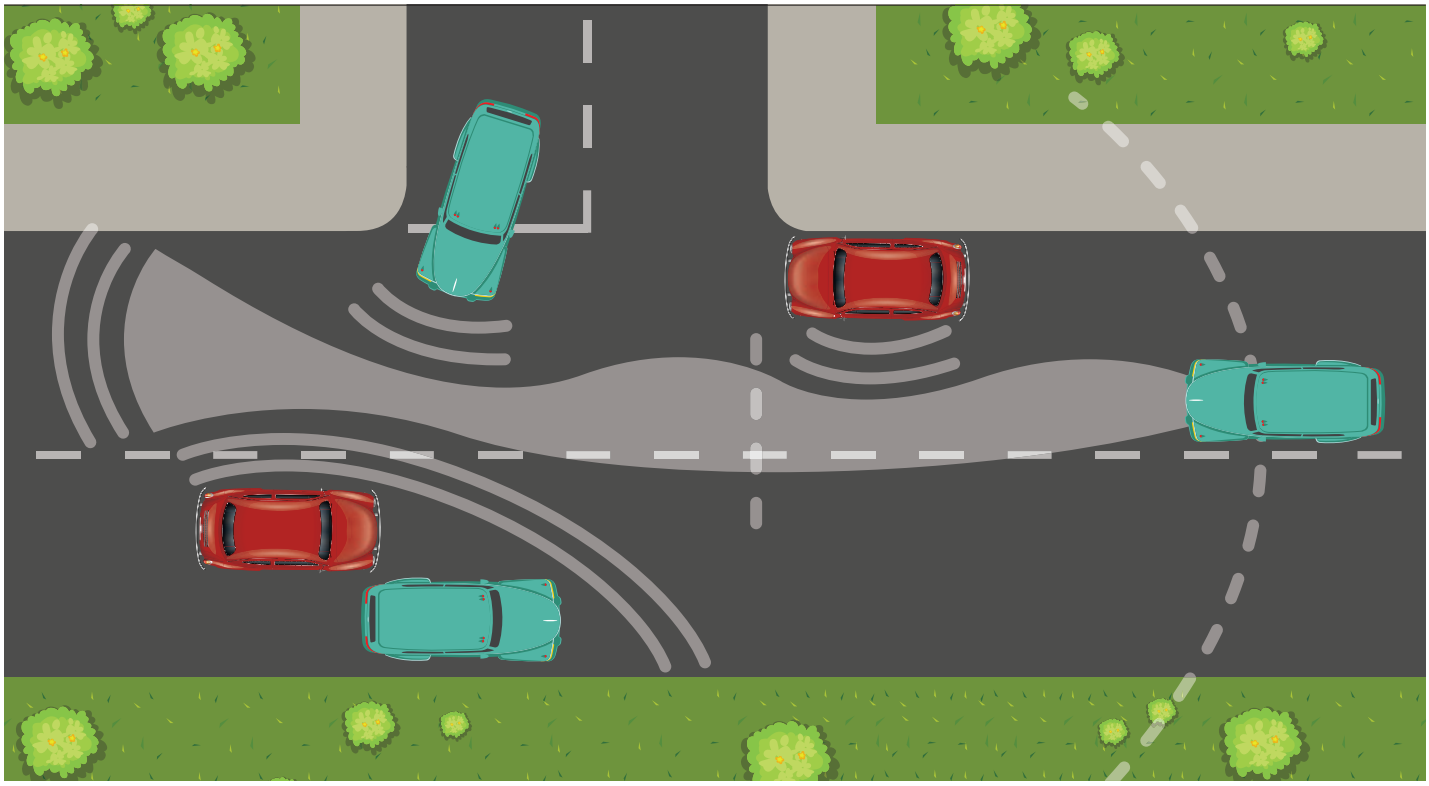

Diagram adapted from Gibson and Crooks (1938) showing how the presence of other vehicles influences the field of safe travel, emanating from the rightmost vehicle.

that the system is more capable than it actually is. In many ways this is a conflict between the day-to-day reliability of such systems and the limitations of current technology. So, when manufacturers consequently offload ultimate responsibility onto the human behind the wheel, it can lead to apparently reckless behaviours. A quick search of YouTube will show the variety of activities that drivers get up to when they should, by the book, be monitoring the road and the autopilot system.

Sadly, this has been demonstrated in tragic fashion through some high-profile fatal crashes involving self-driving cars. The National Transportation Safety Board's investigation into the tragic death of a Tesla driver while travelling in its 'autopilot' mode in May 2016 highlighted that the system allowed overreliance on the automated driving features, which could be used in ways inconsistent with the manufacturer's guidelines and warnings. These findings are a stark reminder that we must understand the correspondence between the abilities and behaviours of the human operator and the demands of the task in which they are engaged.

Tesla cars are famous not just for their autopilot systems but also for their electric powertrains. Although the technologies are independent, future cars are likely to be electric too, thanks to increasing political and societal demand for ultra-low emission vehicles. Here, human factors can play a part in helping to design in-vehicle information systems to relieve the 'range anxiety' associated with remaining battery charge. Where many drivers have an understanding of fuel tanks and miles per gallon, this will translate to power gauges and kilowatt hours. Research has shown that drivers' uncertainty about range can result in 'safety buffers' of up to 25% of full capacity, restricting full use of the vehicle. Human factors can support drivers in making informed decisions about energy usage and altering their driving behaviour in order to maximise range.

Partial automation raises some of the biggest human factors concerns of all

Vehicle electrification and automation have great potential to improve transport. However, real transformation will only occur if we start sharing our trips. Moving beyond the average 1.2 occupants per vehicle would not only dramatically reduce the price per ride, it would lead to fewer vehicles on the road, require less parking space and ultimately less energy. But what will it take for people to give up their cocoon and share their space with strangers? Here again, insights from human factors will play a pivotal role in designing acceptable, or even desirable, alternatives, as ride sharing can unlock similar benefits as self-driving cars in terms of increased comfort and productivity.

We may not need to wait until the year 2057 to drive electric, automated vehicles, but their success, in improving safety and convenience for those outside the car as well as those inside it, will depend very much on integrating human factors into their design. ●

Mark Young is an Inspector of Railway Accidents at the Rail Accident Investigation Branch. He was assisted in writing this article by Nick Reed, Stewart Birrell and Cyriel Diels. It was written to celebrate the 70th anniversary of the CIEHF in 2019.

Further reading

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National Transportation Safety Board (2017). Collision between a car operating with automated vehicle control systems and a tractor-semitrailer truck near Williston, Florida, 7 May 2016. Available at: https://dms.ntsb.gov/pubdms/

New Decade, New Destination?

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JOURNAL EXTRACTS

Featuring research published in high impact ergonomics journals

Flood rescue research

1 The changing climate is making flooding events more frequent across the globe. While this causes devastation to people in the affected area it also puts a great deal of stress on the emergency services, particularly those people that have to physically work in the flooded areas.

A team from the University of Portsmouth decided to look at the physical requirements, thermal profiles and optimum personal protective equipment (PPE) for flood rescue personnel by putting teams of volunteers through simulated flood rescue tasks in both cold and warm water conditions to assess the impact on their performance. The two simulations were selected based on the activities likely to be undertaken during a rescue performed on a typical cold and hot day in the UK.

PPE is required in most flood situations because of the potential for contamination in the water but wearing protective 'suits' and undertaking strenuous activities increases the potential for hyperthermia. In this experiment, the volunteers were kitted out in dry suits and helmets, with long sleeve thermal vests and trousers, gloves, thermal socks and steel toe capped boots.

In the cold water scenario (4°C), the volunteers stood in knee height moving water (4.8km/h), with simulated wind and rain for 60 minutes. Their grip strength, manual dexterity and jump height were measured before and after the experiment.

Researchers found the cold resulted in cooling of the big toe and fingers and that jump height, manual dexterity and grip strength fell by 20%, 22% and 13%, respectively.

In the 'warm' scenario (20°C), volunteers performed 6x7 minute sessions walking in knee height moving water (3.2km/h), pulling 10kg. There was no difference in the physical tests but people reported feeling very warm and uncomfortable.

The researchers concluded that flood rescue represents significant, but different, challenges. In the cold, emergency responders may be incapacitated by peripheral cooling while in the heat they may be incapacitated by heat-related exhaustion. The research recommends that consideration should be given to elucidating and expanding these initial findings as well as exploring different methods of mitigating the risks identified.

Michael J. Tipton et al. The thermal demands of flood rescue and impacts on task performance. Ergonomics *2020, Vol. 63, No. 1, 109–118*

Wrung-out climbers at risk on ladders

2 The proliferation of offshore wind turbines across the globe in recent years is helping to reduce the world's reliance on fossil fuels but it's also putting a potential strain on technicians who need to climb these tall structures to carry out vital inspections, maintenance and repairs.

A team from Portsmouth University set out to understand the ergonomics placed on technicians during prolonged ladder climbing over the working day. To do this they studied the performance and differences in technique between a group of experienced climbers and novices over three simulated 120 metre vertical ladder ascents.

Significant fatigue was demonstrated in all climbers between climbs 1 and 2 and 1 and 3 as demonstrated by slower total climbing speeds from climb 1 to climbs 2 and 3. Reductions in grip strength and endurance compared before and after each climb were approximately 35% and 26% respectively.

A unique aspect of this research was the use of kinematic data to compare novice to experienced climbers. Novices demonstrated a higher proportion of muscle activation in the upper body than the others which meant they were using less of the large muscle groups of the legs and more of the small muscles in the arms.

From a practical perspective, consideration should be taken when climbing 120 metres more than once in a day, as this will lead to greater fatigue and increase the

likelihood of injuries through both chronic overuse injuries or acute injuries resulting from loss of grip.

The study concluded that ladder climbing technique and experience improves performance, reduces the physiological burden and maintains optimal movement patterns for longer. Therefore, it's recommended that further work is undertaken to research optimum ladder climbing behaviours to develop minimum acceptable standards for the wind power industry and to examine training methods to improve proficiency.

Gemma S Milligan et al. An ergonomics assessment of three simulated 120 m ladder ascents: A comparison of novice and experienced climbers. Applied Ergonomics *85 (2020) 103043*

Kidney patients get AKTIV

3 Having to undergo kidney dialysis regularly is both uncomfortable and time consuming for patients, so the development of mobile kidney dialysis devices will be a great boon to people with this condition in the near future. This would allow an individual to undergo dialysis continuously rather than sporadically.

Prototypes, known as Ambulatory Kidney to Improve Vitality devices (AKTIV), are currently being developed so this study aimed to collect the design preferences of both patients and caregivers so that developers could consider the human factors in their manufacture.

Five designs were considered and the study showed that the belt and backpack designs were preferred over the shoulder bag, vest and distributed formats. It was clear that safety and accuracy were more important than attachment ease, comfort, compactness, or operational simplicity. Invisibility and mobility were frequently mentioned when determining the strengths of each of the five design types during the interviews. Participants liked the belt-type device as it's easily hidden from the outside, and the backpack was also preferred as it would not make it obvious that the person wearing it was a kidney patient.

Also, the researchers surmised that the diversity of design preferences and opinions about features implied that more than one type of mobile dialysis device will be required in the subsequent product development phases.

The findings from this interview study should provide important information to both engineers and clinicians for improving the efficiency, effectiveness and user satisfaction in relation to AKTIV prototypes and products.

Ji-Eun Kim et al. Human factors considerations in designing a personalized mobile dialysis device: An interview study. Applied Ergonomics *85 (2020) 103003.*

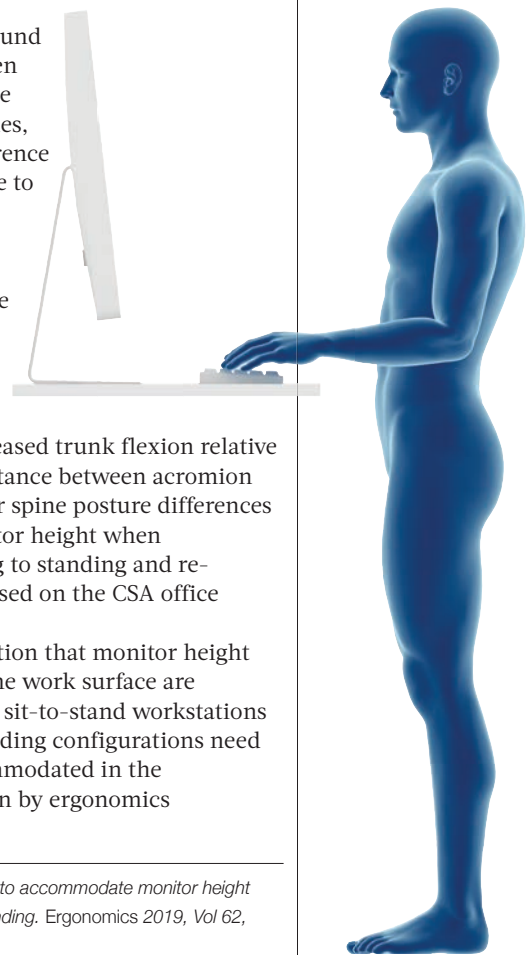
IMAGE: ISTOCK

Monitor checks at sit-stand desks

4 There has been a dramatic increase in the rate at which sit-to-stand workstations are being introduced into the workplace so researchers from the University of Waterloo, Canada, decided to look at the ergonomics when transitioning from sitting to standing.

The introduction of sit-to-stand workstations has been shown to decrease musculoskeletal pain and discomfort but there is a lack of literature regarding the necessary adjustments to the equipment associated with the workstation. Thus, the purpose of the study was to evaluate monitor alterations as well as trunk and lumbar spine posture responses when alternating between a sitting and standing posture setup, according to the current Canadian Standards Association (CSA) Guidelines for Office Ergonomics.

In trials with 16 participants, the study found that transitioning between sitting and standing while adhering to CSA guidelines, resulted in a 3.9cm difference in monitor height relative to work surface between sitting and standing. The results from this investigation demonstrate that lumbar spine alignment differences occur between sitting and standing office work. The observed increased trunk flexion relative to vertical, decreased distance between acromion centre to hip, and lumbar spine posture differences explain changes in monitor height when transitioning from sitting to standing and re-adjusting eye position based on the CSA office ergonomics standard.



Results support the notion that monitor height adjustments relative to the work surface are necessary when utilising sit-to-stand workstations and both sitting and standing configurations need to be assessed and accommodated in the workstation configuration by ergonomics practitioners.

Kayla M. Fewster et al. The need to accommodate monitor height changes between sitting and standing. Ergonomics *2019, Vol 62, No 12, 1515–1523*

Pit-stops for paramedics

In the UK every year approximately 60,000 people suffer a sudden cardiac arrest and survival rates are poor, especially where the emergencies occur out of hospital. Co-ordinated teamwork is vital and new research is investigating the importance of non-technical skills in these scenarios, as **Stef Cormack** explains

IMAGE: GETTY

Sudden cardiac arrest refers to the unexpected cessation of cardiac activity with hemodynamic collapse, typically due to sustained cardiac arrhythmias. This is when the heart stops beating and the circulation of blood around the body is interrupted. This can have life-threatening and life-limiting consequences if not treated quickly, so it's vital that the patient receives immediate medical attention.

Despite increased public awareness surrounding sudden cardiac arrests, including the teaching of Cardiopulmonary Resuscitation (CPR) and increased access to public accessible defibrillators, survival rates from sudden cardiac arrests, especially when they occur outside of a hospital, are extremely low. In the UK, typically only 8% of victims survive longer than one month.

Of those first on the scene when attending a sudden cardiac arrest, paramedics are routinely taught how to perform CPR and trained in advanced life support skills such as maintaining airways, gaining intravenous access and administering life-saving drugs.

The pit stop paradigm

Within wider medical practice, for example in operating theatres and Accident & Emergency departments, the 'pit stop paradigm' has gained traction for managing a variety of procedures. This was adopted from motor racing Formula 1 teams where each team member has a dedicated role. Through specialised training it's possible that such teams can accomplish complex tasks extremely efficiently and quickly, and there have been some positive applications to in-hospital procedures.

In these situations, the pit stop paradigm typically advocates that each medical team member has a predefined role, that there are a minimum of six to eight clinicians attending a patient, a dedicated leader, 360-degree access to the patient, and a standardised layout of equipment. If this was an F1 pit stop then there would be dedicated team members for each wheel, refuelling, attending to the driver, and an overall management of the process. However, the same paradigm does not migrate to out of hospital procedures so readily, as there is little time for briefing, numbers are limited to three or four paramedics for each cardiac arrest scenario and 360-degree access is not always possible.

In some cases, there has been resistance to the pit stop paradigm; medicine is not the same as F1, after all. The human body, with all its complexities, requires a more sensitive and user-centred approach to patient care than is needed to refuel a car or change a tyre in just a few seconds. When medical procedures are transferred outside the hospital the pit stop paradigm can be even less relevant. Sudden cardiac arrests most often occur outside of a hospital setting, sometimes in a public place but more usually in the patient's own home. Such arrests typically occur in a bathroom or bedroom and even gaining access to the patient can be a major issue. There may not be enough room to physically get more than one or two people around the patient.

Even trying to perform chest compressions on a patient can be a major challenge in their home. For example, compressions can't be carried out on a standard bed mattress as it doesn't provide a firm surface and moving the patient onto the floor might be impossible. There may also be relatives present (if at home) or bystanders (if in a public space) and all these factors result in a complex and varied environment, with multiple distractions and where all round access to the patient is rarely possible.

Another key issue is how ad-hoc teams coordinate their activities. In addition to clinical skills, national pre-hospital resuscitation guidance advocates the use of Non-Technical Skills (NTS) such as leadership, communications and situation assessment, to ensure effective team performance but roles can be difficult to determine quickly in ad-hoc teams.

A designated 'hands-off' team leader can improve team performance

Improving team performance

Literature from in-hospital cardiac arrest teams has identified that a designated 'hands-off' team leader, that is, someone who is not involved with any clinical interventions including CPR, and the use of closed loop communication, can improve team performance. Regular team training focusing on a range of NTS can also increase an awareness of task focus, cognitive load and scene assessment.

While these advantages are apparent in hospital settings, there are critical differences out of hospital such as the operational environment and differences in the number of clinicians attending (some of which may be more or less familiar with procedures than others). Paramedics might rarely attend more than six to eight sudden cardiac arrests per year and so potential skill fade is an important issue and can impact team performance. Therefore, the identification of specific NTS for paramedics working as an ad-hoc team is critical.

With these issues in mind, it was established that an observational behavioural marker system was required to assess and provide feedback for paramedics. As part of this, work, it's been necessary to identify specific NTS attributes and descriptors relevant to sudden cardiac arrest scenarios for paramedics that could be developed into an operational tool.

A new behavioural tool

The Paramedic Out-of-Hospital Cardiac Arrest Tool (POHCAT) is intended to be used as an observational assessment method using simulated scenarios. It has been developed to provide paramedics with feedback on specific NTS skills when working as part of an ad-hoc team managing a sudden cardiac arrest. Divided into positive and undesirable descriptors, it →

Two NHS ambulance service paramedics on bicycles

allows an assessor to identify relevant NTS and give feedback to help improve the team's performance.

In order to develop the POHCAT tool, an initial literature review was conducted that identified a range of existing behavioural markers, ranging from those for anaesthetists to maritime/navy deck officers. Although some general medical NTS were identified, specific paramedic NTS needed to be developed that were sensitive and relevant to out of hospital activities. Informed by existing healthcare behavioural marker systems and data gathered from student paramedics, subject matter experts and current literature, essential NTS relevant to a sudden cardiac arrest were identified.

The sudden cardiac arrest behavioural marker system consists of four NTS domains: situation assessment, team coordination, knowledge of procedure/task management, and communication. Examples of observable behaviour were developed along with a 5-point assessment rating system (from unsafe to excellent). This allows assessors to score the observed behaviours of individual student paramedics and provide additional feedback. The POHCAT tool can be used to observe one paramedic whilst also being adapted to take in additional roles as more paramedics arrive.

The NTS categories and ratings have been designed to help improve individual NTS and overall team performance for paramedics. The behavioural marker system allows for the evaluation of training and education, identifying areas of strength and weakness, which can then be improved with further consolidatory learning and practice. Using observational approaches allows the paramedic to learn and rehearse in a naturalistic setting, for example, in a simulated public space or even in an ambulance.

Sudden cardiac arrests can occur in complex and varied environments with multiple distractions

Exploring paramedic NTS

Pioneering research is being conducted at Coventry University where a mixed methods approach has explored student paramedics' understanding and experiences of NTS in a sudden cardiac arrest. A reasonable understanding of NTS was demonstrated, but there were several barriers identified. These included hierarchical problems, communication, leadership and situation awareness issues.

Despite paramedics possessing similar clinical skillsets (regardless of rank or role) students often found they struggled with challenging qualified paramedics who had more experience, stronger personalities or a higher rank. Hierarchical problems included paramedics dismissing student suggestions despite student paramedics often possessing more up-to-date knowledge of procedures as a result of continual assessment. Students also considered that paramedics perceived that they lacked experience and exposure to sudden cardiac arrests and therefore were not competent.

Student paramedics also felt that although a leader is needed in a sudden cardiac arrest, they considered team coordination was more important than leadership. They disliked the term 'leadership' as they felt it equated to an autocratic, egotistical leader who wanted to perform clinical skills, rather than remain hands-off. Student paramedics were clear about their own roles and had a clear mindset and mental model of what should happen in a sudden cardiac arrest, but in reality, they found it difficult to assimilate in the team as some paramedics lacked knowledge in clinical skills and resuscitation algorithms often resulting in poor teamwork.

These issues impact on overall situation assessment. Many students explained that they fixated on the patient and clinical algorithms, missing basic information, often becoming task focused as they had to concentrate more on their role in the sudden cardiac arrest. However, when students were part of a more familiar and smaller team, they found it easier to speak up, received more support when performing clinical skills reducing task overload and there was a greater use of closed-loop communication.

Early work with the POHCAT tool has demonstrated there are benefits of training and assessment of an ad-hoc team's NTS in sudden cardiac arrest scenarios. As yet, NTS are not routinely taught or incorporated into UK university paramedic programmes and so this remains a challenge in terms of developing a culture where NTS are given as much importance as clinical skills, and practitioners are aware of how important this concept can be on ad-hoc team performance.

This research is being led by **Stef Cormack** from the Faculty of Health and Life Sciences with support from **Dr Steve Scott** of the Faculty of Engineering, Environment and Computing, both at Coventry University, and **Professor Alex Stedmon** who runs Open Road Simulation Ltd and Science Witness Ltd.

Further reading

Catchpole K et al. Patient handovers within the hospital: translating knowledge from motor racing to healthcare. *BMJ Quality and Safety* 2010 Aug;19(4):318-2

Hopkins C L et al. Implementation of Pit Crew Approach and Cardiopulmonary Resuscitation Metrics for Out-of-Hospital Cardiac Arrest Improves Patient Survival and Neurological Outcome. *J Am Heart Assoc* 2016 Jan, 5(1). Available from https://doi.org/10.1161/JAHA.115.002695

Andersen P O et al. Identifying non-technical skills and barriers for improvement of teamwork in cardiac arrest teams. *Resuscitation* 2010; 81:695–2.

Hunziker S et al. Teamwork and Leadership in Cardiopulmonary Resuscitation. *J Am Coll Cardiol* 2011; 57:2381–8.

IMAGE GETTY

Conference connections

As the CIEHF is planning even bigger and better events, we're very excited about our upcoming Ergonomics & Human Factors Conference, EHF2020, this year running in conjunction with the Organisational Design & Management symposium. This latter event only happens every three years so we're very pleased to be the host in 2020.

At this event, you can expect to meet international delegates and make valuable contacts outside your existing network. This will help you to widen your horizon and give you an insight into other sectors and areas of the discipline. But attending CIEHF events is not only good for networking, it's also a great way of absorbing new information presented in an accessible way. How often have you thought you should read up on something but just not found the time? Setting aside time to attend this event will make sure you focus on your professional development, get the most important news and updates and have an opportunity to exchange ideas with other professionals at a great venue. Our members tell us that personal interaction with others is precious, despite online communication being a daily standard. Connections made at our events can help open doors for you now and bear fruit even years later, in the form of professional collaborations or joint business endeavours.

Your membership allows you to take advantage of a substantial discount for event bookings so please make the most of it and join us in Stratford-upon-Avon this year. You can select an 'all-inclusive' Gold, Silver or Bronze Package or chose individual days - there are flexible booking options available to meet your needs. If you don't know the discount code, just let me know. For further information on the event programme and all other details, please visit our newly launched conference website at conference.ergonomics.org.uk.

I look forward to seeing you there!

Iris Mynott
Membership & Partnership Manager
i.mynott@ergonomics.org.uk
07702 542166

IMAGE: ISTOCK

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
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 in conjunction with ODAM2020	Mon-Wed, 27-29 April 2020, Stratford-upon-Avon	Masterclasses, keynotes, talks, posters, workshops, discussions and lively social activities, together with an in-depth look at work systems design, technological change, complex systems and much more, all packed into a three-day showcase event.
Human Factors in Rail	Wed-Fri, 24-26 June 2020, London	An exploration of in-cab signalling, traffic management, non-technical skills, the platform-train interface, safety culture and more.
Aviation Safety	Mon-Tue, 9-10 November 2020	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.

Q&A

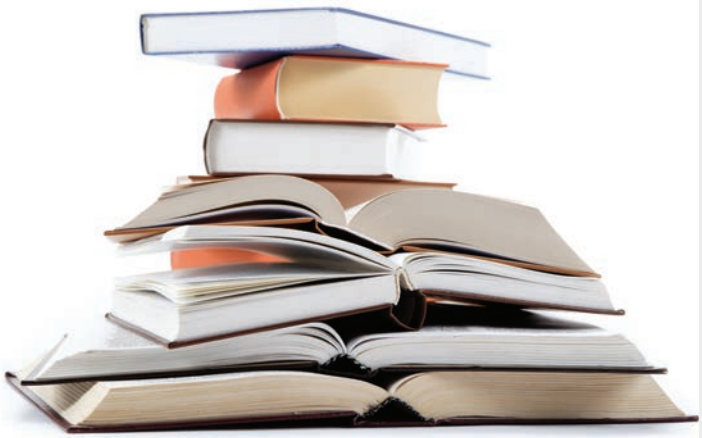
MEMBER PROFILE

Following a major change of direction, **Jane Higgs** talks to Lou Boulden about her career so far

How did you get into human factors?

It was quite an unconventional route! My first degree was in psychology and we did a couple of lectures about human factors then. I loved those but never realised you could have a career in it. I went off and worked in libraries for a few years, eventually becoming a professional librarian following an MA in Information and Library Management.

Ten years later I found myself stuck in a sector dominated by redundancies and closures, unable to move jobs because there were simply no vacancies. I knew I had to change career and remembered those two lectures I'd had 15 years previously. The more I found out about human factors, the more I knew it would be for me – varied, with the ability to work in all sorts of sectors and focused on a huge variety of problem solving. I decided to take the plunge and did one of those big life changes that you normally only read about! I got a place on the Ergonomics (Human Factors) MSc course at Loughborough University, left my job, sold my flat to pay for the fees and moved back into student halls in my late thirties.



It can be done! It was hard work, especially after not having done any studying for ten years, but I absolutely loved it right from the very first day. Even though since graduating a permanent job in human factors has so far eluded me (they're like gold dust at the moment in healthcare), it's still the best decision I've ever made.

Why did you focus on healthcare?

It was for quite personal reasons, really. I have had type 1 diabetes for 30 years, so have spent a lot of time in various healthcare facilities having check-ups and appointments. After a while you start to look around and learn how things work and see some of the struggles of the healthcare professionals, so it was an environment I was interested in and felt personally connected to. Then one of my friends had to have a serious and quite rare operation. Thankfully the procedure went very well, but when I visited her in hospital afterwards there were several elements in her aftercare that didn't run smoothly; what I would now call systems factors. I remember thinking at the time "I'm sure something could be done that would make patients' time in hospital easier, as well as making the jobs of the staff easier." It wasn't long after that I rediscovered human factors and realised it could help with those kinds of problems.

How did your career go?

When I graduated there weren't many jobs around in healthcare human factors, but I gave myself six months to find a position and joined the University of Oxford Patient Safety Academy just within that deadline! I spent an exciting six months there, where I got to work on different projects and also made some great friends. When an opportunity came up in my home town of Birmingham I had a bit of experience and moved to the West Midlands Academic Health Science Network, working as Ergonomics/Human Factors Advisor for their Patient Safety Collaborative group. This covered the whole of the West Midlands

and all healthcare, including services like GPs and care homes as well as the more traditional base for human factors of hospitals, so was a great way of being involved with a variety of projects.

Tell us about a great project you've worked on

I worked with an amazing patient safety team at Birmingham Children's Hospital on the design of their Paediatric Early Warning Score charts. These are charts which record various vital signs of patients across time, enabling clinicians to see trends in patient health and facilitating communication between clinicians on the patient's state and actions required. It was my first project involving usability design and testing and I have kept in touch with the team to follow its progress ever since and the new charts have just been rolled out across the trust. We're all looking forward to seeing the impact they have on patient safety.

What is 2020's top challenge for patient safety?

I think the biggest challenge in healthcare at the moment, which impacts on patient safety, is not having a fully funded and fully staffed NHS. That's an enormous challenge for all healthcare professionals. There's an increasing recognition that using a human factors approach to patient safety is important, but there's quite widespread misunderstanding in some areas of the NHS community as to what human factors actually is and what it covers, although this is now improving. Understanding around the systems side especially is lacking, which makes it more difficult to sell the potential of human factors as a discipline. The NHS generally has a quite specific quality improvement, quantitative data-led approach to improvement projects, into which a lot of training and expertise has been poured and which has achieved great things but doesn't always chime perfectly with human factors work. I believe that our methodologies can generally fit within this framework but introducing new approaches like human factors takes time in such a massive and complex sector. One of the main challenges for human factors in patient safety is the amount of people qualified to do the work versus the number of NHS Trusts, even if just focusing on hospitals.

The more I found out about human factors, the more I knew it would be for me

IMAGES: SHUTTERSTOCK

There simply aren't enough of us! Many clinicians are taking MScs or PGCerts in human factors and qualified professionals are moving into healthcare, but there are still currently very few people trying to cover an enormous amount of work.

What impact can human factors make across healthcare?

Hopefully a great deal! The NHS has recently announced that trusts will be required to employ patient safety specialist staff from April 2020, so that should introduce more human factors practice. My hope is that more people qualified to do the full spectrum of human factors work will become embedded in trusts and this will start to spread to other areas of healthcare as well, such as GP practices. If permanent jobs like this become more common, we should see more, deep, system-wide projects taking place, as well as the smaller frontline projects currently happening. This is the kind of change that will have a massive positive impact on patient safety and staff wellbeing.

What are you doing now?

When my contract came to an end in Birmingham, there weren't any other contracts around in the West Midlands, so I set up my own consultancy. That's been a new challenge and it started slowly but now I'm getting some great projects! Part of this is that I've just got a contract to work with the CIEHF itself, supporting project management and other tasks. It's really interesting to see the Institute from the other side – so much work goes in to all aspects of the organisation from so few people! My long-term aim is to become permanently embedded within an NHS Trust and to be able to work full time on patient safety in an environment that I can truly become familiar with. ●

Jane Higgs has an MSc in human factors from Loughborough University.

Get involved

There are many ways for you to develop your career through activities such as training and delivering presentations for example, but it can be more difficult to find opportunities to grow your management or project skills. Getting involved on a voluntary basis with Institute activities can help to fill that gap. It shows that you are a dedicated professional, willing to give something back to a discipline that has given you the chance to see and experience things no other single discipline could. Training and guidance is provided, which can all add to your own CPD.

Be a mentor: Mentoring can be highly rewarding, enabling someone less experienced and skilled than you to benefit from your help. This is especially true for members just starting out in their career or for those who find themselves as the lone ergonomist or human factors specialist working on a new project. We're now looking for Registered Members or Fellows to become mentors for people taking our new Learning Pathway.

Be an assessor: Assessors play a vital role in upholding standards of professionalism in the discipline by peer-reviewing applications for membership. You will be helping to give confidence to organisations and the public that our members are skilled, knowledgeable and have the experience to carry out ergonomics and human factors work competently. Assessors also accredit externally run degree courses and training courses in ergonomics and human factors. You will be helping to ensure quality content and delivery of these courses for those booking them.

Be a group lead: Regional Group Leads work with us to organise a variety of talks, visits and other small events in regions across the UK. These are invaluable ways to learn and network locally. Sector Group Leads are our eyes and ears on the ground, in sectors such as healthcare, manufacturing, defence and energy. It's a great way to be involved in the latest developments, discussions and consultations.

If you're interested in any of these opportunities, please email Iris Mynott, **i.mynott@ergonomics.org.uk**.



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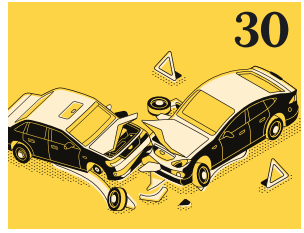

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FROM THE PRESIDENT

Our goals going forward

Bob Bridger
CIEHF President

president@ergonomics.org.uk

One of the highlights of the last Council meeting was a presentation on CIEHF's new Learning Pathway for the energy sector. The pathway sets out the levels of competence required to attain Technical Membership of the Institute. The Technical Member grade was introduced fairly recently and fills the space between Associate Membership (which is effectively open to the public) and Registered Membership, which is awarded to graduates with at least three years' experience in human factors.

Technical Members are typically professionals working in a particular sector who have a narrow but deep knowledge of human factors and as such they are well-qualified to work in specialist areas such as human factors integration.

The Technical Member category is one of the initiatives that is expected to deliver against the key performance indicators of 'The Future Human', our new 5-year Strategy. In particular, we aim to increase membership, adding 1000 new members by 2025 and to increase revenue by at least 5% per year.

Membership has already increased by 5% this year and further increases are expected. A larger membership is expected to increase revenue from events due to higher attendance (virtually as well as in person) and also to increase the variety of events that are offered.

New Learning Pathways are under development for the UX community and for healthcare. The Royal Navy has ambitious plans for human factors training of its personnel and discussions with CIEHF, albeit at an early stage, are underway.

These are exciting times for the Institute. I have thoroughly enjoyed my time as President and look forward, as I am sure we all do, to welcoming Amanda Widdowson - our new President for 2020-2021.

I have thoroughly enjoyed my time as President

FROM THE EDITOR

Working through the coronavirus crisis

In these unprecedented times of global action to combat an insidious threat to everyone's health, our cover article gives advice and insight on how human factors can help us to continue to work safely. As the need grows for ventilators to treat patients suffering from Covid-19, a timely piece from Chris Ramsden discusses new regulations coming into force covering the design of such medical devices.

With the safety of those on the frontline in healthcare in everyone's minds, Fiona Potter gives us a fascinating look into the work that goes on behind the scenes in hospitals from a health and safety perspective. The relationship of health and safety to ergonomics is the topic of a reflective piece by Trevor Shaw, from his time at the HSE. Looking back too are Mark Young and Claire Dickinson who discuss the origins of human factors integration in the rail sector. Transport features in a piece by Neville Stanton who reveals his research into road collisions and also in Darren Doyle's review of a book about error detection in aircraft maintenance.

Technology features too, as Tom Malloy reveals the detailed design of a headset to assist people with low vision and Peter Hancock discusses our relationship with Artificial Intelligence.

Stay safe and well.

Tina Worthy
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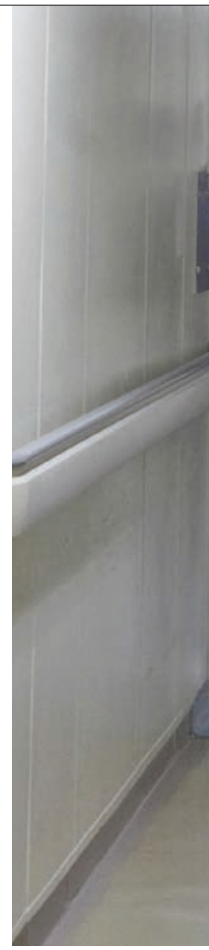


A DAY IN THE LIFE OF AN...

NHS HEALTH & SAFETY MANAGER

Fiona Potter, Northampton General Hospital

Northampton General Hospital (NGH) provides general acute services to a community of 380,000 people, with nearly 5000 employees plus volunteers (which also include dogs from the Pets as Therapy team). Statistics for the 2018/19 year showed 133,460 patients were seen in Accident and Emergency, and 4648 babies born. So, it's a busy environment to work in.

My background is in quality control systems, procedures in an industrial bakery, and the print industry. Having a systems approach to writing down what and how work is done, what gets checked and what happens when the quality of the product does not meet the standard, helped me gain a post as a food safety technician in a local authority.

The technician role involved inspecting food premises, shops and catering outlets for food safety and health and safety legislation. I found the breadth of health and safety legislation far more interesting than food safety, so after a few months I trained to specialise as a health and safety inspector. My career of more than 30 years has spanned being a local authority advisor, a self-employed consultant, an advisor for a national children's charity and at a university, before gaining the post at the hospital.

During my four years at NGH, my experience of working in complex organisations has stood me in good stead to develop a safety management system that's based on observing what activities we undertake at the hospital, across all services, and documenting the key elements that can consistently be applied across the organisation.

One of the main challenges for a safety practitioner working in a hospital is that activities never stop. The hospital is open 24/7 365 days a year. With a 24 hour operation it's important that I'm as visible as possible, so that people put a face to the name, are able to ask questions and for me to listen and to understand how and what work as done looks like, against work as imagined. On occasions I've learnt and understood more about an individual's work difficulties during a chance conversation on a ward, in a corridor or in the grounds by stopping to have a chat or meeting up over a cup of tea. These conversations are invaluable so never underestimate the power of saying "Hello, how are you today?"

Another way of active engagement is to work collaboratively with multi-disciplinary specialist teams. By working in such a way, health and safety becomes an integral part of the safety culture of the organisation instead of being seen as a standalone subject.

An area where I've successfully worked with a multi-disciplinary team has been the management of the Control of Substances Hazardous to Health (COSHH). The group participants range from Occupational Health, Infection Prevention, Oncology and Haematology, Pathology, Pharmacy, Purchasing, Theatres and Waste Management. The chair is a Matron so that a clinical perspective is provided. The team agreed to rewrite the policy and reformat the COSHH assessment form we used. Once the policy was approved, the group set about identifying the most commonly used substances.

The joy of working collaboratively means that all aspects of the assessment from hazards to health identification, from risk categorisation and rating to agreement of effective control and emergency measures, plus monitoring and health surveillance arrangements, can be discussed and agreed within a meeting or virtually afterwards.

In healthcare, hazardous substances cover a wide range from cleaning materials, Blood Bourne Viruses, dusts, microbiological hazards such as Hepatitis B and tuberculosis that's analysed in our specialist (Category 3) laboratory.

Cytotoxic medications are also categorised as a hazardous substances as many are teratogenic, that is, an agent that can disturb the development of an embryo or foetus. The medication has an anti-cancer activity and so has the potential to damage normal tissue. Therefore, staff who handle and administer the medication have strict handling, reconstitution

IMAGE: ALAMY / ISTOCK

A patient is taken for a cardiac operation and pictured right: a surgeon using diathermy during an operation

My experience of working in complex organisations has stood me in good stead

and administrative processes and control measures.

I worked on a project with the theatre staff who had raised concerns regarding the odour and respiratory and eye irritation from surgery where diathermy was used. Diathermy is a surgical technique that uses an electrical current to cut tissue or to seal bleeding vessels. The risks can vary depending on the procedure, the equipment, the technique and the patient. The Health & Safety Executive and the British Occupational Hygiene Society had information on the health effects of diathermy fumes and gave advice on the control measures and precautions to take.

As part of the investigation, I visited the theatre where the equipment was used, (not during an operation I hasten to add, I don't have a strong stomach for blood!). I spoke to the staff, including Operating Department Practitioners, staff nurses, anaesthetists and consultant surgeons, and I soon learnt they all had varying views and sense of humour.

The investigation found that surgeons had individual preferences on which extraction device ('on tip extraction') was used to remove the emission from source. Tip extraction forms part of the control measure by removing the emissions at source, a form of local exhaust ventilation system. Where the preference was not to use the extraction tip, a reason given was it obscured their vision of the wound area. The result of an increase in the level of diathermy fume in the area meant that control measures were needed to be used to comply with the Regulation.

Communication and consultation resulted in a Theatre Champion coming forward who made progress by trialling new equipment including different tip extraction nozzles. They also developed a single COSHH assessment across all theatres, which was agreed and approved by all parties. A short training session was conducted by the theatre staff peer-to-peer group and peer pressure ensured the equipment provided was used. So, all in all, there was a successful outcome for all.

Another area I hadn't had the experience of observing and working in before has been in the use of simulation training. NGH has a simulation training facility where doctors, nurses, midwives and other clinical staff can practise scenarios on dummies, or 'real casualties'. I've been fortunate to observe this in action when the department ran an exercise in one of the hospital car parks, where a simulated road traffic accident was set up, with numerous casualties. Trust Staff and all emergency services including police, fire, ambulance and voluntary agencies, worked together to safely 'save lives'.

The benefit of simulation training is that it promotes learning of skills that are difficult to practise elsewhere. It allows clinicians to work as a multi-disciplinary team and provides an opportunity to assess errors or suggest improvements on safe practice, with immediate feedback. It helps build confidence, enabling people to understand their own reactions to stress, so that they can develop personal resilience and to identify when to ask for help.

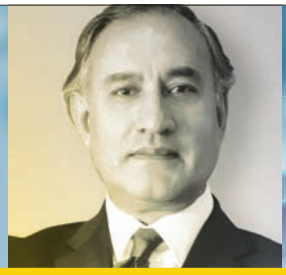
All these provide a vitally important role in improving communication skills with colleagues and patients, and gives an opportunity for self-learning.

I thoroughly enjoy my work at NGH, no two days are the same, and I can never tell what will come across my desk or who will be at the end of the phone. There is a genuine positive regard for each other and the vast number of professions that work in the hospital. Team working is a must and I'm very fortunate to be a part of Team NGH.

Fiona Potter has a BSc (Hons) in Home Economics, an MSc in Occupational Health and Safety Management, and a Post Graduate Certificate in Ergonomics. She is a Chartered member of the Institute of Occupational Safety and Health and is a member of the IOSH Health & Social Care Group.

Further information

Simulation Centre: www.northamptongeneral.nhs.uk/Work-for-Us/Medical-and-Dental/Simulation-Training/Our-simulation-centre.aspx



CHIEF EXECUTIVE'S PERSPECTIVE

Systems thinking and Covid-19

There has never been a more appropriate time for professional membership bodies to take a systems approach to analysing and identifying solutions to help move forward in what I call the era of Covid-19.

This year was to be our most dynamic for engaging members through a wide range of live events at a regional and national level. Our annual conference was to be run for the first time jointly with the International Symposium of Organisational Design and Management ODAM attracting over 30 international speakers. Bookings were coming in thick and fast.

In March, Tina Worthy, our Chief Operating Officer, and myself presented an ambitious delivery plan to the CIEHF Council increasing our budget to help accelerate our growth and reputation as the preeminent voice for our discipline and profession. A new workflow management system was put in place to help manage a wide range of projects and activities helping us to stay on top of the work programme.

Overnight the world changed and six months of detailed planning was disrupted. We saw things change by the hour as the coronavirus spread and as governments around the world evolved policies in a piecemeal way. There has been little evidence up until more recently of taking a systems approach. Ironically, the US Government shut down the pandemic planning unit in Washington some time ago!

For the CIEHF this has meant looking for opportunities and innovation from this disruption whilst remaining focused on our ambitions to grow our membership, engage members and promote our reputation. So, with this in mind, this year our conference will now be run as a virtual conference over two days, on 28-29 April, with live webinars, pre-recorded videos, podcasts and slideshows. Instead of a daily audience of several hundred, we can now expect multiples of this. We're promoting the conference to every member of the International Ergonomics Association, with a price tag of £99 for access to all webinars and online content. For details, see our conference website at https://conference.ergonomics.org.uk. This has now prompted us to think about running future conferences virtually.

Working with allied professional bodies, we're providing guidance on a wide range of topics

We'll also be launching a new interactive webinar series from May onwards covering a much wider range of topics including professional development activity. This is the precursor to a dedicated e-learning platform for CPD that will come later.

The CIEHF will focus on accelerating the development of several Learning Pathways this year and the creation of a much wider range of white papers, for which we now have written guidance.

We've also taken the lead in creating a series of podcasts in response to Covid-19. Working with allied professional bodies, we're providing guidance on a wide range of topics for both the public and professionals working in healthcare, safety and more. The first episode is focused on how to stay physically and mentally fit whilst working from home. It's aimed at the general public and we would encourage you to post it and share it as widely as possible. Visit *https://bit.ly/ciehfpodcast1* Future podcast topics include how to provide human factors consultancy remotely to clients and staying psychologically healthy.

At the request of the NHS, we've also rapidly been pulling together our collective expertise to formulate a guidance note on human factors for designers and manufacturers of much-needed medical ventilators. This followed the creation of Ventilator Challenge UK, a consortium of 14 British companies including Airbus and Rolls-Royce, who took up the task of producing thousands of ventilators in a just a few short weeks.

This demonstrates how our members can rise to the challenge to bring human factors to where it's needed most at a time of crisis.

Noorzaman Rashid
Chief Executive of the CIEHF
Noorzaman.rashid@ergonomics.org.uk

noorzaman rashid

IMAGE: ISTOCK

Major companies help tackle virus

Corporations with access to valuable human behaviour data including Amazon, Google, Microsoft, Apple and Facebook are helping combat the coronavirus having met with officials at Downing Street and the White House. Among the topics under discussion have been the companies' role in modelling and tracking data, as well as the use of artificial intelligence (AI). A previous report from the World Health Organisation noted that AI and big data played an important part in China's response to the virus.

Facebook has been working with Harvard University and Taiwan's National Tsing Hua University to share anonymised data about people's movements and population density maps that help forecast the spread of the virus. The social network is also helping partners understand how people are talking about the issue online.

Google's life-science research arm, Verily, has helped people who want to track their own health by developing a small body-worn temperature patch that transmits data to a phone app. Meanwhile, Professor Sabine Hauert of Bristol University has told the BBC that AI could make daily life easier during the crisis: "It can also be used to put people out of harm's way, for example using robots to clean hospitals, or telepresence systems for remote meeting, consultations, or simply to connect with loved ones."

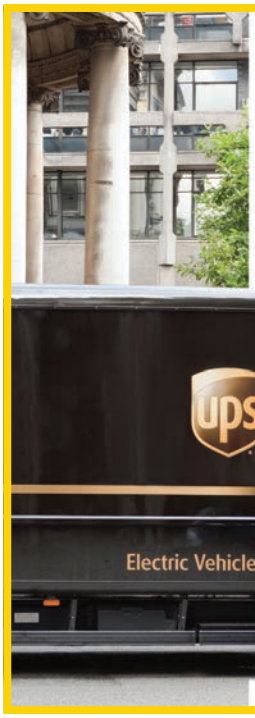


IMAGE: ALAMY / SHUTTERSTOCK

Eco-friendly trucking

The concept of eco-friendly trucking has moved forward in Germany where tests are now being carried out on a new eHighway system on a three-mile stretch of the autobahn between Frankfurt and Darmstadt. It allows an electric-diesel hybrid truck to travel alongside everyday traffic while receiving power from overhead cables. Previous tests in Germany took place at night or in the safety of an unused military airfield.

Sweden was the first country to launch an eHighway back in 2016. That system used the same concept as the German trial; electricity is directed to trucks through pickups on their roofs that latch on to the overhead cables. Meanwhile, the trucks can feed electricity into the grid when they brake.

In the early stages of the trials just five trucks will use the electrified stretch each day. However, that could increase as more trucks support the system and trucking companies begin to realise that electric vehicles can drive longer on a charge.

Rural areas technology boost

Rural areas in the UK are to benefit from government-funded trials to help them seize the potential of modern technology. Digital Secretary Oliver Dowden has announced that nine projects across the country will receive a share of £35 million from the Department for Digital, Culture, Media and Sport's rural and industrial 5G competitions.

Meanwhile, a new £30 million open competition open until the end of June, called 5G Create, will look at how 5G can create new opportunities in industries including film, TV, video games, logistics and tourism. Among the beneficiaries will be Sherwood Forest in Nottinghamshire where cutting-edge apps will transform the visitor experience, and new robotic environmental management will be tested alongside live monitoring of the health of Sherwood Forest.

There will be funding for 5G trials in air and sea search and rescue in Dorset to help save lives using terrestrial and satellite connectivity. This project will also trial 5G connectivity for remote farms to track crop growth, monitor livestock and reduce water pollution.

This forms part of the UK's £200 million investment in testbeds and trials to explore new ways that 5G can boost business growth and productivity, improve the lives of people in rural areas and maximise the productivity benefits of new technologies.

Responding to the challenge of Covid-19

The coronavirus pandemic continues to stretch government, public services and healthcare systems around the world. Ergonomists and human factors specialists are now front and centre in this battle and their expertise will also be vital when the time comes to rebuild our world, as leading figures in human factors and in occupational medicine and health explain.

The first shockwave of the coronavirus has struck with an impact that, for many, only science fiction writers could have imagined. As death tolls soar, every sinew of effort is wrung from those with the skills and knowledge to save lives and suppress the virus's worst effects. Ergonomics and human factors specialists will have a vital role to play in this battle.

Already, CIEHF Chief Executive, Noorzaman Rashid, has been recruited to coordinate expert advice for manufacturers and designers who are skilling up to build the ventilators hospitals desperately need. And the Institute will also be providing essential human factors support across a range of other initiatives in which hospitals are in need of support. "The effort is massive and the knowledge we have is essential to this. Everyone has a role to play," he says.

Institute members themselves, however, face the dual task of ensuring their own safety and, crucially, considering how to continue supporting their clients while this crisis lasts. "This is a particularly challenging time for human factors practitioners," says Sarah Sharples, Professor of Human Factors and Pro-Vice Chancellor for Equality, Diversity and Inclusion at the University of Nottingham, and President of CIEHF 2015–2016.

"Much of what we do is based on an understanding of the whole experience our clients, or their people, are having. Our methods usually involve physical visits to workplaces. Even the remote methods we use are often enhanced by face-to-face communications. Indirect reporting alone gives us only one perspective of a working environment. One of the core skills of a human factors practitioner is to be able to take a step back and see a systems perspective, to spot and help address issues that people may not realise are contributing to the challenges they are experiencing. The current situation means we can't do that. We can't physically access workplaces. We can't use many of the methodologies and equipment we would normally use. But that doesn't mean we have no role to play."

Sarah sees a key element of members' roles being to remind employers to be compassionate and to support their staff. "It's a challenging transition for everyone but if we recognise the impact it's having on others and work to mitigate it, it's a challenge we can meet."

Looking ahead, Sarah recognises that ergonomics and human factors practitioners may have to introduce new working methods to continue fulfilling their roles. "We all really need to think about ways of working remotely," she says. "There are some things we do that in the past would have relied on face-to-face support but which we now have to adapt to these extraordinary circumstances. For example, rather than actively discussing workplace challenges in a focus group, could we achieve the same input through video conferencing or facilitated discussions? Can we use video technologies as a consultation tool? I'm confident that the adaptability and good communication skills that go hand-in-hand with working as a human factors expert means CIEHF members will be well-placed to respond to the challenge."

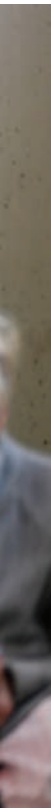


IMAGE: REUTERS

Whatever the future holds for the UK's workforce, working from home will continue to be a part of it. Perhaps the current crisis will unfold entirely new ways of working, ways that people and businesses will want to adopt permanently. What it won't do is change the fundamental principles behind the theory, practice and application of ergonomics and human factors.

Sarah adds: "The most important thing to consider is our health. As practitioners, we have a role to play in reminding employers of that. Our biggest job right now is to give employers the information, advice and support they need to make sure their people are as able as they can be to make health and wellbeing a priority while they work from home."

The Institute is working closely with other professional bodies to harness and coordinate knowledge that aids the fight against the virus. One key area is ensuring that mental health is protected as much as possible. The Society of Occupational Medicine has this high on their agenda, not just for the patients their members care for, but for their members themselves.

Dr Will Ponsonby, the Society's President, says that the pressures on healthcare professionals are growing by the day and that maintaining their mental wellbeing is of real concern and an absolute imperative for his organisation. He says: "When it comes to keeping on top of mental health, friends and family, and even trusted colleagues, are just the tonic. Although there are lots of things people can do in their daily routines at home to keep safe and healthy while self-isolated, keeping in contact with loved ones outside is very important for good mental health.

Will adds: "Discussing or sharing your thoughts or fears can be very useful as well. But if people feel the subject is personal and not suitable to discuss with friends and family then there are other organisations they can contact for advice and support, such as a company's employee assistance programme or other charity support telephone lines."

One of the core skills of human factors is seeing things from a systems perspective

His colleague, consultant occupational physician Dr Charlie Vivian, notes that healthcare workers are now facing emotional responses that are entirely predictable, comprising anxiety, depression and/or guilt. He says: "Fear is a natural and healthy response to a threat. It provokes a 'fight or flight' response, increasing the chances of our survival. But when the threat is extended, we quickly become worn out and need to adopt techniques that help to switch off this response. One of the simplest is to change our breathing. Rather than hyperventilating, we need consciously to slow down our breathing and breathe slowly, taking deep breaths from the abdomen for a few minutes. Rapidly this corrects chemical imbalances caused by over-breathing."

BOHS, the Chartered Society for Worker Health Protection, is also at the forefront of battling the pandemic. Kevin Bampton is their Chief Executive and he says that while dealing with the immediate crisis is uppermost in everyone's mind, looking to the future will bring huge challenges. "We haven't seen the worst yet. There is massive disruption still to come, the ramifications of which I think we're only beginning to consider," he says. "For example, hundreds of thousands of buildings across the country have simply been walked away from. As the country heats up, temperatures will rise and ventilation systems will have been shut off. Air ducts everywhere will have been left for weeks in 'off' mode gathering condensation and so will inevitably create potential serious health hazards. We simply have no idea at this stage what condition, from a hygiene and safety perspective, these buildings will be in when people return. So, how do we restart the engine without us walking into another major health disaster?"

Kevin says specialists in ergonomics and human factors will have crucial roles in the future. He cites just one example, that of protective face masks for healthcare workers. Despite global debate, there is no standardised policy; which ones have worked and which have failed will be a major future issue. They will, he says, need to be redesigned.

"Ergonomics and human factors specialists will have an absolutely central role to play in designing the equipment of the future for our healthcare workers to make sure they have the very best of kit," he adds. What we can learn now for the future is what is critically important. We have to be integrating all our collective skills, and specialists in human factors are absolutely central to this, to be designing the policies, processes and equipment of the future, if we are to prevent this from ever happening again."

The CIEHF is collaborating with other professional bodies to create a podcast series to help increase wellbeing and safety during the pandemic. Please listen and share at https://bit.ly/ciehfpodcast1.

Article compiled by **David Cameron**, Chairman of Connect Communications.

With shockingly high numbers of preventable deaths occurring through poor design of medical devices, regulations will soon come into force to ensure that usability is a key requirement and the potential for foreseeable error is designed out, as **Chris Ramsden** explains

Designing safer medical devices

In the USA, medical error is the third greatest cause of death after heart disease and cancer, according to patient safety research published in the *British Medical Journal* in 2016. This accounts for more than a quarter of a million deaths and the category includes everything from healthcare individuals' poor practice to more systemic issues such as communication breakdowns when patients are transferred from one department to another. Many issues are also caused by medical devices.

There are three general classes of medical device, ranging from low risk, simple items such as tongue depressors to high risk, complex products like heart valves. To give an indication of the scope of what's considered to be a medical device, the official definition is as follows:

"Any instrument, apparatus, appliance, software, implant, reagent, material or other article intended to be used for any of the following medical purposes:

- Diagnosis, prevention, monitoring, treatment or alleviation of disease, disability or injury, where prevention of disability and injury is excluded.
- Investigation, replacement or modification of an anatomical, physiological or pathological process.
- Providing data via in vitro examination of samples derived from a human body.
- Products intended for cleaning, disinfection and sterilisation of medical devices.
- Devices for the control and support of conception, even if they achieve their intended purpose by pharmacological, immunological or metabolic means."

The date when new EU Medical Devices Regulations (MDR 2017/745/EU) were to come into force was 26 May 2020 but in light of the current Covid-19 pandemic and lobbying from trade bodies, the European Commission has just confirmed that it's working on a proposal to postpone this date.

CE marking is a certification mark that indicates conformity with health, safety and environmental protection standards for products sold within the European Economic Area. Whether

or not a product or system meets applicable requirements for CE marking is determined by an independent certification organisation, known as a Notified Body. To sell CE marked medical products in the EU, manufacturers must comply with these new regulations.

The new MDR replaces the existing Medical Devices Directive (MDD 93/42/EEC) and is a much more all-embracing standard, bringing within its remit many items of equipment that have previously not been considered as medical devices. It also reclassifies devices that have been the subject of concern in the past, notably breast implants and artificial joints.

One significant change within the new MDR is that, for the first time, the ultimate legal responsibility for the safety of a product is now equally shared between the manufacturer and the certifying Notified Body. As you can imagine, this has not been popular with Notified Bodies and has resulted in many of them pulling out of the medical sector completely. Across Europe, under the current MDD, there were up to 82 Notified Bodies but now there are only nine for the whole of Europe and only one in the UK, namely the British Standards Institution (BSI). One body, TÜV SÜD in Germany, has dropped 20 UK manufacturers. Imagine the time delay this bottleneck causes for industry trying to get a new medical product onto the market.

IMAGE: GETTY

Stefan Kluge, Director of the Clinic for Intensive Care Medicine at the University Hospital Eppendorf gives explanations about the functionning of a ventilator

As professional ergonomists, we have the core skills to be able to support the medical devices industry

After May 26th, manufacturers will only be allowed to sell their existing MDD CE marked products in the EU for four years, after which they must be recertified to the new MDR standards. Many manufacturers are responding to this by removing products from their catalogues as they realise that they will never be able to meet these timescales, as there are not enough Notified Bodies or usability experts available to help them.

For many companies in the UK, the scale of impact of the MDR is only just being recognised, despite being three years after it was first implemented, eight years after it was proposed by the European Commission and 12 years after its first public consultation.

This presents an opportunity for ergonomists. How? There are many positive improvements within the new MDR, and key amongst these is the greater emphasis on usability and ergonomics and the primary need to design out use error. All classes of medical devices, not just high-risk implantable devices, are required to demonstrate compliance to usability standards and to demonstrate that manufacturers have a post market surveillance scheme in place to record and action user feedback. Supporting the ergonomics considerations is a specific ISO standard, ISO 62366 Application of usability engineering to medical devices.

This situation will repeat in 2022 when a new In Vitro Diagnostic Regulation (IVDR) comes into force. The IVDR is the regulatory basis for making available and putting into service in vitro diagnostic medical devices on the European market.

It was June 1998 when the word 'ergonomics' appeared once, for the first time, in the Medical Devices Directive. We now have a Directive that explicitly calls for ergonomics evidence and input. The increased recognition of the importance of the discipline has been rapid but the number of ergonomists currently working within medical devices development is very small. Brexit has meant that a significant proportion of these have now moved abroad to continue working within an EU country.

However, there is a huge opportunity for all ergonomists to support UK and global medical technology industries in designing more user-friendly products and to help them comply with the requirements of the MDR and ISO 62366. It has become far more difficult to 'out tech' your competition, but to 'out usability' them offers a tremendous commercial opportunity. As professional ergonomists, we have the core skills to be able to support the industry and to protect patients. This is a great opportunity for our profession.

Chris Ramsden is a Fellow of the CIEHF, Co-lead Healthcare and Fellow of Royal Society of Medicine. He is also the current President of the Chartered Society of Designers. Contact him at Chris@ronin-uk.net.

Further reading

M Makary & M Daniel (2016) Medical error—the third leading cause of death in the US, *BMJ* 2016; 353 doi: https://doi.org/10.1136/bmj.i2139

UK Government website guidance: www.gov.uk/guidance/medical-devices-eu-regulations-for-mdr-and-ivdr

Platform painter

"Like painting the Forth Road Bridge" is a common idiom to describe a time-consuming piece of work that never seems to ever actually get completed. But for many industries, such as oil and gas, chemicals, shipping, defence and large infrastructure projects, this is the reality as the need to cover structures with protective paint and coatings remains a continuous battle between man and the elements to halt corrosion and extend the life of these critical assets.

For ageing assets in the North Sea, this battle ranges continuously, leading to significant backlogs and increasing costs. This is why the Oil & Gas Technology Centre (OGTC) in Aberdeen is working with industry partners to look at ways of increasing the efficiency of applying protective coatings and to help reduce the risk to operatives working in this area.

The non-profit research organisation, set up in 2016 with £180 million from the Aberdeen City Regional Deal, aims to help support R&D in the oil and gas industry that will maximise efficiency and safety in projects on the UK Continental Shelf, as well as help companies transition to renewable energy technologies.

Rebecca Allison, OGTC's Asset Integrity Solution Centre Manager, said: "Organisations spend a lot of money in the care and maintenance of their assets from oil rigs to wind turbines. It's a challenging business as these assets are often located in remote areas and in harsh environments, which also makes it a high-risk environment to work in. Our work with Aberdeen-based Quantum Leap Technologies (QL Tech) is to help them develop their prototype intelligent coatings robot, affectionately called RoboCoat, and to explore the contribution that autonomous systems can make to efficiency and safety in this area."

RoboCoat is an intelligent autonomous surface preparation and coating robot designed to work in complex unstructured environments, such as chemical plants or offshore platforms, and react to real-time changes in the environment. The system comprises an intelligent robotic manipulator embedded with pioneering machine learning algorithms to allow it to explore its environment and autonomously undertake fabric maintenance.

The manipulator is mounted on a tracked-base station, providing manoeuvrability around the platform, and this can be adapted to undertake a range of functions from cleaning, surface preparation (removing old rust and paint) and painting. The system also provides real-time quality control analysis – both post preparation and coating, using a suite of camera and lidar sensors. This is key to providing end users with the reassurance that the end result meets industry standards and ultimately ensuring a long-lasting coat. Industry estimates suggest that 65% of coating failures are attributed to poor surface preparation that could have been avoided with more precisely controlled preparation methods.

Ben Stuart, QL Tech's Commercial Director, said: "People are familiar with painting robots in factories, but these are not well suited to complex offshore environments. Robots can weigh up to 200kg, so our challenge is to produce a robot that's lightweight and flexible but at the same time it also needs to be very robust and adapt to changing environments. The real efficiency driver comes from the robot's autonomous capabilities; its ability to map its location within the environment on the fly, identify and plot the most efficient course and undertake real-time quality control. There are also a number of key safety features built in including collision avoidance and human detection so the robot can shut down in the event it detects someone within its reach."

While the current robot uses a tracked base station, allowing it to move on flat surfaces and up to an incline of 45 degrees, other mobile platforms are being explored to allow for vertical access to heights and to gain access into confined spaces.

Ben said: "Ultimately, efficiency comes from effective human-robot collaboration as there will be things that people do better and areas where robots can offer improved performance. We want our robots to work alongside people in this this sector. The whole community has been incredibly supportive as they have seen the benefits of adopting autonomous systems through the potential in increased efficiencies and risk reduction to operatives. At the moment, people are often put in precarious situations in dangerous environments in the North Sea and we are seeing quite a drive from the operators to reduce the level of human exposure to 'confined space entries'." ●

Before lockdown, people watch a Neolix autonomous delivery vehicle in Beijing

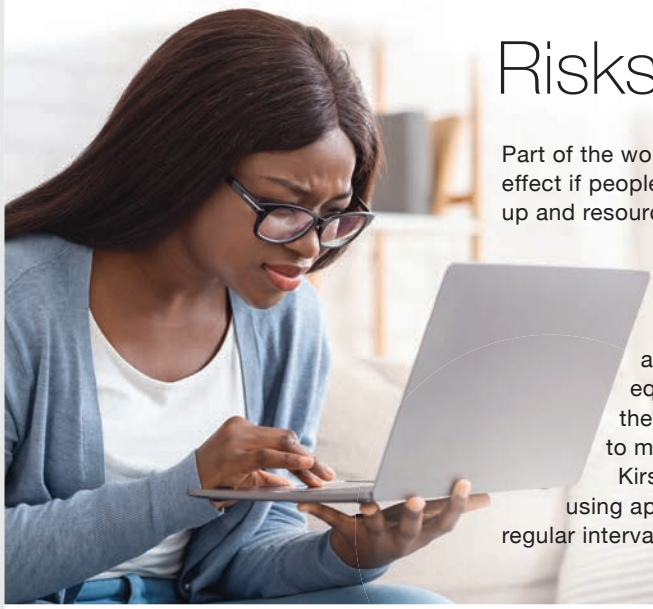
Innovation in disruption

It's likely that many things that have changed due to the restrictions surrounding the coronavirus pandemic will remain changed afterwards, because they are better, more efficient or safer than what went before. One example could be 'deliverybots'. Beijing-based company Neolix claims that orders for its driverless delivery vehicles had risen significantly because of higher demand for home delivery and because the roads were clear of cars due to the imposed lockdown allowing the vehicles to make more use of them. The company claim that demand has risen because people are seeing the possibilities for the first time and they are liking what they see.

Change is also being felt keenly in schools and universities with the sudden switch to remote teaching, and of course, in the countless families that have suddenly found themselves home schooling their children. The amount of software and resources available to assist with this is bewildering but one organisation, UNESCO, have pulled together a curated list of educational applications, platforms and resources. The aim is to "help parents, teachers, schools and school administrators facilitate student learning and provide psychosocial support during periods of school closure".

The list includes digital learning management systems, systems built for use on basic mobile phones and those with strong offline functionality, Massive Open Online Course (MOOC) Platforms and self-directed learning content. There are also lists of mobile reading applications, collaboration platforms supporting live video communication, tools for teachers to create digital learning content and finally, external repositories of distance learning solutions.

So, enforced change causes disruption but that in itself can also lead to innovation, much of which will only become evident as we move through these unprecedented times.



Risks for new home workers

Part of the world's response to the coronavirus pandemic could have a negative effect if people are encouraged to work from home without the necessary back up and resources, according to one ergonomics consultant. CIEHF member Kirsty Angerer has said: "The move to encourage more home working will test the robustness of the systems put in place by businesses, particularly as it relates to IT and people's home setups. I fear many people will start working from home and not do it in the best setup and/or have a lack of good quality equipment. It's also likely that people will move less at home as they don't have meetings to walk to, a commute to do or the chance to meet colleagues for chats."

Kirsty said that in those circumstances people may benefit from using apps that can be set to prompt you to stand and move at regular intervals.

It's estimated that over a billion people across the globe experience some form of visual impairment that's significant enough to affect their daily lives. But now, specialist technology is being used to enhance vision for those with impairments but incorporating this technology into wearable devices brings its own set of challenges, as designer **Tom Malloy** explains

Creating better vision

Low vision can have an enormous impact on an individual's ability to perform a variety of everyday tasks from driving and shopping to travel, resulting in reduced independence and quality of life. In 2010, researchers at the University of Oxford began work to gain a deeper understanding of how the brain manages visual information, and to explore ways that this capability could be amplified in the low vision community. Their work gained international recognition and, in 2016, they founded OXSIGHT with the goal of developing this technology into aids that would help visually impaired people to live more independent lives. Today, OXSIGHT produces patented 'smart glasses' that address impairment caused by conditions such as myopic degeneration, glaucoma, retinitis pigmentosa and diabetic retinopathy.

One of the products created by OXSIGHT is a powerful pair of smart glasses called *Prism* that expand a user's field of vision by up to 68 degrees. *Prism* captures live video of the real world via a small HD camera on the front of the headset, which relays to two HD displays that are then projected in front of the user's usable area of vision. Through the use of Mixed Reality, *Prism* can display in a variety of modes to help the user in various scenarios, for example, to enable them to pick out specific details such as faces, to make writing more legible, or to highlight approaching objects and obstacles.

OXSIGHT challenged Oxford Product Design (OPD) to incorporate their technology into a wearable device that would be both stylish and comfortable enough for the user to wear for extended periods. The team at OPD has extensive expertise in applied ergonomics and human factors engineering, ensuring the design process results in products that are safe, efficient and create an enjoyable experience for the user. Consideration of factors including weight, size, position and fit are key to the design of any wearable device. Aesthetics are also critical, particularly with devices to be worn on the head; users are quickly turned off by a product that makes them feel like a 'cyborg'.

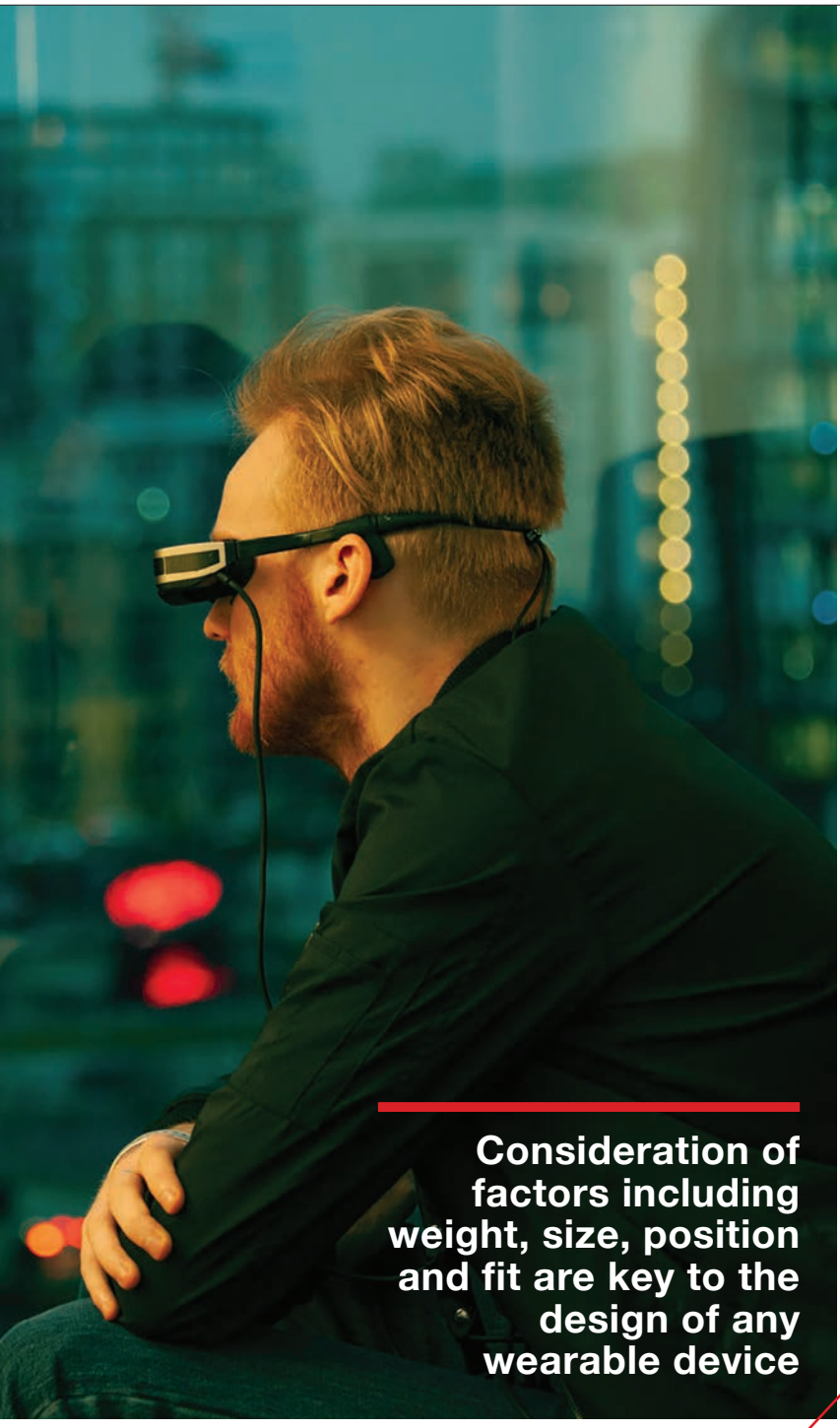
Initial testing proved that while a lightweight headset was important to users, the quality of the received image was even more so. As a result, it was established that one of the most integral parts of the device would be an occluder – a component which surrounds the user's eyes to ensure that no light or visual stimulus enters the headset from outside so as to enhance contrast and quality of the received image. Because of its placement, the occluder would also support the weight of the headset against the user's nose.

As anyone in the field of human factors engineering will appreciate, creating components that fit tightly to the face requires a great deal of input data and testing to validate. Human heads have some of the largest variation in contour and shape of any part of the body, from fullness of cheeks to length and width of nose, to the depth of eye sockets, and every factor varies independently from the others. *Prism* was created for the European market in the first instance but needed to be easily adaptable for other markets in the future.

With this in mind, the team at OPD employed anthropometric data that captured a range of multi-ethnic head sizes across genders from fifth to the ninety-fifth percentile adults. As a result, the occluder's seal will fit a large proportion of the target market and its design is such that it can be easily and cost effectively adapted to suit specific markets.

Occluding light in headset design is most often achieved through the use of thick foam which compresses against the face, but this can very quickly become hot and uncomfortable for the wearer. The OPD team applied knowledge from

Headset in use and OXSIGHT Prism components, pictured right



Consideration of factors including weight, size, position and fit are key to the design of any wearable device

their previous work with respiratory face masks, opting to build the occluder from a soft touch, biocompatible rubber designed for low force but high interference against the face on contact. The seal was designed to roll and flare away from the face, resulting in a consistent path thickness around the face which evens out pressure and reduces the overall contact area, ultimately making the device cooler and more comfortable when worn for prolonged periods.

Multiple prototypes of the occluder were created to ensure that the seal would roll evenly and dynamically across a range of face types. A variety of techniques were employed in the prototyping process, from Objet 3D printing for rapid design iteration to vacuum-casting the stable design in polyurethane when a more realistic elastomer was required. Prototypes were tested on a wide range of real-world users during user trials, and feedback was incorporated back into the design to ensure that size and shape of the contact area were optimised for comfort.

The product's original arm design did not account for the level of force that the occluder was applying and, through initial user testing, it became clear that the force pressing the device to the user's face was in some cases pushing the headset up and away from their head. Many Virtual/Augmented Reality headsets solve this issue with a ratchet wheel (often seen on bicycle helmets) which holds the device on to the head securely. This can make the headset cumbersome to put on, requiring two hands and easily catching on hair. It also increases the visual weight of the headset, creating the dreaded cyborg look. Another advantage of the rolled occluder design utilised by OPD is its relatively low compression force which allows *Prism* to achieve stability with a lighter weight solution.

The team investigated and tested a variety of solutions to secure the headset to the user's head. The final design features hooks that rest behind the ear, maintaining the familiar glasses design and reducing the visual weight of the product. The ear hooks add stability and are easily adjustable, enabling the user to tune the occluder against the face to the required tightness. A thin membrane was also added to improve the comfort of the component, enabling it to mould to the shape of the user's ear.

By integrating human factors engineering throughout the design process, OPD was able to design a truly adaptable and usable product, resulting in an effortless and enjoyable experience for the user which in turn increases adoption with the intended product market. ●

Tom Malloy is a Senior Consultant at Oxford Product Design. Oxford Product Design is a full-service, multi-award-winning product design consultancy, committed to delivering innovative, commercially successful products across industries. Find out more about the team's expertise and process at opd.uk.com. Find out more about OXSIGHT at www.oxsight.co.uk.

The railway is an example of a complex system that has benefited hugely, not least in its safety record, from the widescale integration of human factors into its development, operations and investigations. **Mark Young** and **Claire Dickinson** explain how this came about

Staying on track

Aviemore
Track section

IMAGE: NETWORK RAIL

At about quarter past one in the afternoon of 19 September 1997, an inter-city train heading for London Paddington passed a red signal at Southall, West London. The signal was red because a freight train was crossing the path of the inter-city at a junction ahead of it. The inter-city crashed into the freight train at a relative speed of 80mph. Seven people died in the accident and many more were injured.

Just over two years later, during rush hour on the morning of 5 October 1999, a Thames Trains commuter service passed a red signal on its way out of London Paddington station. It collided head-on with an incoming inter-city train at a combined speed of 130 mph. Thirty-one people lost their lives, including both train drivers, and more than 400 others were injured.

The public inquiries into the Southall and Ladbroke Grove accidents were led by Professor John Uff and the Rt Hon Lord Cullen respectively, and together they conducted a joint inquiry into train protection systems. As well as having major ramifications for the UK rail industry, these inquiries laid the foundations for a significant upturn in rail human factors.

There had been human factors research in the rail sector before the tragedies at Southall and Ladbroke Grove – work by Paul Branton into train seating and the skills of train driving can be traced back to the 1960s and 70s – but it was the events around the turn of the century that provided the catalyst for the human factors presence in the industry that we benefit from today. Recommendation 1 of the Southall report captured the requirement: "All parties in the rail industry should co-operate in the collection of evidence to support reliable research into human behaviour studies relating to driver performance." (paragraph 17.5)

Lord Cullen reinforced this in the Ladbroke Grove report, stating: "...if and to the extent that the safe operation of a train is dependent on one person, it is essential that the demands which the railway system makes on him or her take adequate account of human factors." (paragraph 7.129)

In response, Railtrack (the infrastructure controller at the time) appointed human factors experts to address these issues.

The Cullen report covered a wide range of human factors issues, from driver performance through training to culture and even the investigation of human factors. But the key contribution for human factors was Annex 7 of the joint inquiry report which presented an agreed statement on human factors from five experts who took part in the inquiry. This statement set out a consensus for future development in areas including:

- **Equipment design:** to incorporate human factors thinking early in the design process, to involve future users of the equipment in the design process, and to include operators' perspectives in the evaluation of automatic protection systems.
- **Warning devices:** to consider the clarity of warnings and what they are signifying, particularly where there are multiple warning modes or systems overlaid on each other, and the problem of over-dependence on warning devices.
- **Training and assessment:** to be strengthened by the use of interactive, computer-based instruction and exploiting simulated environments to practise dealing with those abnormal or →

CASE STUDY

Understanding workload

It's important to understand whether people are subject to high workload, potentially leading to overload and poor decision-making, or are subject to low workload where they may become distracted, demotivated or lose situation awareness.

Workload evaluation methods have been used consistently for resignalling and recontrol projects across the GB rail industry since 2007.

However, as the complexity of the railway increases, so too must the sophistication and effectiveness of the workload tools. Techniques originally designed to predict task demand following the migration of signal boxes into computer-based control rooms, are now being stress-tested by the age of AI-based automation, digital train control systems, and the need for safer track worker access on the 24/7 rail network.

Responding to the ever-evolving needs of the railway is a key part of the work of Network Rail's Ergonomics team. As such, the team is developing new workload tools to ensure that human-centred improvements to railway safety and performance can be delivered.

Mike Carey, Head of Ergonomics at Network Rail, said: "We're developing novel approaches to extend and update workload tools by integrating large-scale feedback from end users, cognitive task analysis and control system data."

Aberdeen Inverness double-tracking works

emergency situations that are otherwise rarely encountered.

- **Alertness and fatigue:** to apply good practice guidelines on shiftwork and rest breaks more widely within the rail industry.
- **Human factors integration:** a wide call for human factors in risk assessments, safety cases, incident investigations, training (of safety-critical staff and their managers), research and an increase of human factors expertise in the rail sector.

Annex 7 inspired the uptake of human factors and a subsequent surge of activity in the rail industry. In 2003, an industry advisory committee was formed including representation from the Ergonomics Society (the forerunner of the CIEHF) and set out a strategy for promoting the consistent and coordinated use of human factors best practice, based on the Annex 7 report.

The early 2000s saw the formation of the Rail Safety and Standards Board (RSSB) and the Rail Accident Investigation Branch (RAIB) – both as a direct result of Lord Cullen's inquiry into the Ladbroke Grove accident. In the next few years there was substantial growth in the human factors teams at RSSB, Network Rail, London Underground and the regulatory body, now the Office of Rail and Road (ORR). In 2012 the RAIB became the first of the UK's accident investigation branches to employ a human factors inspector. The influence of human factors even extended to Europe, with the establishment of a human factors network within the European Union Agency for Railways.

While the Southall and Ladbroke Grove accidents focused on factors associated with the train driver, human factors work since has also turned to signallers, level crossings and wider human factors areas such as fatigue management, safety management systems, and organisational factors and culture. In recent years, human factors input to the design of new London Underground and inter-city trains has been recognised with awards by, respectively, the CIEHF and the Human Factors and Ergonomics Society.

Nevertheless, there is much work still to be done, with current challenges including issues at the platform-train interface, crowding and the evolution of the digital railway. But human factors is now on a strong footing within the UK rail industry and we can be confident that it will have more impact in the years to come.

Dr Mark Young is an Inspector of Railway Accidents at the Rail Accident Investigation Branch.

Dr Claire Dickinson is a former Principal HM Inspector of Railways at the Office of Rail and Road. The case studies were provided by **Richard Bye**, Principal Ergonomics Specialist at Network Rail.

Further reading

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CIEHF award: www.ergonomicsdesignaward.org.uk/portfolio-item/tube-train/

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CASE STUDY

Enabling high performance

Although often perceived as simple software solutions, apps have the capacity to provide advanced capabilities and rich functionality. The potential offered by the deployment of mobile devices to frontline railway workers is virtually limitless.

Network Rail's Ergonomics team worked on an innovative software development programme designing apps for reporting, guidance, data capture, maps, standards and location services, and creating design principles, guidelines and processes to lay down the foundation for future work.

The development of these first mobile applications for Network Rail allowed the Ergonomics team to understand what makes a successful app for railway maintenance and engineering.

Designing apps for use at night, in the rain, with gloves on, alongside other equipment, and in areas with poor data connectivity, requires levels of human factors understanding and insight that would be hard to achieve for those without in-depth knowledge of trackside working.

The apps have been a success, enabling frontline staff to have data at their fingertips and to update and process information faster and easier than ever before. As technology advances, ergonomics work continues to help develop and inform future iterations of mobile apps for Network Rail.

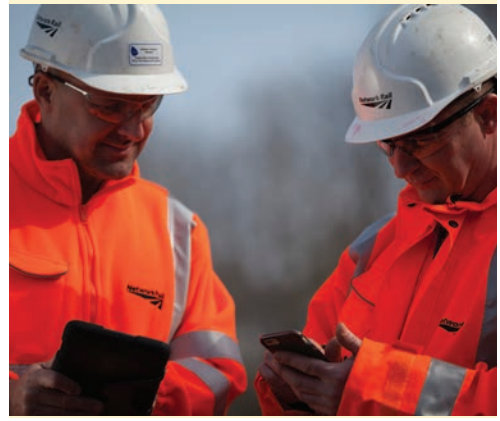

IMAGE: NETWORK RAIL

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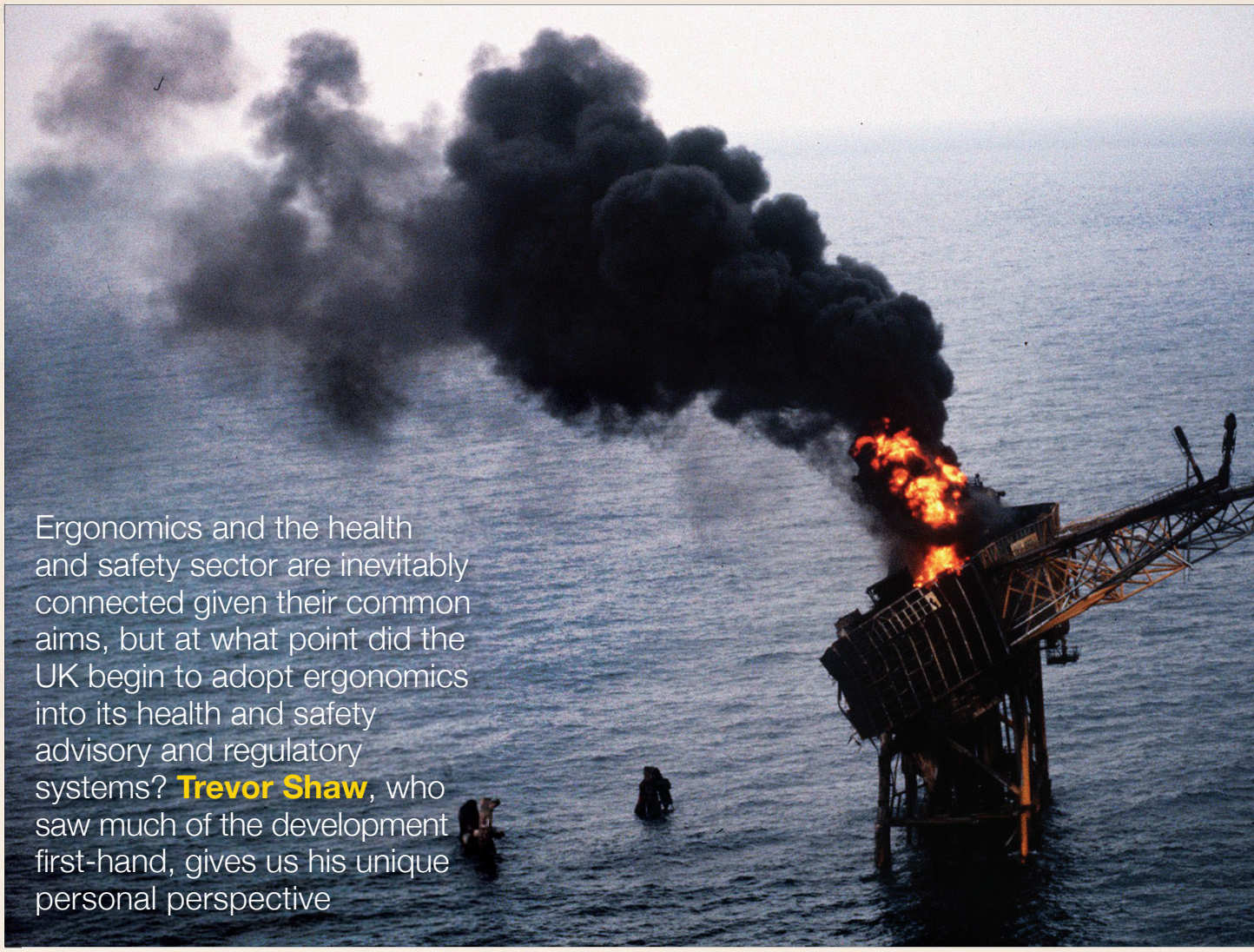


Ergonomics and the health and safety sector are inevitably connected given their common aims, but at what point did the UK begin to adopt ergonomics into its health and safety advisory and regulatory systems? **Trevor Shaw**, who saw much of the development first-hand, gives us his unique personal perspective

Health, safety and ergonomics

A view of the burning Piper Alpha oil rig 100 miles off the coast of North East Scotland after a massive explosion

IMAGE: ALAMY / GETTY

A Photo on display at the Ukrainian National Chernobyl Museum

Ergonomics has a number of origins, including the UK Industrial Fatigue Research Board's work in the early part of the 20th century. There are some parallels in the development of ergonomics and the UK's health and safety system.

UK health and safety has its origins in the early 19th century with the establishment of the Factories Inspectorate in 1833. However, the modern UK system and framework was established with the 1974 Health & Safety at Work etc Act. This has been further built-on and revised by subsequent legislation, notably the so-called 'six-pack' of the 1990s, which itself was derived from EEC (EU) Directives.

Several events occurred in the late 1970s and 1980s which prompted HSE and others to take note of the relevance of ergonomics to health and safety at work. These included manual handling injuries in the construction industry (the industry where I discovered the first recorded mention of ergonomics at HSE), human error in the process industries (sparked, for example, by Chernobyl in 1986 and Piper Alpha in 1988), and the spread of computers and computer-based work.

As a result of a working group discussion, I believe in about 1978, it was agreed that the research arm of HSE should recruit some ergonomics expertise to work on the manual handling problem. The research arm was then called the Research and Laboratory Services Division (RLSD), which, in 1995, became an agency of HSE called the Health & Safety Laboratory (HSL), and now, since 2015, reintegrated as HSE's science division. It resulted in HSE gaining one of their first ergonomists, Mike Gray, at RLSD. This eventually led to HSE driving the agenda in Europe for what was to become the Manual Handling Directive (1990/269/EEC) and the Manual Handling Regulations (1992).

Interestingly, in 1979 HSE had also recruited a psychologist/ergonomist to look at stress, Dr Colin Mackay, but who was diverted for some years into looking at the issues relating to work with computer screens, or Visual Display Units as they were then known. The UK, Sweden and Germany appear to have led the agenda on this topic, which eventually produced the Display Screen Equipment (DSE) Directive (1990/270/EEC) and the Health & Safety (DSE) Regulations (1992). The work leading especially from the DSE and Manual Handling Regulations led to the recruitment of additional ergonomists and psychologists in both HSE's core science division and RLSD/HSL.

In March 1987, following the 1986 Chernobyl disaster, the HSE Group on Major Risks discussed the issues and identified human factors as relevant. This led to the formation of an internal Working Group on Human Factors, which included Dr Mackay and David Whitfield, who was then with the Nuclear Installations Inspectorate. The pre-meeting brief put a large emphasis on psychometric testing but this was altered at the meeting with a greater emphasis put on human error.

It appears that the origins of HSE's tri-partite definition of human factors (the individual, the job and the organisation) came from this meeting since there was reference to ergonomics (the 'man/machine interface'), the individual (their characteristics in terms of selection, screening and training) and the management system. A particular need to understand the man/management system interface was expressed but it was suggested that an approach that incorporated all elements would need to be found.

Another major accident, the Piper Alpha explosion in 1988, led to the establishment in 1991 of HSE's Offshore Division for offshore installations, as a result of the Cullen inquiry. Technical support on human factors was provided more or less from the start.

Clearly, by the late 1980s HSE recognised the importance of ergonomics/human factors to its regulatory work and had some technical support within its nuclear and offshore divisions, but its largest field group, the Field Operations Division (FOD), which then included onshore major hazards, did not.

In the late 1980s HSE created the Human Factors Unit. This had its origins in the work of Dr Mackay and was established with an occupational physician and former member of the Employment Medical Advisory Service (EMAS) as head, Dr Ron McCaig. It started with three members of staff but as demand for ergonomics expertise increased it employed as many as 13 staff at one point including some →

In the 1990s interest in ergonomics grew and demand outstripped supply

At its peak the work of the Human Factors Unit covered practically the whole gamut of ergonomics and it provided support internally

Offshore windfarm workers on jetty at sea

on temporary contracts. In total, over 25 ergonomists/psychologists passed through this unit between 1989 and 2004. At the time I joined HSE in 1995, the unit employed six ergonomists/psychologists and was concerned with a range of topics including manual handling, back injury and other musculoskeletal disorders, work with computers, stress, working hours, organisational factors and human error.

In the 1990s interest in ergonomics grew and demand from policy and operations outstripped supply. Various parties in HSE saw the new rising star of ergonomics as attractive. Staff within EMAS were particularly quick to see the potential, no doubt since preventing conditions such as back injury and upper limb disorders linked to their medical remit. HSE encouraged this as a way of filling the void in internal expertise (there were constraints on recruitment) and adopted the notion of ergonomics portfolio holders, that is, other specialists who were given an intensive short training course and then acted as a first point of contact for other field inspectors. This was organised and co-ordinated by the Human Factors Unit in the 1990s. At the same time HSL was also recruiting ergonomists and psychologists to help meet the demand.

At its peak the work of the Human Factors Unit covered practically the whole gamut of ergonomics and it provided support internally to policy, field inspectors and other specialists, as well as commissioning research and communicating to the outside world on relevant topics. However, it was disbanded through re-organisation in November 2004 when HSE decided it needed to focus more of its own specialist staff (non-HSL) in direct support of front-line enforcement activities. Some staff from the unit went on to establish human factors teams in operational divisions including the onshore major hazards division (CHID) in 1999, and later, the Railways Inspectorate in about 2002 and Field Operations Division in 2004. In 2003, in an attempt to pull all the separate strands together, HSE established a Corporate Topic Group in Human Factors, which I led, with the remit of co-ordinating ergonomics across HSE. In 2005 the argument for additional specialist inspectors in ergonomics led to a corporate HSE initiative to retrain ten existing, experienced field inspectors in the topic.

Up until the financial crisis of 2008, ergonomics in HSE was thriving. At its peak it employed around 35 staff with ergonomics/psychology roles within HSE and a further 40 or so at HSL. It had also published guidance on a range of ergonomics issues and been involved in writing relevant British, European and International Standards. The impact of the crisis led to decisions to slim down the public sector and from around 2011 the numbers of permanent ergonomics staff in HSE reduced; some moved outside into industry or HSL, others took voluntary redundancy or retired. As far as I'm aware, the majority of ergonomics staff are now located in what was HSL, although a number remain as specialist inspectors directly employed in operational activities.

I believe that ergonomics had little impact on UK health and safety in general until the 'six pack' Directives were published by the EEC and then implemented into UK legislation in the early-mid 1990s. The inclusion of the term 'ergonomics' in the guidance had a positive impact in raising the profile of ergonomics both within HSE and in the wider population. I would argue that because of the emergence and growth in the use of personal computers, the 1992 DSE Regulations in particular sent ripples out regarding ergonomics and led to the term being used (sometimes inappropriately) in relation to both workplace equipment and consumer products.

During my time in HSE it never quite succeeded in taking a unified approach on ergonomics within the organisation. However, for at least two decades HSE did play a significant role in disseminating ergonomics knowledge and practice through its publications and the efforts of staff in educating and raising awareness within employer organisations as well as in recruiting and training ergonomists. For me, the ideal remains for ergonomics knowledge and thinking to be integrated widely into all aspects of work.

Trevor Shaw notes that this article is a partial history of this topic. His interest in health and safety began in the 1980s when he was involved with the maintenance of machinery and he first came across ergonomics while studying engineering in the mid-1970s. He joined the HSE in 1995 primarily as a psychologist where he remained until he took voluntary redundancy in 2011.

IMAGE: ALAMY

A new normal

Five days after the UK Government responded to the coronavirus pandemic by instructing residents to stay at home, Principal Ergonomics Specialist, **Richard Bye**, discusses the issues facing the Network Rail Ergonomics team at the beginning of their uncharted journey

As ergonomists working in the rail sector, we're used to managing others through periods of flux and change. However, these are extraordinary times; times in which we're now having to mitigate the sudden and unexpected transformation of our own working conditions in order to provide optimum levels of service.

The railway can't stop because of Covid-19. Key workers need to be able to get to work and back home again, and freight trains carrying vital supplies need to traverse the network. It follows therefore, that, just as the railway can't shut down during this time of global crisis, nor can the work that keeps it going.

Business (not) as usual

Ergonomics and human factors are an integral part of everyday rail operations and maintenance activities, but right now, along with great swathes of the population, the Network Rail Ergonomics team are all confined to working from home. Ironically, this change in circumstance means that the issues usually at the forefront of our day jobs – people, process and technology – now form the basis of the challenges we must overcome as individuals before we can undertake even the simplest of tasks.

As human factors specialists, as a team, and as one very small cog in the gears of the GB critical national infrastructure, we must now assess whole new dimensions of risks, assumptions, issues, dependencies and opportunities. These challenges are forcing us, in tandem, to shine a spotlight on our own working practices and methods. As a team we design for human needs, capabilities and constraints, work which requires an in-depth evaluation of our subjects' tasks, equipment and environments. But with the team's workplaces morphing from Network Rail's large corporate offices to desks in spare rooms (for the lucky ones) or to a kitchen table or the corner of a sofa, we've had to turn this analysis inwards.

In addition, we're having to address the ingredients of our normal healthy work practices (communication and information flows, routines, and comfortable and distraction-free spaces). Our new reality is that much of what we know has been thrown into chaos. However, importantly, the team's efforts have not been and nor will they be. Although there will be numerous obstacles to navigate, we're confident that we'll be guided through these uncertain times by the principles and governance that anchor Network Rail's ergonomics work. Indeed, if nothing else, the prevailing degraded conditions have underlined the importance of our standards, processes and requirements as they underpin everything we do, holding constant why we exist and what we deliver.

Crucially, it's these standards and requirements, combined with the team's rail experience, that will provide the knowledge and latitude needed to flex approaches in response to the current socio-political climate. This is where rigour must meet pragmatism, and where a strong centralised ergonomics function is essential for the collaboration, coordination and control required to respond to the dynamic pressures facing the railway, as we attempt to maintain business (not) as usual.

IMAGE: GETTY

IN THE FIRST WEEK…

In the first week of the official lockdown, the rail industry delivered a new timetable (normally a 14-week process) and moved 370,000 tonnes of freight (20% more than usual) to power stations, hospitals, petrol stations and supermarkets.

Network Rail has cancelled rents due from retail tenants whilst volunteer rail teams have turned station units into outpatient clinics and have used company vehicles to drive masks to NHS workers.

Down the line

Over the coming weeks we'll be re-prioritising and de-risking our work to meet all emerging needs and restrictions. Solving difficult multidisciplinary problems to improve safety and productivity across the rail network is our raison d'être, so in these unprecedented times we're uniquely placed to make significant and meaningful contributions. From constraints come innovations, and it's to this end that we'll channel our resources and creativity to reduce opportunity cost and bring about lasting strategic improvements that will deliver benefits down the line.

Over the next few issues, we'll be following the Network Rail Ergonomics team's journey as they react and adapt to the Covid-19 situation and help to ensure the continued safe running of the GB rail network.

Richard Bye is a Principal Ergonomics Specialist at Network Rail.

BOOK REVIEW

Error detection

How often, after the event, do we suddenly remember something we should have done? Darren Doyle, a Chartered human factors engineer with a background in cognitive psychology, talks us through insights into how latent error detection acts as a system safety control that helps recollection of past errors through environmental cues.

Engineer analysing engine parts

Having worked in air safety it's refreshing and reassuring to read a body of work that addresses maintainers, who can sometimes be neglected compared to aircrew. Saward and Stanton's *Individual Latent Error Detection (I-LED): Making Systems Safer* introduces a phenomenon we have likely all experienced and begins to provide a theoretical explanation, early research and helpful materials practitioners and researchers can use to investigate in their own settings.

I-LED describes the moments we're reminded that somewhere, somehow, we didn't do what we were supposed to. In the maintenance context of the book, I-LED describes the instances where a maintainer realises they have committed an unintended lapse. Importantly, often these realisations come after we see, hear or perhaps smell something sometime after which brings it into focus. Having recently become a father for the second time this resonates with me on a personal level. Recently, I unstrapped the baby out of the car seat, brought him to his mother, walked back into the hall to see the empty car seat, and remembered that there was still a toddler in the car, and rushed to retrieve her before her mother noticed that I forgot we have two children.

The book quickly directs the reader to the sections that are most relevant to their calling, be that academic, practitioner or a safety role. I would recommend that every reader familiarises themselves with the theoretical elements in chapter two in order to understand the proposed mechanics of I-LED. The theoretical aspects will be familiar to those with a cognitive psychology background, but for those without, the concepts here are not only useful for thinking about how I-LED might work in a particular setting, but are key cognitive theories which may assist the reader in other elements of their work. Similarly, towards the end of the book there is something of an overview of human factors in system safety, which would be helpful to a human factors practitioner new to safety by briefly demonstrating some key concepts, such as organisational resilience and competence, in context. I'll admit that I found both the theoretical and safety sections useful revision.

Early on, the authors present real-world evidence of I-LED occurring from the Ministry of Defence's Defence Air Safety Occurrence Reports. Unfortunately, the number of reported instances is on the light side at three out of over 30,000 reports. That the authors decided to continue to research I-LED I think shows their conviction to its existence based on experience over evidence, which I agree with as an approach. Fortunately, their research quickly confirmed it, with the first study showing that of a sample of 48 maintainers, only one had never knowingly experienced an I-LED.

The book runs through a number of studies that were carried out, demonstrating the existence of I-LEDs, when and where they happen, as well as the impact of a number of interventions designed to artificially promote I-LEDs occurring in a representative setting. These studies do provide support for the existence and the possible application of I-LED interventions in system safety but some of this is lost in the presentation. For one, the book is laid out as a series of experiments as you would expect from a postgraduate thesis rather than a book and, while this is common in technical literature, it does make it difficult to read in places. This is especially true of later chapters where some of the writing is repeating, or at least ramming home, earlier chapters. A format where different aspects of I-LED were presented, with support from each of the studies, may have made the book more accessible. The writing also assumes

I-LED describes the moments we're reminded that somewhere, somehow, we didn't do what we were supposed to

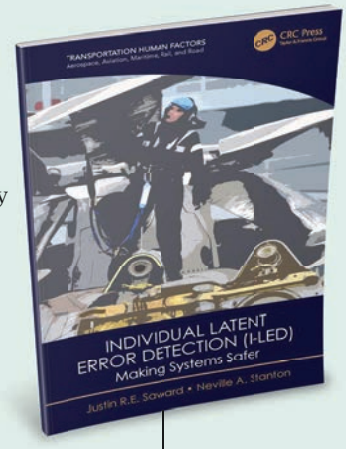
slightly more than a base level understanding of the domains, which may hinder a reader unfamiliar with either military or maintenance terms. A list of abbreviations is provided which does help but a glossary of the domain specific terms would be particularly useful.

Having said that, careful reading of the results of each study draws out some interesting points and I suspect that each reader will have a different take home message. I particularly found interesting that a number of the I-LEDS took place outside of work which suggests that maintenance workers don't 'switch off' at the end of the day, raising questions around welfare and appropriate rest for a safety-critical role. Also, the finding that a number of I-LED interventions actually increase the number of errors detected suggests novel methods of recovering from human error in maintenance. The primary intervention, called "Stop, Look and Listen", appears to be simple to implement and will be of interest to those looking to improve maintenance procedures.

It is, perhaps, too early for I-LED interventions to be used as a formal safety control though, as the authors suggest, given the lack of evidence outside of the book. Including a mechanism that relies on cues which may or may not appear as part of a safety strategy might not appeal to a duty risk holder. However, that's not to say there is no value in including them in processes, just that they may not yet be appropriate for a safety argument. In my opinion, the interventions could be of interest to system designers and it would certainly be interesting to see how reminders could be designed into systems, both physical and process, to reduce common routine maintenance errors.

The appendices provide the necessary materials (questionnaires and data to compare against) to repeat the studies mentioned, or as resources to otherwise investigate I-LEDs suitable to the reader's needs. This is particularly appreciated given the issues around replicability currently being experienced by a number of scientific fields, and I'd be very interested to see the results of replication studies that investigated I-LEDs in other areas.

The book was a useful and interesting read, covering an area that I haven't seen discussed before. It's a body of research that I hope is expanded upon and is worth keeping an eye on for anyone working in safety. I can see the I-LED concept being applied in other safety-critical industries, but also other areas such as cyber security, manufacturing and indeed many others - unloading children out of a car for example. Perhaps to avoid my eldest having abandonment issues down the line, I should put a family portrait next to my front door!



Aircraft in hangar for maintenance service check by technician, before flight.

Darren Doyle is a Senior Human Factors Consultant at QinetiQ, in the Human Performance Group. He has a BSc in Applied Psychology from Durham University and specialises in human factors in safety-critical systems, as well as the human component of cyber security.

Further reading

Justin R E Saward & Neville A Stanton, 2019, *Individual Latent Error Detection (I-LED): Making Systems Safer*, CRC Press
ISBN: 113848279X

JOURNAL EXTRACTS

Featuring research published in high impact ergonomics journals

Fast fonts

1 Typefaces can make all the difference to the effectiveness of communication but is it a case of personal preference or is there more to it? An experiment conducted by American researchers comparing the differences in legibility between eight popular sans-serif typefaces shows typography to be more than a matter of taste, especially in safety critical contexts like in-vehicle interfaces.

The work provides actionable information to guide design decisions, particularly for the fast-paced mobile world in which information is increasingly consumed in a few short looks. Currently, there is no accepted scientific method for comparing font legibility under time pressure. People often 'glance' at interfaces like smartphone notifications. A 'bake-off' method was used in this study to demonstrate 'at-a-glance' legibility.

Elegant, intuitive interfaces that communicate clearly and quickly have become the gold standard in attracting customer attention and building market share. At the same time, users live in a world of glances, where screens of information constantly vie for a moment of attention. Information hungry users inevitably gravitate to this feed during critical but interruptible tasks. Driving, walking, socialising, all presently compete with glanceable interfaces. Failures in these tasks involve consequences ranging from the inconvenient to the fatal.

The human tendency to multitask makes it imperative that digital information be delivered efficiently; every moment spent focused away from important situational information makes failure at a task more likely. Typographic choices can have a pay out or a cost and so digital text plays a crucial role in the contest for our limited attention.

Researchers concluded that typefaces with more open shapes and contours, such as Frutiger, FF Meta and FF Speak, outperformed typefaces with more closed ones such as Gill Sans, Eurostile and DIN.

B D Sawyer, J Dobres, N Chahine & B Reimer (2020): The Great Typography Bake-Off: Comparing Legibility at-a-glance, Ergonomics, *DOI: 10.1080/00140139.2020.1714748*

Virtual seafarers

2 The role of people in areas of great technological advancement is a key area of interest to human factors professionals. In cases where people are removed completely from the process, like driverless vehicles, many questions are raised. Norwegian researchers have published a paper in which they study the perceived impact of autonomous shipping.

Ten Subject-Matter Experts working within industry and academia were interviewed to find out their perspectives on the current state and future implications of autonomous technologies. Four main themes emerged: Trust, Awareness and Understanding, Control and Training, and Organisation of Work. A fuzzier fifth theme also appeared in the data analysis, that of Practical Implementation Considerations, which encompassed various sub-topics related to real-world implementation of autonomous ships.

As autonomous shipping rapidly moves closer to real-world implementation, researchers believe it's critical to develop an understanding of the future roles of people in autonomous maritime operations. This study found that future maritime operators are finding themselves in progressively supervisory roles meaning that traditional seafaring skills may become obsolete.

The profile and skillset a future ship operator may need ranges from a traditional seafaring education, certification and at-sea experience, to non-seafarers who have a computer science background with coding skills, to video game enthusiasts comfortable with command and control of virtual agents and virtual worlds. Future maritime operators may never go to sea themselves but instead, they may receive training on ship operations remotely through simulator exercises or shoreside centres.

The introduction of autonomous shipping in reality requires amendments of many international treaties which means a departure from well-established regulatory frameworks. This presents significant

regulatory barriers to the practical implementation of autonomous shipping as well as the human element.

Researchers found that issues relating to system trust, understanding and predictability of decision-making, as well as the skills required to develop, operate and maintain such technologies will become increasingly relevant to the successful and sustainable functioning of highly automated and autonomous maritime systems. As autonomous technologies continue to rapidly advance, it's critical to develop a better understanding of how and where humans fit into operations in ever evolving complex safety-critical systems. ●

S C Mallam, S Nazir & A Sharma (2020) The human element in future Maritime Operations – perceived impact of autonomous shipping, Ergonomics*, 63:3, 334-345, DOI: 10.1080/00140139.2019.1659995*

Tools for global issues

3 The climate emergency is a pressing political issue the world over, but could human factors professionals contribute to the solution? Researchers from South Africa and the UK looked at the complex systems around sustainability, specifically to understand the possible application of the systems analysis toolset currently available.

Three common systems analysis tools: Accimap, System Theoretic Accident Mapping and Processes, and Cognitive Work Analysis were analysed, then further explored through applying the first two of these tools to a trans-national food integrity system problem, specifically, the horsemeat scandal in 2013.

This case study showed that no single systems analysis method can be used in isolation to help identify key insights for intervention and that new methods may need to be developed, or existing methods need to be adapted, to understand these dynamic, adaptive systems.

The researchers suggested what's needed is a re-mixing of systems analysis tools, taking parts from multiple tools both within and outside the human factors domain for a more complete understanding of complex adaptive systems.

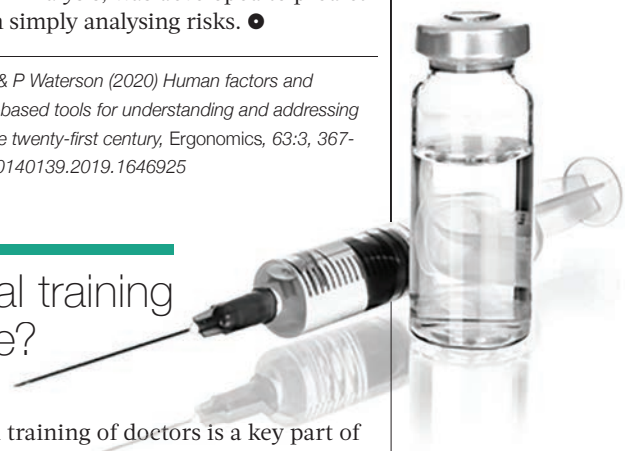
Different tools enable people to uncover different aspects of the system functioning, but it also shows us that further tools are still required. There are no current human factors complex system tools that incorporate all the necessary system properties and in particular, the ability to dynamically track changes, although attempts are being made with Cognitive Work Analysis.

IMAGE: ISTOCK/ SHUTTERSTOCK

Recently, a new tool called Net-Harms, based on Hierarchical Task Analysis, was developed to predict risks rather than simply analysing risks. ●

A Thatcher, R Nayak & P Waterson (2020) Human factors and ergonomics systems-based tools for understanding and addressing global problems of the twenty-first century, Ergonomics*, 63:3, 367-387, DOI: 10.1080/00140139.2019.1646925*

Is medical training too sterile?



4 Virtual training of doctors is a key part of the training process but is it too sterile to use simulations of a variety of illnesses and injuries that allows safe learning in a controlled environment? Researchers were keen to know if students should face more unexpected challenges in the course of such simulations. Would that enhance their learning experience or would it have a detrimental effect?

One group of medical students studied by the German researchers performed cardiopulmonary resuscitation on a patient simulator but the second group had a defibrillator with a defect. Participants showed increased biological stress levels, whichever group they were in. Paradoxically, participants who encountered the equipment failure subjectively reported less stress. The study looked at the comparable high stress levels in both groups with regards to future studies and discussed the subjective stress levels within the framework of attribution theory.

Researchers concluded it was important to consider specific characteristics of the learners, such as experience, when designing the simulation environments. They also said there was a need for future studies on different proposed stressors for different target populations, to further elaborate on the question of what works for whom.

The study underlines the need to include physiological measures of stress in the piloting of different simulation scenarios. The result of the high stress levels in both groups calls for research on the question of whether low stress conditions for inexperienced medical students exist. ●

G Ontrup et al (2020) Does simulation-based training in medical education need additional stressors? An experimental study, Ergonomics*, 63:1, 80-90, DOI: 10.1080/00140139.2019.1677948*

Understanding how accidents happen

As autonomous vehicle development continues at speed, we still need to understand more about where control lies and what happens when things go wrong, sometimes with drastic consequences. **Professor Neville Stanton** describes work to unearth the real causes of road collisions and the potential to reduce fatalities

For Rafaela Vasquez, Sunday 18 March 2018 was just another quiet night, driving her Volvo XC90 on her usual route around the roads of Tempe, a quiet suburb of Phoenix, Arizona. That's until 9.58pm when she suddenly looked up and saw a woman caught in her headlights and a fatal accident occurred.

Normally, this would not have caused much media attention, but this was not a normal car: this was Uber's new 'self-driving' car, and Ms Vasquez was conducting a series of test drives while operating in autonomous mode. A subsequent two-year investigation into the incident by the US National Transportation Safety Board found that an "inadequate safety culture" at Uber was a major contributing factor. It also highlighted poor governance concerning the testing of self-driving technology, particularly as Uber's test driver had been allegedly streaming a TV show on her mobile phone while behind the wheel immediately before the incident.

The details of this incident were also of interest to us at the University of Southampton as part of our work for the RAC Foundation's Road Collision Investigation Project. We were tasked with assessing the human factors accident analysis models and methods used in other safety-critical contexts to suggest the best approach to take to analyse UK road collisions on a consistent and national basis. This is part of the project's wider remit to establish whether there is a business case for investing more resources into the investigation of road crashes, by adopting the approaches used to collision investigation in other modes and safety critical industries.

The RAC Foundation was keen for us to use methods that would be able to handle the analysis of road collisions involving automated vehicles as well as manually driven vehicles, so we chose this particular Uber incident because it appeared that the driver was distracted from the road, which is often the case in road collisions in manually driven vehicles. However, there are many other contributing factors such as road conditions, weather or infrastructure that need to be assessed as well as wider considerations such as the regulatory framework and vehicle testing standards.

Our research involved comparing eight different human factors investigation models and associated methods to review how well they captured multi-causal and contributory factors in the Uber road crash incident in order to highlight the differences in the approaches. After assessing all eight models using the Uber incident, we concluded that the twin methods of Actor Map and AcciMap were the best to use: Actor Maps as they identify the major actors (including organisations, associations, people and technology) that could have (unwittingly) created the conditions within which the collision occurred; and AcciMap which identifies the events, failures, decisions and actions taken by those actors and offers the most comprehensive description of the collision.

The AcciMap process begins with an Actor Map to identify the main parties that are potentially involved in influencing the collision, such as 'equipment and environment' at the lowest level up to 'international influences' at the highest level. The next step was to identify the contribution, or lack of contribution, of each actor that influenced the events leading up to the collision, which was then illustrated in the AcciMap.

AcciMaps typically show events, failures, decisions and actions in boxes with relationships between them indicated by arrows. For example, in this case, the lack of international and national standards for automation design and testing meant that Uber had no technical guidance for appropriate

interfaces, safety standards or testing regimes.

After California revoked the vehicle registrations from Uber for its automated vehicles (because of a dispute over the need for testing permits), it took up the offer from Arizona to conduct on-road studies but here the Uber engineers decided to disable the Volvo's autonomous emergency braking (AEB) system to ensure a smoother drive. Test drivers worked eight-hour shifts, driving around a pre-set route, monitoring the automated vehicle's functioning and making any notes on a tablet mounted in the centre console.

Although the vehicle's AEB system had identified the pedestrian – who was not crossing at the designated pedestrian crossing nearby – it did not respond because it had been disabled, and the driver only looked up about half a second before the collision and only at that point attempted to swerve. Police allege that Ms Vasquez was streaming a TV show on her mobile phone and determined that she looked down 204 times over the course of 11.8 miles, meaning her eyes were off the road for 25% of the journey. The pedestrian died at the local hospital and an autopsy revealed that she was intoxicated with drugs.

The AcciMap showed the analysis of the collision together with the many underlying influences that led up to the fatal event. From the collision analysis, it's possible to develop recommendations with the aim of preventing this type of event from reoccurring. For example, at international and governmental levels new standards for vehicle automation and on-road testing are required. At an organisational level, the company needs to undertake a comprehensive analysis of human and technical risks, accompanied by task and workload analysis. Technical and operational management need to better understand the demands made on drivers of automated vehicles and share tasks accordingly, and the vehicles should be fitted with dual control with two drivers present. Even local authorities have a role to improve lighting and fence off central reservations where there is a natural crossing point.

The point here is that collisions do not result from any single point of failure; rather they are systemic and multi-causal in nature. To reduce collisions, issues need to be addressed at all system levels. The Uber incident was the result of a catalogue of mishaps, misadventures and misdeeds which the Actor Map and AcciMap models highlighted showing the broader system influences that were necessary for the collision to occur.

This project could establish whether there is a business case for investing more resources into road collision investigation

A two-year trial, led by the RAC Foundation on behalf of the Department for Transport, is now under way in the UK to analyse historical collision data and identify systemic factors as well as understand the common themes and patterns that result in death and serious injury on the public highway. This is probably one of the most far reaching pieces of research concerning road accidents as it has the potential to result in a road collision investigation branch for the UK, which could have a substantial effect on reducing road fatalities and casualties.

Neville Stanton is Professor of Human Factors Engineering and Director of the Human Factors Engineering Team in the Transportation Research Group at the University of Southampton. Email him at n.stanton@soton.ac.uk

Contributions to this article were also made by Elizabeth Box, Head of Research at the RAC Foundation. Find out more about the Foundation at www.racfoundation.org.

Further reading

RAC Foundation report: www.racfoundation.org/research/safety/models-and-methods-for-collision-analysis

Road Collision Investigation Project: ww.racfoundation.org/collaborations/road-collision-investigation-project

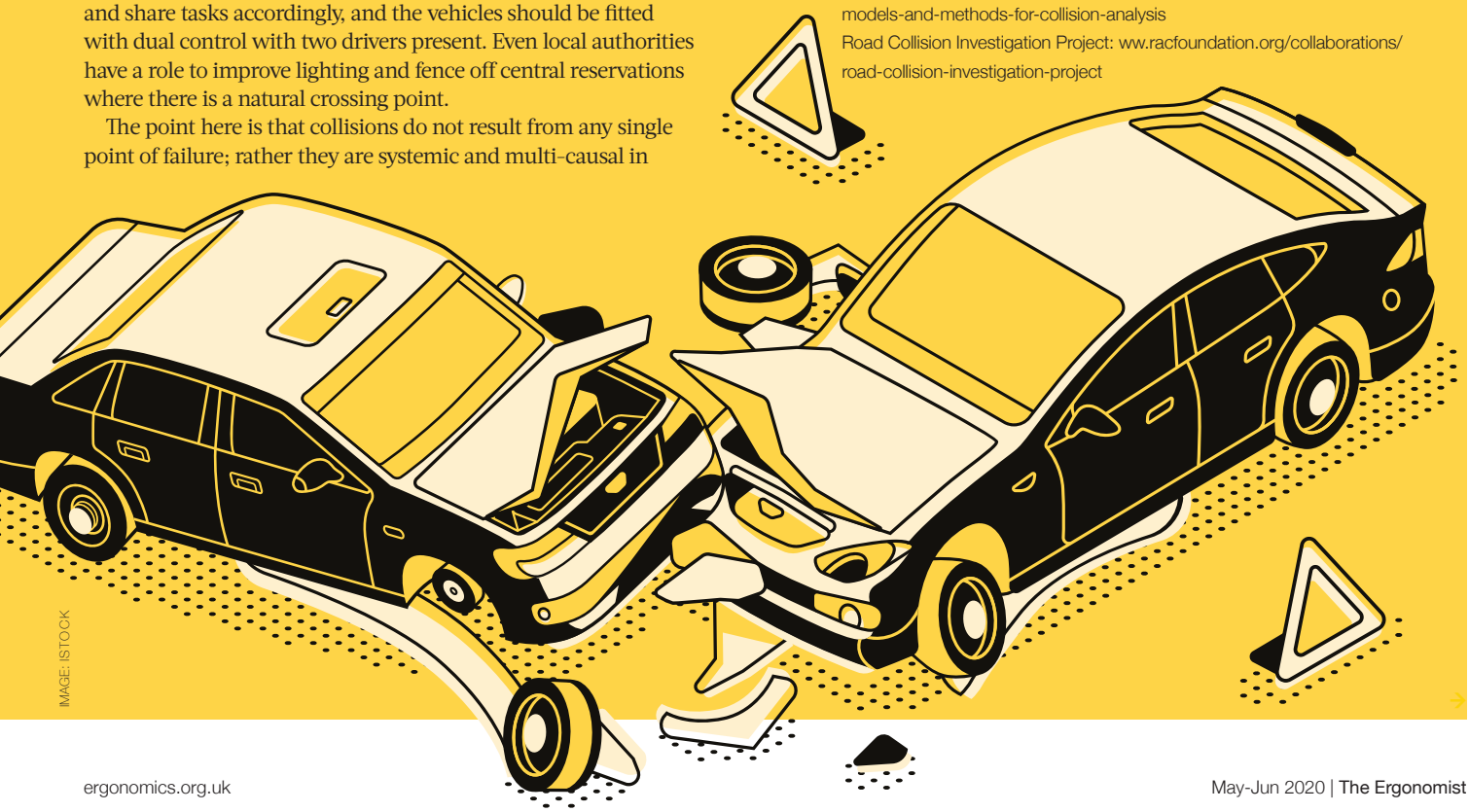
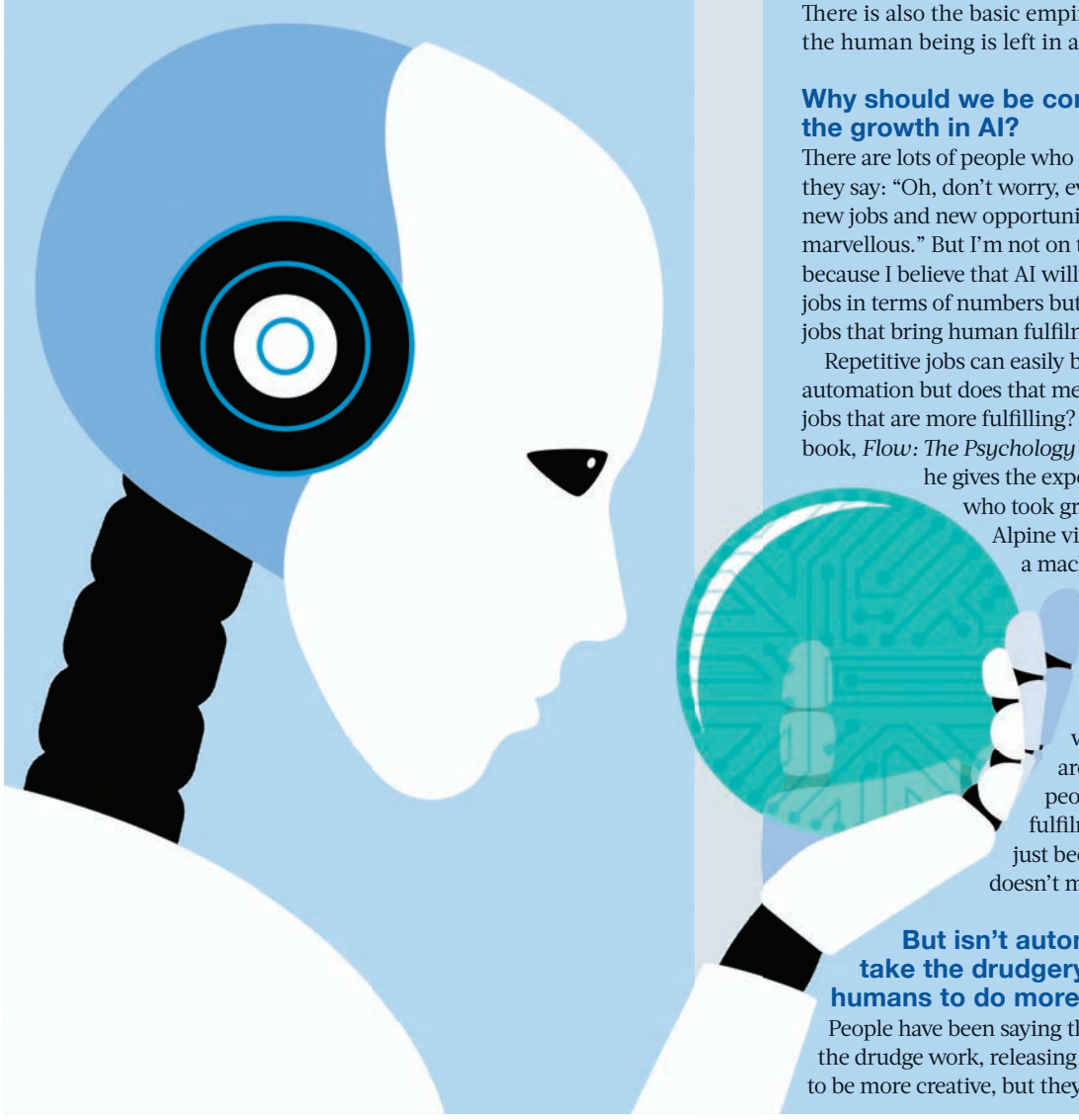


IMAGE: ISTOCK

What does AI mean?

In advance of a Donald Broadbent Lecture at next year's CIEHF Ergonomics & Human Factors Conference, Tina Worthy spoke to **Professor Peter Hancock** about his topic of 'Trust and the Future of Autonomous Systems' and his thoughts on the role that our discipline has to play in the development of autonomous systems



What can we expect from your lecture?

Everything from 17th century necromancers and golems – the prototype intelligent automata – to the influence of the early pioneers in cybernetics such as Norbert Wiener. I'll also examine the transition that's currently happening as we move from automation to autonomous systems and its effect on our society, particularly in terms of jobs.

My overall theme is the issue of the growing use of autonomy – basically artificial intelligence-based (AI) machine learning improvements – and whether we can trust these technologies and indeed, whether it's wise to. There is also the basic empirical question about where the human being is left in all of this.

Why should we be concerned about the growth in AI?

There are lots of people who are optimistic about AI and they say: "Oh, don't worry, everything's fine. AI will create new jobs and new opportunities and everything will be marvellous." But I'm not on that end of the continuum because I believe that AI will result not only in the loss of jobs in terms of numbers but also in terms of the quality of jobs that bring human fulfilment and enjoyment.

Repetitive jobs can easily be replaced by robots and automation but does that mean people will be free to do jobs that are more fulfilling? In Mihaly Csikszentmihalyi's book, *Flow: The Psychology of Optimal Experience*, he gives the experience of a road sweeper who took great pride in his work in an Alpine village but was replaced with a machine, taking away not only his job but also his vocation in life. He didn't mind that his work was seen as mundane as it gave him great enjoyment, fulfilment and a wider sense of purpose. There are many occupations that give people pleasure and a sense of fulfilment so I would argue that just because we can automate jobs, it doesn't mean we have to.

But isn't autonomy a good thing to take the drudgery out of jobs, allowing humans to do more creative work?

People have been saying that automation will replace the drudge work, releasing humans to have the freedom to be more creative, but they've been saying this for the

past 30 years and it hasn't come to fruition. Indeed, many people are now working two or even three mundane jobs just to get by. The idea of the 20-hour week was predicated on the idea of equal distribution of the wealth created but the problem is that it manifestly didn't happen. I believe the same fallacy will be promulgated by the 'pro-robot' lobby and the increasing use of autonomous systems.

What's the issue with autonomy and trust?

Humans have frequently had an initial distrust of automated technology; look at the Luddites in the 19th century as a case in point. Today this issue is still with us, for example with the proposal for not having guards on some trains in the UK, which is a contentious issue with the unions.

I've been researching the area of autonomy and trust over the last ten years and the bottom line is "no trust, no use". If people don't trust the technology, they're not going to use it, and if they're forced to use it, that can be even worse.

But how can you build up trust with inanimate objects or software?

Trust comes from reliability and if the system works consistently then that trust grows. It's strange but people treat robots differently than humans. One of the interesting findings from our research is that people are prepared to give a robot more leeway. If you have exactly the same action happen where a robot and a human make a mistake and then both apologise, the human recovers trust much more slowly from their peers compared to the robot; why that happens is still a mystery!

Take the case of a supermarket chain where cleaning robots have been installed. They look like giant grey upright hoovers, which unnerved the employees and customers as they moved around. After the manager put some goofy looking eyes on one of them it helped it to be accepted; the staff even gave it a name and helped celebrate its first birthday at the store with a birthday cake.

So how can we control the growth of autonomous systems?

That's the real question. I've just finished a white paper for the United States Air Force which is focused on this exact issue and I've come up with five strategies: the first is "don't do it in the first place"; and the second is make sure you have an off switch or can pull the plug out of the wall!

That might sound tongue-in-cheek but I don't think anybody's going stop developing AI. The problem for me with autonomous systems is that they are generative. They learn and evolve through feedback from both their operational and contextual environments and their actions necessarily become more indeterminate over time. The trouble with that is that we won't know what it's doing as it learns more and more and makes its own 'decisions' based on its evolving goals. That's what my 2017 paper 'Imposing limits on autonomous systems' covers and I'm not very sanguine about this, as human beings have never imposed a limit on a computer system; humans will always want to go further... and this is the problem I have with AI.

IMAGE: IKON

Do you think we should be worried about AI?

We should be extremely worried. It's not about the rise of killer robots, it's about the wider concerns for what it means for human society; job loss is one thing but I see few new quality jobs coming in to replace the ones that are lost. The robot brigade say that AI is for the betterment of humankind, but which humans are they talking about and who reaps the benefits? The simple answer right now is that it probably isn't you or me.

There's an interesting paper out on the future of employment that predicts how fast certain jobs are going to be lost through automation and AI, and there's swathes of them that can be wiped out in the near future, with significant ramifications for society. Even Robert Reich, former US Secretary of Labor under President Bill Clinton, has said recently he thinks the rise of automated jobs could mean the United States will have to bring in a universal basic income because so many people will be jobless. He also said: "A world inhabited only by robots, their billionaire owners and a large and increasingly restive population is the plotline for countless dystopian fantasies, but it's a reality that appears to be drawing closer."

Humans have frequently had an initial distrust of automated technology

So, what role does our profession have in the development of autonomous systems?

I want to sound the alarm and ask the question: "Are we, by improving things like autonomy or human interactions with autonomy, enhancing the quality of people's lives or are we actually getting rid of gainful employment and eventually propelling the world towards terminal disfunctionality?" I will leave these questions hanging in the air until the conference.

Peter Hancock is Provost Distinguished Research Professor in the Department of Psychology and the Institute for Simulation and Training at the University of Central Florida.

Further reading

Carl Benedikt Frey and Michael A Osborne, 2013 *The Future of Employment: How susceptible are jobs to computerisation?*

Robert Reich, *New York Times* book review of *Give People Money: How a Universal Basic Income Would End Poverty, Revolutionize Work, and Remake the World* by Annie Lowrey

Our main conference, Ergonomics & Human Factors 2020, this year in conjunction with ODAM 2020, has moved to a virtual conference, taking place on 28-29 April. We wanted to make sure the important work that's been done can still be presented and shared and so, for a single fee of £99, the content will be available in easily accessible ways including webinars, videos, podcasts and slideshows. Webinars will focus on four themes, namely, Safety in Healthcare, Intelligent Vehicles, Human-Centred Systems and Future Work, and all will be recorded too, so they can be listened to later at any convenient time. For all details and to buy your ticket, visit conference.ergonomics.org.uk

Stay in touch

At this difficult time, we're keen to support our members in any way we can.

One of those ways is by helping you connect and stay in touch with other members through our members' discussion forum, Communities. Here, you can ask the community a question, join in a discussion or post information that others might find useful. If you work in healthcare, pharma, nuclear or workplace ergonomics, you can now join a dedicated Sector Group community to discuss specific issues and topics. You can also make contact with, and send a private message to, any other individual CIEHF member just by searching a list. If you're unsure how it all works, we've got lots of information for you so you can make the most of this great resource. Log in to MyCIEHF and look for the Communities menu item.

Another way we can help if you find yourself with more time to spend collaboratively but remotely reading, writing or researching, is through our journals and research gateway. The gateway is an invaluable source of insight and ideas, for example, the gateway lets you perform targetted searches on millions of resources including journals covering all sectors, business magazines and trade publications, plus critical news content. Log in to MyCIEHF and look for the Research menu item.

Please contact me if you have any questions or thoughts on how we can provide you with a better membership experience!

Iris Mynott
i.mynott@ergonomics.org.uk
07702 542166

IMAGE: SHUTTERSTOCK

MEMBERSHIP

Our latest accreditations

Congratulations to the following members whose applications for accreditation by the CIEHF over the past few months have been successful. Registered Members and Fellows also have Chartered status.

Fellowship

- Wen-Chin Li

Registered Membership

- Jill Farmer
- David Golightly
- Bjarte Knappen Røed
- Emma Smith
- Jenny Sutcliffe
- Gethyn Churchill
- Laura Anderson
- Zheng Jie

Technical Membership

- Matthew Souvertjis: Technical Specialist (Oil & Gas)

A change to our media activities

We say goodbye and thank you to Louise Boulden for many years of hard work and insight on our PR and media activities. During Lou's time, we raised our social media profile across all platforms and had many articles published in trade magazines. Lou brought human factors to the attention of many journalists, including those from national TV and newspapers. She also took the lead on bringing about a contribution by members to an historical programme for the Discovery Channel. We wish Lou all the best for the future.

We welcome David Cameron and Kim McAllister of Connect Communications, who will be taking over this role and we look forward to working with them both. They are keen to have contact with as many members as possible on a wide range of topics, to increase our communications output through a range of media including video and podcasts. If you're interested in this, please contact us.

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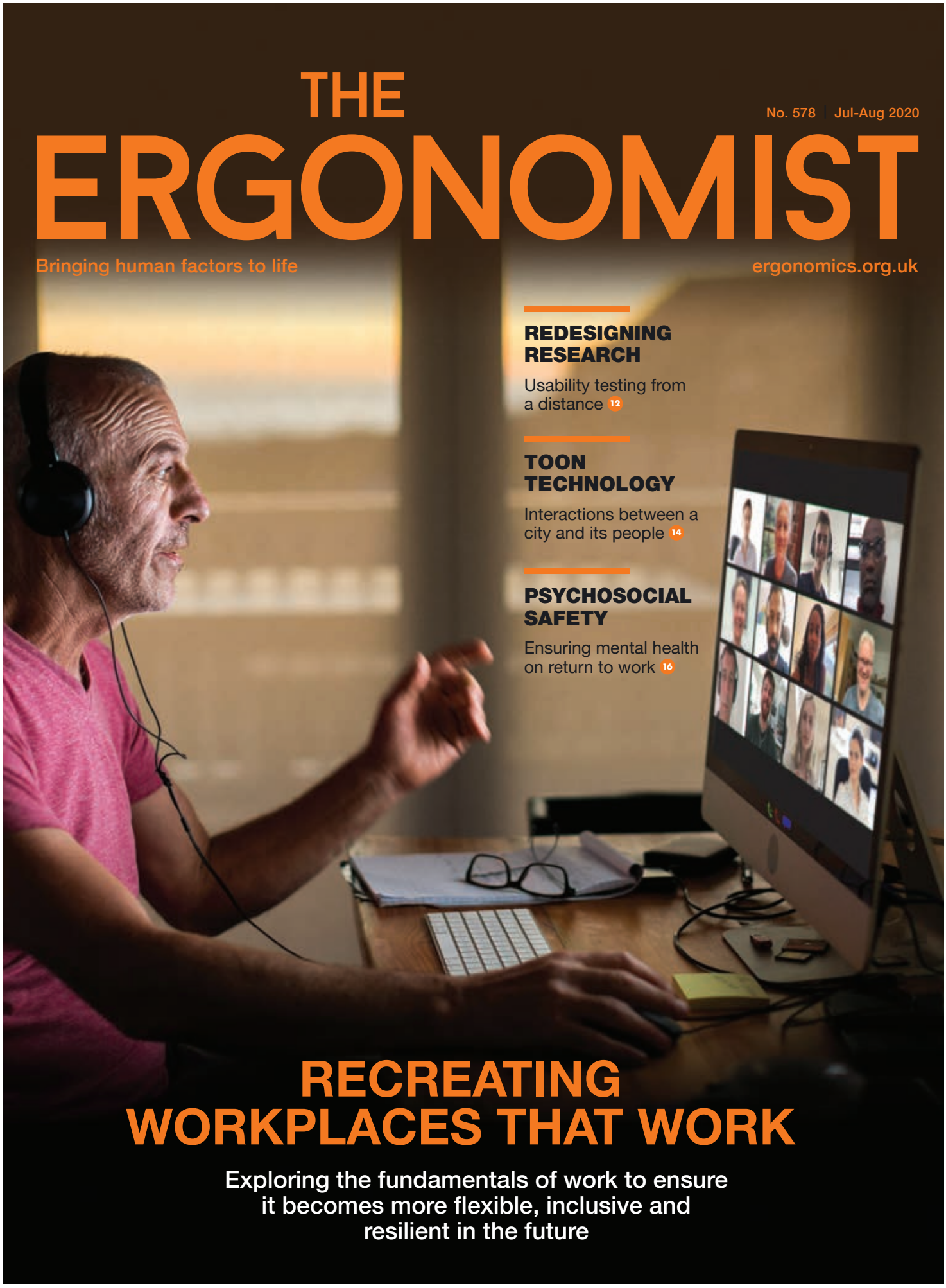

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RECREATING WORKPLACES THAT WORK

Exploring the fundamentals of work to ensure it becomes more flexible, inclusive and resilient in the future






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FROM THE PRESIDENT

Aspirations for the year ahead

Amanda Widdowson
CIEHF President

president@ergonomics.org.uk

I'm honoured and excited to take over as President after a year as President Elect, serving on the Executive Committee and Council (board of Trustees). I'd like to start by thanking Bob Bridger for his hard work and leadership as President over the last year. And for those 100 or so member volunteers who regularly support our committees and even more who work in regional, sector and special interest groups. I'm amazed by your efforts and look forward to welcoming newly elected members.

I have two main aspirations for the Institute. Firstly, I want to increase knowledge sharing. We have a wealth of multi-sector knowledge and we could learn a lot from each other. To this end, we're planning professional development and sector group webinars, and the addition of methods and templates to our website. We're developing learning pathways in healthcare and user experience (UX), and our online *Communities* forum is available to keep us talking.

Secondly, I want to raise the public profile of the CIEHF. Members have much to offer in areas that are currently of great interest to the public, such as diversity and usability in design. I discussed this with Noorzaman Rashid when he joined as CEO last autumn and have been impressed with the energy with which he has responded to the challenge. Further to this, I'd like to collect more case studies that demonstrate where the application of ergonomics and human factors has made a positive difference. My President's Project, Design for Everybody (bit.ly/DesignForEverybodyGuidance), engages the public, as well as providing a mechanism for generating updated, diverse anthropometric data to drive inclusive design.

Naturally, we'll have to work around the lockdown situation and social distancing restrictions. However, I think our recent virtual AGM and very successful EHF2020 conference demonstrates that we can overcome those challenges.

Members have much to offer in areas of great interest to the public

FROM THE EDITOR

A cautious move forward

As we move cautiously out of lockdown, emphasis is growing on how to create safe spaces and workplaces for people to return to. Our cover article brings together research and opinion on how to recreate and redesign tasks and workplaces, and Sarah Sharples and Jim Taylour give us their views on the psychosocial aspects of adjusting to working in new ways.

Eugene Canavan shares his experiences of remote usability testing and Peter Hancock and Alexandra Caplan give us their thoughts on designing for new behaviours to encourage distancing. Mark Sujan looks at the potential of AI to support greater understanding of the spread and treatment of Covid-19.

Dave Golightly explains how a major city is using advanced analytics to monitor movement of people and traffic to feed into planning for future infrastructure. Our member profile features Val Noble whose career started in physiotherapy, and we report the sad passing of Carys Siemieniuch.

We also profile our new President, Amanda Widdowson, looking at her background, current work and goals for the coming year. And last but definitely not least, we celebrate the achievements of our recent award winners with a glimpse into their work in the discipline.

Stay safe and well and enjoy the summer.

Tina Worthy
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Students evaluate data from an ear sensor, designed to measure the biological values of COVID-19 patients

The promise of AI during Covid-19

Over the past few years, health systems worldwide have started to embark on a data revolution with the widespread development and deployment of artificial intelligence (AI). Hopes are high that AI can help health systems to manage the current Covid-19 pandemic and to prepare for a potential second wave of infections, as **Mark Sujan** explains

As of the end of May, there have been over 37,000 deaths in the UK directly linked to Covid-19 and over 350,000 deaths globally. The economic and social burdens of this pandemic are so significant that they will be felt for years to come. New treatments, vaccines and ways of reducing the spread of infection are urgently required.

At the outset of the current crisis, innovative AI-based analysis of social media data and news reports helped to predict the spread of the outbreak. Canadian company Blue Dot is credited with being first to recognise an unusual cluster of pneumonia cases in Wuhan before official sources confirmed this as Covid-19. Large amounts of data can be gathered and aggregated quickly from a range of sources, such as Twitter, Facebook, local news outlets and public health statistics to reconstruct, and then potentially predict, the spread and the behaviour of the Covid-19 outbreak.

Social media analysis could potentially be triangulated further with mobile phone data or data from wearables, which capture people's movements and symptom status to give a real-time prediction of risk and disease spread, and to support the public with social distancing by routing people away from crowded or risky areas. Contact tracing apps, such as those developed by NHSX in the UK or the Apple and Google partnership, can support rapid identification of people who might have been exposed to the virus in order to speed up testing and isolation.

In the past, AI has been deployed for imaging, diagnostics and prognostics, and this is something that could be put to good use during the pandemic. For example, deep learning neural networks have been developed to identify Covid-19 from chest x-rays and to distinguish this from other forms of pneumonia. Machine learning has also been used to help clinicians with predicting deteriorating Covid-19 patients who might require escalation of care, such as treatment with a ventilator.

These are some of the numerous examples demonstrating the potential of AI to help health systems fight Covid-19 through predicting and reducing spread, and by supporting diagnosis and treatment. However, there are also justified concerns and open questions that need to be addressed. AI requires data, ideally lots of it and of high quality. As we are now only a few months into the crisis, data is still relatively scarce. In addition, the symptoms of Covid-19 can vary from patient to patient, and it is as yet unknown whether and how the virus might mutate and how the human immune system might respond.

Every health systems records data in different ways. This poses challenges for the successful development of trustworthy AI systems. And these systems are needed fast – to the extent that we are observing a period of 'speed science', where solutions are deployed without rigorous testing and evidence about their performance or transferability across settings and countries. A recent systematic review of AI models for diagnosis and prediction found that all 31 of the investigated systems were at high risk of introducing bias, and that the accuracy and performance estimates were likely to be overly optimistic.

Public confidence and trust are going to be crucial. In order to feed data-hungry AI algorithms, people need to download and use apps, and consent to the sharing of their data. Transparency is required with respect to how these data are going to be used, for what kinds of purposes, over what time period (for example, what happens after the immediate crisis), and who will be granted access to the data. While many of us will probably be keen to support government measures during the crisis, is there going to be a genuine citizen dialogue about post-pandemic data access or will we have to accept a new normal? Concerns about data repositories held by technology giants about people are already high and with the rapid rise of AI, further transparent ethical discussions are needed. The crisis provides us with an opportunity to gain a glimpse of the future and to ponder these questions.

Dr Mark Sujan is founder of Human Factors Everywhere, a small company dedicated to helping people adopt human-centred approaches for running a safe and secure business. He leads the CIEHF's Digital Health & AI Special Interest Group.

IMAGE: REUTERS

CIEHF publications

CHIEF EXECUTIVE'S PERSPECTIVE

Building the visibility of human factors

As we entered lockdown, the CIEHF had six weeks to convert our Ergonomics & Human Factors Conference to a virtual event. With 450 delegates who joined from across the world, this was our best profile-raising event ever. In parallel, we established a Covid-19 response team using our discipline to tackle critical issues facing the country, the NHS and associated industries. The resulting work can be viewed on our Covid-19 website at www.covid-19.ergonomics.org.uk. This work is unparalleled when compared to other professional bodies our size. Downloads of our publications are increasing every day and with the International Ergonomics Association promoting each one to over 40 member countries, our credibility is growing too. Tweets and LinkedIn posts are regularly achieving many thousands of views.

Our guidance on ventilators has influenced government policy and ECRI, Innovate UK and many others have disseminated the formative usability testing of rapidly manufactured ventilator systems across the world. Professor Mark Sujan co-authored with me our first piece of advice to government within 48 hours: *Human Factors in the design and operation of ventilators for Covid-19*. This in itself has set a new benchmark for the CIEHF in terms of rapidly turning around guidance.

Working with the Intensive Care Society and Faculty of Intensive Care at Oxford, we have just published guidance on *Tracheotomies, A critical procedure in the treatment of patients with Covid-19*. This work was led by Professor Sue Hignett and Professor Peter McCulloch. Supporting healthcare systems further, Professor Paul Bowie, one of our Healthcare Sector Group co-leaders, has created guidance for NHS Trusts to support more effective design of procedures in an environment that is highly regulated.

More recently our Workplace Sector Group, co-led by Kirsty Angerer and Ed Milnes, have produced a brilliant 7-step guide for *Creating a Safe Workplace*. This was a significant collaborative piece of work with the British Occupational Hygiene Society and the Chartered Society of Designers. Contributors included the Royal Academy of Engineering, the Confederation of Business and Industry (CBI), the Design Council and the International WELL Building Institute, CIPD and many others. This piece of work clearly demonstrates a systems approach to dealing with Covid-19.

The CIEHF is on a mission to bring human factors into the boardroom and help businesses, industry and commerce

All of our work is being reviewed to share organisational learning and links will clearly be made to our latest White Paper *Learning from Adverse Events* to maximise the impact we can make as professional human factors practitioners. Individuals, families, communities, universities, hospitals, industry and commerce are already considering what they have learnt from the pandemic, and what and how things can change for the better. Healthcare organisations are considering the use of technology to help remote diagnosis of patients, and consultants are finding ways of remotely advising clients. Office-based businesses are considering balancing home working with office working.

The pandemic has highlighted the issue of psychological wellbeing and physical wellbeing both at home and in the work environment. The CIEHF is concerned about the 'Future Human' and that's why we must begin addressing some of these issues through new White Papers and engage collaboratively to win work.

The CIEHF is on a mission to bring human factors into the boardroom and help businesses, industry and commerce as well as public service entities. The purpose of this is to help share understanding of the benefits that human factors professionals can bring. Right now, we're looking for new case studies about how human factors has made a difference across commercial as well as public service bodies. This builds on the *Human Connection* series of case studies produced under the leadership of Sarah Sharples and Claire Dickinson. (Visit www.ergonomics.org.uk >Resources>Publications>Case Studies). These will be made available to members and others to help promote our work. Registered Consultancies can particularly benefit from this. Please contact me directly if you'd like to provide a case study.

Later this year we will launch our 'Learning Network' to support professional development through shared learning for the future. I'm also looking to produce our own industry specific textbooks on human factors, so all ideas welcome!

Noorzaman Rashid
Chief Executive of the CIEHF
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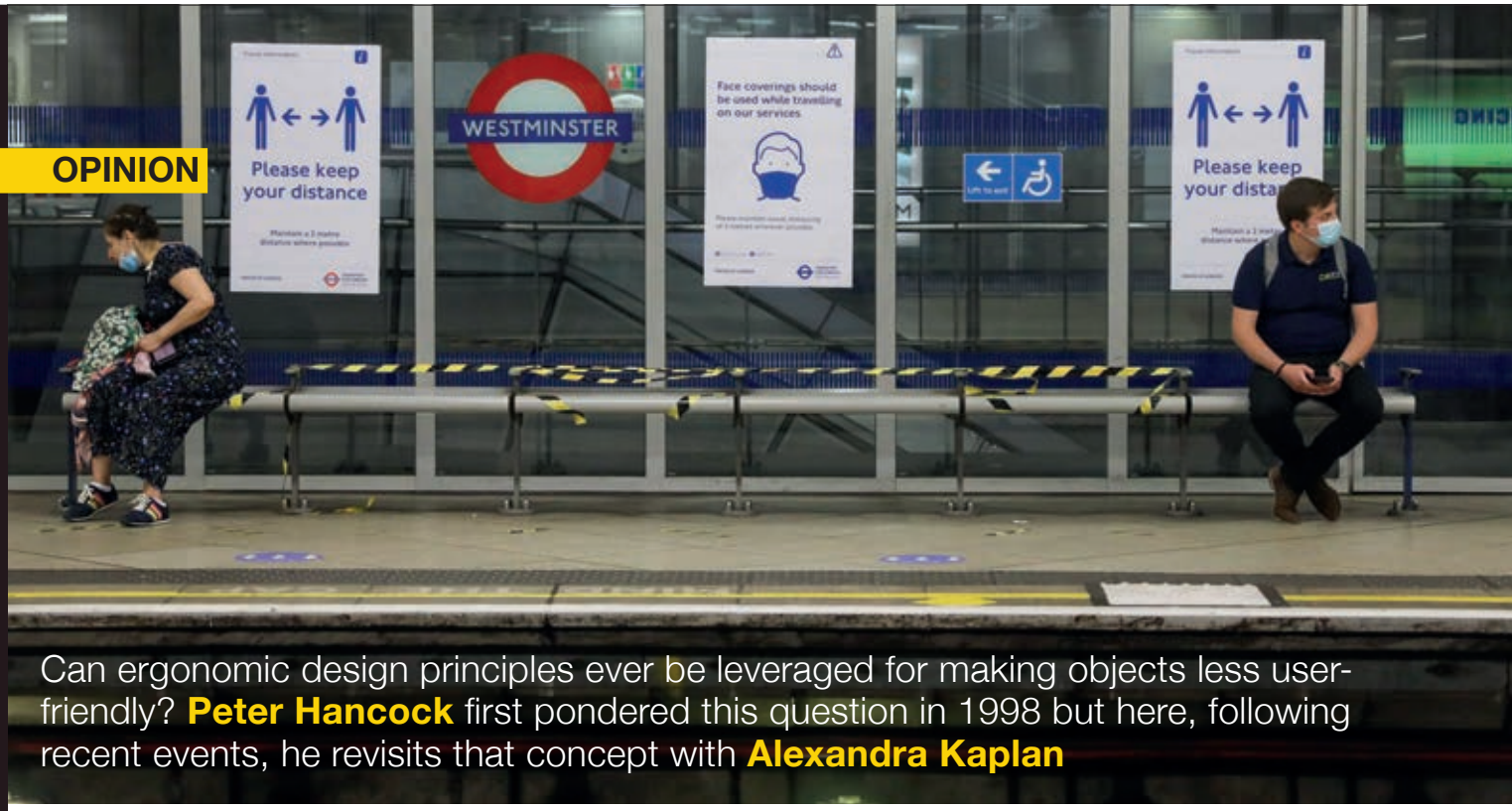
noorzaman rashid

OPINION



Can ergonomic design principles ever be leveraged for making objects less user-friendly? **Peter Hancock** first pondered this question in 1998 but here, following recent events, he revisits that concept with **Alexandra Kaplan**

Designing for distancing

Since the novel coronavirus, Covid-19, emerged in late 2019, it has claimed a third of a million lives. Despite the rising death toll, many public venues are now beginning to open taking a variety of precautions intended to stem the spread of disease. Most proposed to enforce social distancing rules through posted signage and warnings, which, like most warnings, may prove to have limited efficacy.

A warning should be the last line of defence from physical harm. That is, any rules and regulations regarding safety should be preferably preceded by physical barriers which prevent individuals from accessing the dangerous situation in the first place. After all, walls and locked doors do a better job of preventing unnecessary risk than posted warning signs. However, what does this look like when the source of danger is contact with other people?

Physical barriers are not practicable in locations where crowds gather. We propose that a rational application of affordance design can create gathering spaces to frame behaviours that maximise social distancing. These actions are designed to facilitate implicit compliance on behalf of users and not to engage attention-demanding requirements. Safe behaviour therefore becomes the option of least effort and one that fosters the minimum of contact.

Affordances

Affordances represent sets of possible interactions between a human and a system, whether that system is an object such as a chair, or a landscape feature such as a pathway. Objects are often designed with specific affordances in mind. For example, a wide, flat, paved path affords walking, using a wheelchair or riding a bicycle. A winding dirt path that is steep, narrow and rough affords walking but perhaps not the other activities.

Designers can leverage affordances to encourage wanted behaviours while at the same time discouraging unwanted behaviours. For instance, the two paths we mentioned each have their function. The first, anywhere one might want groups to traverse collectively and slowly, such as through a community park or shopping centre. The second, a location that a designer might not want to be easily accessible, or particularly inviting. Up until very recently, most public places have been designed with the intention to comfortably fit as many people as possible into a relatively restricted space. Such design imperatives have now changed. Similarly, high-

Commuters sit at either end of a bench, taped off to ensure social distancing, at an underground station in London

touch surfaces have been designed to be tactilely engaging and pleasant to contact. Again, the design imperative has changed. Now, to maximise social distancing, a differing approach must be used.

Designing new behaviours

The first step in leveraging affordance designs for social distancing is to decide which aspects of a public venue are possible vectors for contagion. While a variety exist (queues, entryways, high-touch surfaces, and restrooms, to name a few), we focus here on high-touch surfaces as one example of how design can be exploited to maximise safe behaviour. People frequently touch handrails, benches, tables and door handles, often directly after other people have touched those objects and often in exactly the same place. This can spread germs but none of these objects can be removed entirely. Such high-touch objects must be redesigned to become low-touch objects, only handled when absolutely necessary.

To begin redesigning an object, consider its requirement. A door still needs to be opened, so any updated door handle must still afford use in this way. Some places have already experimented with the addition of foot-operated pedals for opening doors. These have had a mixed reception, as most people instinctively lean towards the more common motion of using the regular handle. Eliminating the traditionally placed handle is not an option; it must remain in its regular location for intuitive use during emergencies. If it can't be removed, it must be redesigned so that it's less appealing to use than the other, more sanitary, options. But how can that be accomplished, if a consumer's natural impulse is to reach for a door handle?

Inspiration can be drawn from so-called 'hostile architecture', which is designed to repel rather than attract. It's often used to deter loitering or increase the speed of customer turnover. This concept seems to be at odds with the ergonomist's normal goal of making an object as comfortable to use as possible. However, for the sake of minimising

Hostile architecture is designed to repel rather than attract

touch, we must embrace the 'anti-ergonomic' practice of designing objects which are as unusable as possible, while still affording the required actions.

In the case of the door handle, this would mean making the handle less practical than the foot-operated pedal. A handle that is magnitudes larger or smaller than normal is clearly less comfortable to grasp, which will be apparent to consumers before they ever lay hands on it. It still affords use in the situation where someone cannot or will not use the foot pedal. However, the odd appearance would give most users pause, hopefully long enough to notice any signage relating to the foot pedal. More importantly, the new design would make it easier to open the door by foot than by hand. This would guide user behaviour more than any rules, simply by making the more hygienic option the natural choice.

In these strange times, designing an object to be less ergonomic may be the method needed to minimise touch. It's a reversal of normal ergonomic design principles, but usability encompasses both ease-of-use and safety of use. Perhaps, for now, it's necessary to trade the first for the latter.

Peter Hancock is a Provost Distinguished Research Professor at the University of Central Florida and has a PhD in Human Performance and a DSc in Human-Machine Systems.

Alexandra Kaplan obtained a Master's degree in Applied Experimental and Human Factors Psychology in 2019 from the University of Central Florida, where she is currently a PhD student.

Further reading

Hancock, P A (1998). Should human factors prevent or impede access? *Ergonomics in Design*, 6 (1), 4.
Norman, D A (1999). Affordance, conventions, and design. *Interactions*, 6 (3), 38-43.

IMAGES: GETTY

Mixed reality for medics

Healthcare staff have been using mixed reality headsets to assess patients infected with the coronavirus. It allows them to see x-rays, scans and test results while they are with the patient, and at the same time, to discuss treatment options with colleagues in another, virus-free room. It cuts down the requirement for PPE, so saves time and resources, whilst giving patients access to the specialists they need. For more details, visit **https://bbc.in/3eTL4yp**

Wellbeing and safe operations

Issue 30 of *HindSight*, the EUROCONTROL magazine on the safety of air traffic management, is available now. The theme of this issue is 'Wellbeing', which has an undeniable link to safe operations, though this is not often spoken about. The authors of the articles were considering wellbeing in the context of aviation and other industries but they touch on topics that are deeply relevant to the current pandemic. Download the issue at **https://www.skybrary.aero/index.php/Hindsight_30**

Driving change

A factory in Newtown, Wales is still running at full production, despite the coronavirus pandemic. The company manufactures drives which run pumps and fans such as those used in pop-up hospitals. After shutting down for just three weeks, 350 staff have returned to work having helped to put a number of changes in place, from the shift patterns and the corridors to the canteen and the toilets. Washing stations and innovative mobile plastic shields are now in place in the factory, together with a one-way system to keep staff apart. Find out more at **https://bbc.in/2XuJe12**

LEADERSHIP

Improving design for everybody

New CIEHF President **Amanda Widdowson's** 25-year career has included ground-breaking work in rail, defence and cybersecurity. Here, she tells Andrew Collier about the inspiration for her latest project examining the impact of people's different body shapes and sizes on design

Amanda Widdowson vividly recalls when she was learning to drive. Like everyone taking a test in the UK, she had to demonstrate the ability to parallel park and her instructor suggested that to do this, she looked out of the rear quarter window at the kerb. The only problem was that she was too short when seated to actually see out of that window. "The instructor could see, so his perception was different to mine," she remembers. "I just didn't have the same reference point and that affected my ability to park."

The incident, and her frustration, got her thinking. If the vehicle had been designed differently in order to cater for the shapes and sizes of a wider range of people, she felt it could have made a big difference.

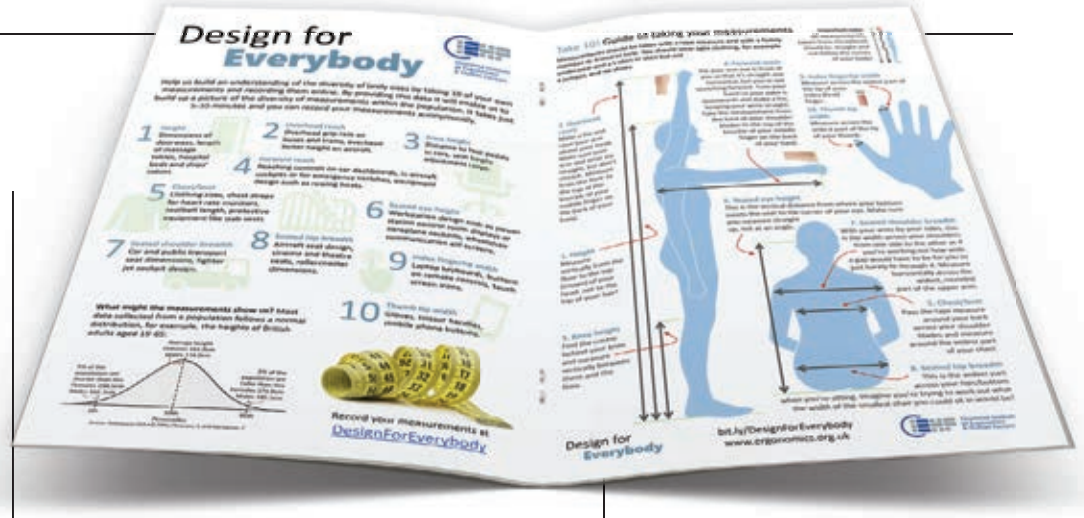
Where does this story take us? To the present, and the fact that Amanda now has the chance to put her thoughts into action. As CIEHF's incoming President, starting her term of office on 28 April, she's chosen to undertake a closer study of the impact of body shape and size on design as her nominated project. "I'm really excited by it," she explains, "There's a lot of discussion at present about female issues, and particularly diversity. For instance, during the coronavirus pandemic, we've been hearing about the problem of ill-fitting personal protective equipment for women. This body issue is something I want to raise awareness of, and I think it's an area where CIEHF can help. We need to make sure, for example, that workstations fit people, and that public transport is suitably designed, so I'm trying to gather a more diverse set of data to help influence design."

She points out that it's not only women who can suffer from inappropriate ergonomic design. "I remember in the course of my work seeing a well-built American soldier trying to use a mobile phone. "He had huge hands and was making errors. It just wasn't working for him; the buttons weren't big enough or far enough apart. Ethnic groups may also not be well represented in data sets. It's all about designing around people so we need to recognise diversity."

In her president's project, called 'Design for Everybody', Amanda plans to use volunteers to carry out the study by getting them to taking a series of their own body measurements and logging them online to start to create a set of data that could be used to influence the design of products, equipment and places. She's hopeful that the project may eventually attract funding or sponsorship to build a significant and robust data set for use by designers and engineers. "We were going to run a series of roadshows and ask people to measure their colleagues in the workplace, though the Covid-19 lockdown has changed that for now. But one positive thing is that the measurements can all be taken at home. Once we get the data, we'll analyse it and work out the range of responses."

Information is provided about how to take the measurements and all data is anonymised. Find out more about the

Human factors application has made a real difference to society and brought it all sorts of advantages



The Design for Everybody project has illustrated guidance to help you take measurements

project by downloading the Design for Everybody project guidance at https://bit.ly/DesignForEverybodyGuidance.

Amanda's presidency comes as a high point in her 25-year career in ergonomics and human factors. A member of CIEHF since she was a student, she is a recognised authority in the discipline, particularly in the defence and rail industries. She currently works as Human Factors Lead for the consulting arm of the international Paris-based services company, Thales Group.

How did she originally become interested in ergonomics and human factors? "Biology and psychology were my favourite subjects at school, and I thought it was a good marriage of the two," she says. "I studied for a degree in psychology and then I received a Medical Research Council grant to allow me to do my MSc, and that was my big break. I've been working in the discipline ever since."

One of her first jobs was as a psychology researcher on Royal Navy projects with what is now the Defence, Science and Technology Laboratory. "I enjoyed it but I wanted to get into consultancy which gave me the opportunity to travel, which was great. I went to California on a UK-USA armoured reconnaissance vehicle project, I also visited Italy on a human interface assessment project to look at an issue with software affecting people with eyestrain and headaches. I assessed the system and found that whilst it was lovely, with lots of bright, garish colours which looked very pretty, I could see why it gave regular users a headache! I burst their bubble a bit by saying that light grey would be easier on the eye."

"Another trip was to Romania to visit a navy base on a UK knowledge sharing exercise. I also did an offshore project based in London and Aberdeen which was a new sector for me."

A later move was into rail. Human factors really became important in this area after the Paddington rail crash in 1999. Amanda was seconded to Network Rail, largely on west coast engineering. "It was really interesting. I evaluated a signal centre at Motherwell and also worked on a separate contract with London Underground, where I was brought in to ensure that the software in signal control rooms was designed around people. I also worked on the upgrade of the Jubilee Line to increase capacity on the Tube and on additional work for the 2012 London Olympics. Another project involved Crossrail, initiating the human factors strategy there, looking at train cab, station and control room design."

In rail, Amanda adds, human factors is all about safety. "We considered all the possible causes of human error and what could go wrong from a human point of view. Making things safe is a huge responsibility."

She moved to Thales seven years ago, covering mainly transport and defence and, increasingly, working in cybersecurity, looking at how human factors can help and adopting a pioneering approach towards this.

"If you're trying to make an organisation secure and prevent cyber-attacks, you need to consider the human element as well as the technical controls. Interestingly, the statistics don't really back up the idea of malicious personal attacks. People often don't mean to cause incidents. The biggest violation is likely to be writing down your password or storing it on your mobile phone. People have so many passwords they have to remember these days. I would eradicate that problem by investing in biometric data such as facial and iris recognition."

A Network Rail worker assesses the visibility of signals against the background lighting

Amanda's ground-breaking work on human vulnerabilities and cybersecurity has been applied to defence companies and also, intriguingly, to the Williams Formula One team. "They really do have to protect their data, especially around the car. If that was leaked, it could put them out of business."

She foresees a busy year as CIEHF President. Her agenda for the coming months includes raising awareness of the Institute through publicising its activities and highlighting areas where members' work has made a real difference. By doing this, she believes, the benefits of ergonomics can be promoted. "I'm also proposing a new award this year to encourage people to document case studies. I'd also like to increase the number of tools available for members, including on the website and in webinars, providing more knowledge sharing across our broad range of sectors. We can learn a lot from each other, and it will be useful for professional development.

"Human factors application has made a real difference to society and brought it all sorts of advantages, including cost benefits. That's something we need to flag up, and I'm delighted to have the chance as President to do so." ●

Amanda Widdowson is Human Factors Capability Lead at Thales.

Further reading

Design for Everybody project guidance: https://bit.ly/DesignForEverybodyGuidance

IMAGES: NETWORK RAIL

Human factors from a distance

Covid-19 has presented many challenges in our personal and working lives, arguably none more so than the need to socially distance. Surely this puts an end to human factors usability studies…or does it? Remote testing and data gathering is possible during lockdown, according to **Eugene Canavan**, who shares his insights and learnings from the field

Executing remote human factors engineering usability studies and testing - tasks which are generally conducted face-to-face - is a challenge we recently took on, and we delivered with positive results and satisfied clients.

Working with a pharmaceutical company, we were tasked with exploring user understanding and attitudes towards a complex series of interactions relating to a physical device. This traditionally would have required an in-person test protocol including hands-on personal interactions with the test participants, which of course would not be possible during the Covid-19 lockdown. The sponsor company had significant timeline challenges, requiring this work to be completed to keep engineering development on schedule. So, what do you do

when your client needs human factors work to go ahead and the delivery date can't change? You get creative!

Using the experience of our team, we adapted and created a robust, remote human factors test plan and test protocols. Taking a user-centric approach, we put ourselves in the shoes of the participants and imagined the interactions from their point of view to pre-empt their virtual needs, anticipating any potential gaps in communication and understanding due to not being present. We realised that gathering user feedback based on quantifying the sensory inputs of sight, hearing, touch and feel needed a fresh approach.

The solution was a complete test kit delivered to participants and supported by a remote test protocol and a screen-sharing video conferencing platform. The screen-share facility allowed the use of visual communication tools, such as step-by-step story boards and instructional videos, so the remote moderator could systematically take participants through various user integrations. The test protocol was supported by a semi-structured interview questionnaire and moderator's guide based on a Perception – Cognition - Action model approach. This approach allowed data gathering in a sequential manner, exploring participant understanding, attitudes and preferences. It concluded by sharing a video of the complete interaction from start to finish to confirm participant understanding and to collect additional feedback.

The test kit delivered to each participant contained an interactive prototype, to allow for understanding of the sensory engagement side of the interaction in terms of scale, feel and audio notifications. All of this, in addition to an experienced moderator, ensured that there were no gaps in our data collection. The experience of conducting a remote usability test programme was positive, resulting in quality data which enabled the development to continue on time.

In conclusion, despite the limitations caused by Covid-19 lockdowns, it's possible to carry out human factors research and testing work very effectively. So possible in fact, that it's a very viable option when travel is prohibitively awkward or expensive. Remote testing is especially valuable for user populations that are difficult to find within a close geographical area, such as with healthcare treatments with low numbers of users, or in niche medical fields.

Executing human factors studies remotely requires extra preparation to create test materials to support communication, and interview time with participants is longer. Generally, it's not a cost saving option, as any cost saved on travel will be spent in preparation and execution. But, most importantly, done well with an experienced team, it produces excellent and detailed data sets. ●

Eugene Canavan is head of healthcare at Design Partners and has over 27 years of product development experience. He heads a team of designers and engineers solving highly complex, mechanical and ergonomics challenges.
Visit www.designpartners.com

SIX TOP TIPS FOR RUNNING A REMOTE HUMAN FACTORS USABILITY STUDY

1 Allow extra preparation time

Any time saved on travel, needs to be redirected into preparation. Additional documents and materials are needed to support participant dialogue and bridge the gap created by not being present in person. Create a visual presentation or story board as support mechanisms and a video as a confirmation tool.

2 Be flexible with participant scheduling

Interviews with participants simply take more time. This needs to be considered and prepared for in advance, with participant expectations carefully managed from the outset. Build in additional flexibility and contingency, as participants can postpone or cancel more easily when conducting remote testing. Your schedule is also at the mercy of postal or courier services and border control and customs, so there can be delays that you have no control over. Build in time to be flexible.

3 Build a story for engagement

More than normal, you need to think about the flow of your test protocol as you would a book - a beginning, a middle and an end. The primary goal is to build participant understanding while not giving too much away. Where the usability test is complex, creating a video of what should happen (to review at the end of the test) will serve to provide positive reassurance that everything was as per participant expectations, after going through the other test materials. This is an important confirmatory step, to ensure that participant and moderator are on the same page. Be mindful of biasing or otherwise influencing the user's response in some way.

4 Technology is brilliant when it works

We've all had those anxious technology 'moments' but they're compounded on the participant side, as they can be difficult to fix remotely. Having a backup communication platform can be useful in this instance. However, despite our best intentions, some participants who, although being connected and having all the correct pieces of technology working, were simply not tech savvy enough to properly engage and complete the test. Consider your test participant demographics carefully in advance and build in extra participant numbers to account for this.

5 Keep paperwork to a minimum

When conducting face-to-face interviews, those quieter moments when you need to take notes or fill in test criteria on a form are understood by the participant. In a remote situation using a screen share, the moderator may not always be visible. These pauses can seem like an eternity to the participant. Using MS Teams, Zoom or similar software, it's very simple to record the whole session and do your paperwork afterwards. Of course, you need informed consent of the participant in place, with the clear understanding of the need for recording. It's best to get consent in advance of the video conference session.

6 Practice being a moderator

It's important to have a moderator who can skilfully explore the reasons behind a participant's response, without irritating or leading them. Knowing the reason why something garners a positive or negative response is more important than the initial reaction. Over video conference, getting to the bottom of the 'why?' driving a response is a skill and will take some practice. Conducting a simulated run through of the test using colleagues or client personnel is a particularly useful preparatory exercise.

Many people will be familiar with the City of Newcastle, a place famous for its industrial history, its nightlife and, through thick and thin, its football. It also stands on the brink of new technological opportunities, as **Dave Golightly** and **Roberto Palacin** explain

Human factors for the digital city

Newcastle is the major centre in a region that's home to the UK's largest car manufacturing plant. It's a significant transport hub with its ports and logistics, it has major universities and research centres, and a growing presence in offshore renewable energy and hydrogen production. It is, nonetheless, in many ways an ordinary, and therefore highly representative, city.

It has around 300,000 inhabitants, rising to over one million when including the larger metropolitan area. Like any other, it's a city that needs to employ, educate and entertain its citizens and therefore faces significant challenges in moving people, and the resulting congestion and emissions. It also sees inequality and exclusion, with the richest wards adjacent to areas with some of the highest levels of deprivation and exclusion, and an ageing population. Most pressingly, it's a city that's trying to understand the implications of Covid-19.

But Newcastle is leading the way in taking technological approaches to resolve its different challenges as a contemporary city. These approaches also need a user-centred philosophy in how the technology is deployed for operational staff, policy makers and, most importantly, the people who live, learn and work in the city. We see these technical innovations in a number of areas. The first is in sensing the city.

The Urban Observatory (https://urbanobservatory.ac.uk/) at Newcastle University is using a wide array of sensors to detect the interactions between the environment, the city and the people who live there. This includes sensing footfall across key points in the city centre, such as Northumberland Street, the main shopping thoroughfare. This gives real time data on movements around the city for pedestrians, for example, to see the increase in footfall on match day or Saturday shopping, but also most recently to understand the effects of Covid-19. This is also captured in accurate, real time sensing of the fall in nitrogen oxide emissions due to a rapid reduction in traffic congestion, and in sensing traffic noise. These measures are critical as we find new ways to configure our city in the light of increased walking and cycling, and social distancing.

Looking from the Tyne Bridge towards the Gateshead Millenium Bridge

IMAGE: NEWCASTLE UNIVERSITY

These data sources are only as useful as the intelligence, decision making and action that they support, and we see this too through the adoption of advanced analytics for monitoring the city. On 28 June 2012, Newcastle and the North East experienced unprecedented flash flooding. The 'Toon Monsoon' as it's known locally, highlighted the need for the city to be more aware, in real time, of the state of its infrastructure, particularly with the emerging challenges of a less stable climate. This has led to analytics to predict availability of assets such as drainage, and the development of digital twinning of aspects of the city and its infrastructure.

This intelligence needs an outlet, and Newcastle is looking at new ways to integrate this intelligence and control the city. A key development is the Urban Traffic Management Control (UTMC) centre. In a unique arrangement, the centre is housed within Newcastle University alongside the Urban Observatory and is therefore able to take advantage of the latest innovations in sensing and analysis. The UTMC presents a single control environment where decisions are made on the state of traffic and potential actions are applied to manage congestion. It's in the UTMC that we can see the future prospects for merging together data, intelligence and control, where responsive actions are taken by traffic controllers to manage sensed spikes in congestion due to data from other transport modes, such as the Tyne and Wear Metro, weather or declining air quality.

The application of this innovation throws up a number of human factors challenges if we're to ensure that the technology works safely, leads to actionable decisions and, vitally, a better environment for citizens. While the technical aspects of sensing and analytic technologies have been developed for many types of infrastructure and asset management, the human-machine interface aspects need attention. This is vital so as to design interfaces that make complex arrays of data interpretable, particularly if the data are incomplete, or the analysis gives probabilities of failures or events occurring.

Work in human factors for intelligent infrastructure points to the importance of taking a decision-led approach. This entails working with operational staff to understand the aims of their decisions, the stages of decision making, expertise, coping strategies and constraints that shape those decisions. This supports the design of representations and the tailoring of automation that will give the most meaningful decision support.

One future challenge with control environments like the UTMC will be to both interpret behaviours via channels such as social media and use social media as an output channel to communicate with travellers about their available options and congestion. This requires an understanding of user-centred information presentation, as well as how different channels need to be used in a complimentary manner to ensure coverage of all demographics. We therefore need to understand the affordances and reach of different information channels, both new (social media, variable message signs, travel apps) and more traditional (local radio) to understand how they shape people's behaviour.

This points to the human factors challenge of participation in the city. One of the concerns with notions of the 'smart city' is that it's a centralised, technology-driven endeavour. Human factors, and its user-centred ethos and methods, can be vital in ensuring the voice of the citizen is heard in how the city is shaped. One recent example is with children, young people and Mobility as a Service (MaaS). The MaaS approach involves the orchestration of multiple travel modes to mesh together travel services and ticketing, while also embedding new travel services, such as shared travel and e-bikes. However, there's a risk that this kind of application may not reach those who need it most; those with limited mobility options. This includes children who need transport to get to school, for socialising and for access to leisure facilities. Through structured focus groups, we found this often-overlooked user group has very specific concerns around the use of MaaS in terms of their trust in underpinning modes, the branding and messaging of MaaS, and their need to feel safe and secure when travelling on public transport. This kind of elicitation of user perceptions is central to making sure the technology-driven city is fit for its citizens and underpins user experience for travel apps and travel service design.

Human factors has a key role to play in the success of the future city

Where human factors may contribute the most is addressing the sociotechnical systems challenge. Approaches such as Cognitive Work Analysis, Systems-Theoretic Accident Model and Processes (STAMP) or Event Analysis of Systemic Teamwork (EAST) allow us to understand a whole systems view of events, and can be used prospectively as a design tool to predict and select the ideal configurations of people and technology. This can make them truly resilient both to the small-scale ebb and flow, such as breakdowns at traffic lights, as well as to major events such as rapid flooding or a virus pandemic. This is particularly challenging when functions span organisational boundaries such as in an integrated city.

Newcastle is making strides in technology adoption to make it a better place to live and work and this technology needs to be implemented to reflect the operational users and its citizens. Human factors, with its methods, knowledge and philosophy of user-centred design and sociotechnical systems, has a key role to play in the success of the future city.


Dr David Golightly and **Dr Roberto Palacin** both work within the Future Mobility Group at Newcastle University. Their work includes human factors for transport operations, decarbonisation of mobility, user-centred transport automation, and acceptance and adoption of innovation such as Mobility as a Service.

Further reading

Casadó, R G et al (2020). Children, Young people and Mobility as a Service: Opportunities and barriers for future mobility. *Transportation Research Interdisciplinary Perspectives,* in press.

The current phased return to work, such as we've never experienced before, throws up a myriad of human factors issues. We'll all be working in new ways, from the physical constraints of social distancing to dealing with the psychological impact of what we've gone through. Three workplace experts give their views on what lies in store

Life after lockdown

Everyone has been affected differently by the coronavirus outbreak. Some people will be grieving lost loved ones, others will be recovering from the disease, and many people will be returning to an altered reality in terms of role and environment. Now, as we begin the process of returning to work, the landscape is going to be radically altered and this, inevitably, will bring with it a fresh wave of challenges.

Occupational psychologist, Dr Roxane Gervais, says that for many people it will take time to process the stress they have been through. "When the situation ends it doesn't mean the stress will end," she explained. "The fight or flight response allowed them to function but when it stops, they might stay stressed for a while." Now, she suggests, is the time that human factors specialists need to be working closely with

employers to offer programmes of support so that individuals can access whatever help they need for their circumstances.

"We need to humanise our communication," adds Sarah Sharples, Professor of Human Factors and Pro-Vice-Chancellor for Equality, Diversity and Inclusion at the University of Nottingham. "People need to have their anxieties listened to. I think that allowing people to feel able to raise anxieties and making sure there is no judgement against those who do raise them, is incredibly important. These changes in management style are likely to be challenging as they can be quite personal conversations, so we've got to make the words meaningful. It might mean being really strict about scheduling meetings so that people get a proper break, it might mean ongoing conversations around care responsibilities."

Professor Sharples added that many people will be returning to work having had to deal with huge emotional difficulties. Some will have been furloughed and some not. Some will have been dealing with loneliness. Others may have had the stress of caring for and home-schooling children while managing their work output. She said, "We mustn't impose our own experience on other people. We don't know the details of people's individual circumstances so we need to recognise it's been difficult for everyone and have honest conversations about how we're going to manage the return to work."

A survey by WKSpace, which polled 22,000 people, found that most would like to come back two to three days a week in order to collaborate. This, the survey revealed, is the part of workplace life they are missing the most. However, Professor Sharples argues that great care must be taken throughout the months ahead and strongly advocates a phased return to work for most people as the most appropriate way forward. "People might need to move more gradually into the workplace and there might be a lot of anxiety around the return to work. We must allow a dialogue to take place before they go back," she says.

There are two actions she maintains are absolutely essential. The first is to make sure that government and scientific guidance is followed as a bare minimum. The second is the need to implement systems to make people feel confident the workplace is safe. Employers must know, appreciate and understand what their anxieties are. Only then, she says, can work and practices be designed to overcome those anxieties.

Dr Gervais says that for some, the psychological effects of the pandemic and the return to work will be greater than for others. Issues around fatigue and stress will affect certain professions more adversely, particularly those in health and social care who have to return to their regular responsibilities after a crisis period. She has considerable experience of dealing with work environment issues and maintains that the biggest problem for those in health and social care was, and still is, the level of demand on them. "Demand is a stressor, their fatigue levels will have been significantly increased and they'll feel tense," she says. "If we have low support levels or no control to do things in the way we want, we find that very stressful. There is only so much control frontline workers can have – they just have to keep going. It can be overwhelming and they will require different coping strategies."

IMAGE: GETTY

Commuters wearing protective masks leave a train station in Rome during the so called 'phase two' period

For other types of work, those on furlough may have been suffering adverse psychological effects, such as the fear and anxiety around whether they will have a job to go back to and what they will do if they are made redundant. "Furloughed workers need to be encouraged to keep in touch with colleagues and know what's going to happen when society starts to inch back to normality," Dr Gervais adds. "Employers should be honest with staff and let them know the possibilities. Individuals are resilient so they will adapt and adjust."

No matter what the work situation, no-one has been spared some form of consequence of the pandemic. She advocates doing a self-assessment every day to figure out how comfortable you are at different points during the day. "Some people are using avoidance tactics but I always tell people, 'Step back. Stop. Breathe and assess how you might do things differently'," she said.

Human factors specialists can analyse the issues and how they play out as the world recovers from the crisis

Jim Taylour is head of design and wellbeing at Orangebox. He emphasises the importance of human factors and ergonomics specialists in not only advising companies but also in designing, implementing and analysing research projects to better understand the issues and how they play out as the world recovers from the crisis. "People don't want to risk their health in coming into work if they're going to spend their time at work trying to avoid each other, particularly if it's a job they could do pretty well from home," he says.

He focuses on the practicalities of returning to an office or workspace environment where workers will have to keep two metres apart and potentially use screens, implement one-way systems and make many other physical adjustments. In consequence, Jim says companies must take time to consider why people need to return to the workplace at all. "All those issues we were worried about – trust and technology – have been proving to work tremendously well from home," he said.

However, substantial numbers of people will remain working at home long-term and this, he says, means employers will have to put a lot more thought into the equipment their staff will need to stay safe and well. "There is a real concern at the moment that employers may be too nonchalant, perhaps a little bit too laid back about people sitting for long periods of time while working at home. Musculoskeletal disorders aren't going to go away, people will still need training and kit." he said.



Dr Roxane Gervais is an occupational psychologist. **Sarah Sharples** is Professor of Human Factors and Pro-Vice-Chancellor for Equality, Diversity and Inclusion at the University of Nottingham. **Jim Taylour** is head of design and wellbeing at Orangebox

Recreating workplaces that work

After lockdown, many organisations will want to get people back to work quickly as restrictions relax but it's also an opportunity to examine and change work practices which could provide more beneficial long-term gains. **Tina Worthy** highlights where application of human factors can help to improve the future of work

Whilst the personal, organisational and financial devastation caused by Covid-19 is evident to all, we've also seen some positive benefits to a global slow down, for example through improvements in the natural world as indicated by better air quality and an increase in wildlife. Whilst many people have been working hard throughout, others have had time to take stock and think about their own futures. So how can we recreate workplaces and redesign work to allow us to retain some of the benefits, whilst being realistic about what individuals and businesses need to achieve in order to survive and thrive?

Work design, organisation and management was the topic of many presentations and papers at this year's CIEHF Ergonomics & Human Factors conference, in conjunction with Organisational Design & Management 2020, in April. The papers, relating to academic research and practical applications,

were submitted towards the end of last year, before Covid-19 emerged globally, and are highly relevant to where we find ourselves now, as the following extracts indicate.

Optimising human performance

If we're going to emerge better and stronger, one way is to go back to basics to understand how our brain works and then ensure we design work in a way that enables us to more easily succeed.

Through improved education, technology and data analysis, safety leaders have become increasingly adept at recognising and controlling external hazards and exposures related to people, processes, and materials, says Sebastian Blair of DEKRA Safety Consulting in his paper, *Brain-Centred Performance: Understanding how the brain works, so we can work more safely*.

He says that what we're beginning to understand is that this isn't sufficient for driving operational excellence or sustained reductions in significant injuries and fatalities. The missing key to unlocking sustained performance reliability and safety comes from within the human brain. Neuroscientists have confirmed that different systems in the human brain compete to control human behaviour – the so-called fast brain and slow brain - which operate independently and at times cooperate to direct all human action.

"With our new, deeper understanding of the workings of the brain", Sebastian argues, "it's become clear that the way our work systems operate and the way the human brain works are not always in sync. The time has come to re-examine our systems, processes and procedures, to isolate the newly identified brain-centred hazards, and to put in place solutions that encourage intentional actions, eliminate reflexive risk, and enable employees to respond to all operating conditions with right-first-time performance. While we cannot change the way our brains work, we can change the way that our organisations work with our brains."

Using technology appropriately

Technology, without doubt, will be part of these solutions. During lockdown, millions of people have been using technology at home in a way they never have previously, for example through virtual meetings, exercise classes and schooling, and with it, confidence has grown in the connectivity and reliability of the technology. But how do we make the best of it?

Sarah Sharples, Professor of Human Factors at the University of Nottingham, notes that as personal and workplace technologies develop, so we need to understand and analyse workplace experience and behaviour in response to introduction of, and engagement with these technologies. Data can present challenges, in terms of how it's interpreted, how it's used to inform decisions and how we manage personal privacy, for example. In her talk, *The digital footprint at work – human factors challenges and opportunities*, she says that human factors professionals have a vast range of tools available to help organisations take a systems perspective to ensure technologies are used responsibly to influence safer and more effective workplaces.

IMAGE: GETTY

Workers with car body part in welding jig in car factory

Working flexibly

Technology has enabled us to work remotely, and whilst working at home might have seemed like a great idea to many before lockdown, the reality can turn out to be very different. Having a quiet place to sit and concentrate can be tricky with a family, so some are having to work more flexibly to accommodate competing demands on their time.

Professor Christian Korunka from the University of Vienna in his paper *Effects of work flexibilization: The role of Interruptions and unfinished work tasks*, says that core elements of flexible work are time schedules, locations and work organisation. Getting these right for the work required is important and many studies have examined the effects of these different aspects of work flexibility on quality of working life indicators. Professor Korunka points out that the results show a wide range of often contradictory results. Some studies reported increases in intensity of work and employee strain, and a strong link between work flexibility and interruptions. Interruptions are work stressors which may result in unfinished work tasks, reduced detachment from work and a decrease in wellbeing. However, other studies found mostly positive effects, for example on work-life balance or job satisfaction.

The time has come to re-examine our systems, processes and procedures so as to encourage intentional actions, eliminate reflexive risk, and enable right-first-time performance

Working comfortably

Many people will be prepared to continue to be flexible and work remotely from home, if they can, at least for some of the time. Many businesses will see financial benefits of this from needing less office space, perhaps through providing co-working space, but will it work in the long term? It's important for individuals and organisations to understand too, the health and safety implications and liabilities of working from home and in shared workspaces.

Guy Osmond of Osmond Ergonomics points out, "whilst it should be easy for employers to equip dedicated workstations and provide adaptable shared spaces in the workplace, working from home will almost certainly be less accommodating. Even well-designed workplace environments will offer poor ergonomics if used incorrectly, so it's very important to train personnel and provide them with an understanding of what good posture looks like to empower them to find the best available comfort in any environment."

"In terms of physical activity, sitting in an office chair all day isn't much different from staying in bed all day and the effects on health appear to be similar", argues Dr Bob →

Bridger, Past President of the CIEHF. He says that prospective studies of 'sedentarism' demonstrate that daily sitting hours are associated with the development of adverse health outcomes and that more than eight hours of sitting per day seems harmful. Dr Bridger states that regular exercise has a protective effect but is an independent factor; even people who exercise a lot will benefit if they sit less.

He says, "Systematic literature reviews of active office interventions show that there is weak evidence for their benefits; office workers given standing desks normally don't stand for long. As demonstrated in research on standing work at computers conducted in the 1990s, people stand very still when doing mentally demanding computer work. Standing still is unnatural, unhealthy and soon leads to discomfort." So, what's the solution? Dr Bridger says that we need to fit the task to the active working option and not to fit the posture to the task.

"An ergonomic working environment needs to support comfort, provide easy access to technology and smooth communication channels with management and colleagues", says Meg Honan of the University of California San Francisco, "Standard shared workspaces often include fixed height desks and chairs that do not have the full range of adjustment necessary for a diverse range of workers, and little in the way of choice about where and how to work. Ergonomically designed workspaces however, include fully adjustable furniture, additional equipment such as headsets and wireless mice and a choice of spaces, including quite zones workers can use that best suit their tasks."

Supporting workers

Provision of well-designed shared workspace is one way to assist workers, but with many people taking an enforced break how do we ensure their fitness for work when they return, both physically and mentally? Support will be needed from many quarters, not least from occupational health professionals.

First line managers can develop resilient action strategies, enhancing the ability to rapidly recover or respond when work is disrupted in a way that minimises loss or increases gain

Ole Broberg and Dr Sisse Grøn of the Technical University of Denmark ran a training programme to investigate if occupational health and safety professionals could learn a design thinking approach to frame and solve problems in complex workplaces. The ultimate goal of the work to was to develop guidelines and tools to support them, as described in the paper, *Training of Occupational Health and Safety Professionals in Design Thinking*.

A workplace with space allowing flexible work practices

Worker health and performance can be improved by taking a participative approach to change and including workers in discussions and idea generation. In a paper called *New Ways of Working: Implications for Office Ergonomics*, Dr Michelle Robertson, a lecturer at Northeastern University, USA, points to an organisational design approach called macroergonomics. She says it can help to reduce health risks and increase performance by providing flexible physical work environments and accommodating the ergonomics needs of individual employees and project teams. This approach incorporates an understanding of the individual components of the work system as well as their interrelationships, specifically the social, technical and physical environments. Emphasis is placed on participation of workers in the workspace design process in terms of understanding work process needs and business requirements and training in the optimal use of the workspace as a tool for safe and effective work.

Dr Robertson says that field studies that included this macroergonomics perspective in the design and implementation of new workplaces, along with comprehensive ergonomics training and practice, have shown significant and positive effects on worker health and performance. "Significant improvements in ergonomics knowledge, ergonomic workstation set up and postures, as well as a significant reduction in musculoskeletal and visual symptoms and an increase in productivity are all possible."

Managing change effectively and sustainably

Ensuring workspaces are fit for purpose will be even more important with modifications now needed to allow for increased distancing and hygiene measures. This could result in a move to fewer workers on site at any one time, introduction of shift systems to sustain levels of output, and reorganisation of work tasks to match available skills and resources. Reductions in staff numbers may shift the manager/worker proportion and dynamic. What effect will this have and how will work be allocated? What will be the effect on system performance and workforce health and safety? How can we make change for the better sustainable?

Dr Christine Ipsen of the Technical University of Denmark says the idea behind sustainable management is to be proactive to prevent stress and ensure wellbeing by adjusting how work is designed, organised and managed to ensure organisational performance. Dr Ipsen's study presented in her paper, *Sustainable management of job (re) design*, aims to further the discussion on management of job (re)design. It looks at how managers and workplaces can ensure both organisational performance and employee wellbeing in practice by focusing on prevention, job design, organisational design and business models. Get these right, Dr Ipsen says, and an organisation can enjoy a continuous competitive advantage and a healthy workplace.

Dr Colin Drury, of the Applied Ergonomics Group Inc. in the USA, says the level of staffing in an organisation

IMAGE: GETTY

is an important determinant of both the organisation's effectiveness and of the workforce wellbeing. In his paper, *Staffing Models in Ergonomics/Human Factors*, Dr Drury argues that it used to be comparatively simple to figure out how many staff were needed when work consisted of repetitive tasks, with total output measured in numbers of identical items produced per unit time but this isn't the case now as it's common for teams to work together to carry out more complex tasks.

Dr Drury says there are several models, one example being those that take staffing data from a number of enterprises to predict the staffing needs of other enterprises with analogous tasks. Another example are those that calculate total workload and therefore numbers of staff through summation of task times. Human factors principles can help with examining and recommending rational workloads for staff considering cost, error rate and the consequences of workload on the individual staff member.

For many years, both private and public companies have been developing policies to strengthen the sustainability of their operations, which will stand them in good stead for the future. Professor Peter Hasle from the Department of Technology and Innovation at the University of Southern Denmark in his paper, *Integrating social and economic sustainability with lean production methods*, says such methods open possibilities of creating a tangible link between the traditional drive for productivity and the need to secure a safe and healthy workplace. Lean offers possibilities to get in-depth insights into the flow of work, which has a clear link to the ergonomics approach to work analysis. He highlights studies of two very different industries, clothing manufacture in Bangladesh and healthcare in Denmark, to show how a lean approach can be used to integrate productivity and health and safety improvements and thereby initiate a movement towards greater economic and social sustainability.

Emphasis is placed on participation of workers in the workspace design process

Building resilience

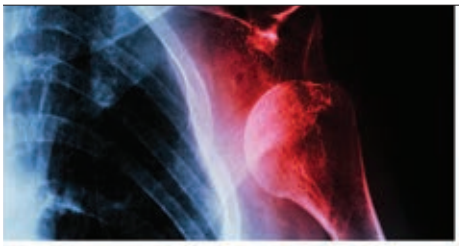
Sustainability needs to be complemented by resilience. Organisational resilience can be a source of competitiveness, enabling companies to respond and adapt to unexpected changes, ensuring that a company can thrive whilst dealing with the unexpected.

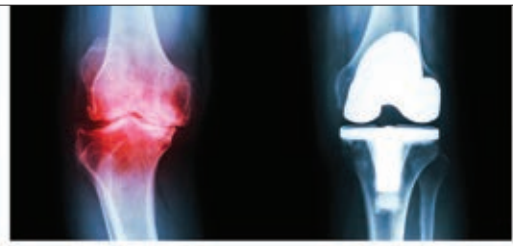
The ability of first line managers to handle their daily work at the operational level to maintain stable production output, while managing the many challenges in the complex industrial context, is key, argues Magnus Karlsson of Jönköping University in Sweden. In his paper, *Resilience through the daily work of first line managers*, he outlines a study that aims to fill these knowledge gaps and develop both scientific and practice-orientated knowledge on how the daily work of first line managers is enacted and how it can be improved. It also looks at how first line managers can develop resilient action strategies, enhancing the ability to rapidly recover or respond when work is disrupted in a way that minimises loss or increases gain. Resilience can consequently act as a source of competitiveness.

The world is changing in a multitude of ways, and with it, the future of work. These studies show that application of human factors principles and expertise can help ensure it's a better future for everyone. ●

Further reading

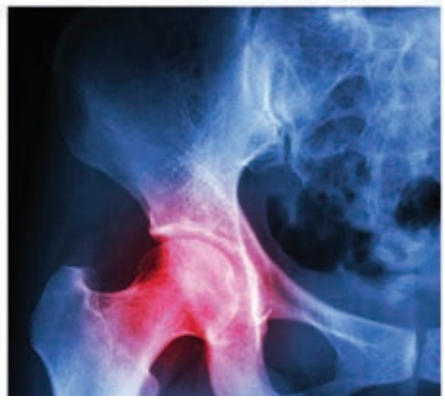
All papers have been published in the CIEHF's digital book, *Contemporary Ergonomics & Human Factors 2020*, and are available from https://publications.ergonomics.org.uk. Accompanying talks are available to access from https://conference.ergonomics.org.uk.





Designing out risk

Musculoskeletal disorders are a major cause of work-related ill health but a competition to design out specific problems has resulted in some innovative solutions, as **Ian Hobson** explains, in two very different sectors of the UK economy



Embracing new and innovative ergonomic design solutions, re-designing and improving existing solutions, and encouraging others to think about how they might themselves reduce musculoskeletal risks through design, form an important part of the Health & Safety Executive's health and work programme.

Musculoskeletal disorders (MSDs) include injuries and conditions that can affect the back, joints and limbs. They can be caused or made worse by work. They are found across most industries and are associated with many different physical activities such as manual handling, lifting heavy or bulky loads, pushing/pulling heavy loads, stretching, twisting and reaching, repetitive work and awkward fixed postures.

The latest figures from the Labour Force Survey show that musculoskeletal disorders are the second most common cause of work-related ill health – only stress rates higher. Last year it was estimated that there were 498,000 cases of work-related musculoskeletal disorders resulting in 6.9 million working days lost. That's an average of 14 working days lost per case, together with the associated human and economic costs.

Research shows the cause of musculoskeletal disorders is multifactorial including physical and biopsychosocial factors. Addressing the cause therefore needs a holistic approach which includes applying ergonomic designs to reduce musculoskeletal risks but also ensuring participation of the workforce in the process. This should be a core part of any employer's armoury to tackle these issues and make a real difference to the lives of workers who otherwise would be just a number in the national statistics of those suffering from these conditions.

Risk reduction through design

The 'Risk Reduction Through Design' awards are now in their third year and are jointly sponsored by HSE and CIEHF. They are intended to highlight the important contribution that design changes can make to reducing the risks of musculoskeletal disorders by giving recognition to businesses and rewarding design changes that have made a real practical impact to the lives of their workers. Through the awards, we also want to inspire and encourage other businesses (large and small) who have perhaps not previously been involved, to consider how they could also make design changes to eliminate or reduce the risks of work-related musculoskeletal disorders in their own workplaces.

This year, as in previous years, the awards competition had a broad scope, aiming to attract design solutions from a wide range of sectors. This year's entries came from across the UK including the railways, construction, transport and logistics, manufacturing, utilities and health sectors.

Entrants were asked to tell us about the musculoskeletal problem before any design changes. They then had to explain the design solution and describe the MSD benefits – the risk reduction that the design changes had achieved. We were also interested in any wider benefits that the changes may have brought about, and particularly how workers had been involved and participated in the process, and what they thought about the changes and how they were affected.

Given the scope of the award, there was no surprise at the breadth of nominations which ranged from specifically designed lifting aids and equipment to exoskeleton vests, an ergonomics risk reduction strategy, and the re-design of an ambulance to reduce the ergonomic burden and musculoskeletal risks to staff.

As with previous years, entries were assessed by a judging panel consisting of representatives from the employers' organisation Make UK, the Trades Union Congress, CIEHF and HSE. There was stimulating debate between the judges on the relative merits of each entry. Some showed novel design solutions, some with the potential to reduce musculoskeletal risks to large numbers of workers, some which had

great elements of worker involvement, and others which had used data to say how many workers had been affected before and after the design changes had been implemented.

The judges unanimously agreed this year's winning entry was Severn Trent Water, for their work to reduce the risks around handling standpipes. The judges said: "This is a demonstration of how effective solutions don't have to be massive or technically complicated. It captured the brief of the competition by providing a simple, effective, engineering solution designed in collaboration with an equipment provider."

The judges also commended the entry from Network Rail which tackled rail-side movement of heavy points equipment.

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 and develops case studies to illustrate what good looks like. The growth of this competition will be a measure of how successful HSE has been in encouraging employers to move towards musculoskeletal disorders risk elimination and reduction through design.

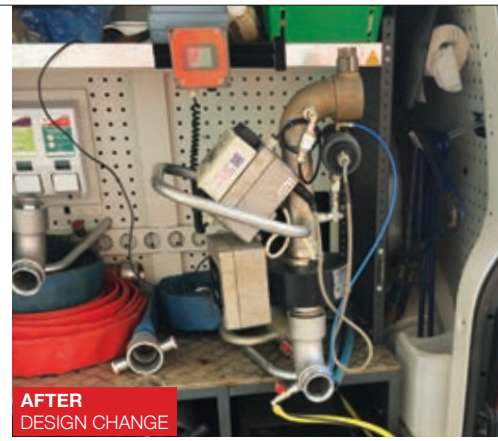
We hope this article will encourage all businesses, large and small, to think more about reducing the risk of musculoskeletal disorders by design, and even to think about entering next year's competition. In the meantime, HSE's message continues to be that risks from musculoskeletal disorders must be controlled and that employers should eliminate risk at source where possible.

Ian Hobson is a Senior Policy Advisor in the Health & Work Branch at the Health & Safety Executive.

Further reading HSE Risk Reduction Through Design Award: www.hse.gov.uk/msd/awards.htm
Labour Force Survey: www.hse.gov.uk/statistics/lfs/index.htm

IMAGE: ISTOCK

BEFORE DESIGN CHANGE



AFTER DESIGN CHANGE

Winning Entry: Severn Trent Water

Severn Trent's entry, a re-design of heavy standpipes (used for water quality testing and monitoring) fitted to water hydrants was the idea of Anthony Skellett, a network maintenance technician on one of the maintenance cleaning teams.

Before the design change:
The maintenance teams used standpipes as part of the process to flush out water hydrants and monitor and record water quality data at each location. However, the problem was that the existing standpipes were top heavy and cumbersome and had to be lifted off the vans and mounted onto the water hydrants at each location where the water quality needed to be tested, an operation that happened up to 20 times a day by each maintenance technician. The nature of some of the water hydrants also increased the awkwardness of the lift when fixing the heavy standpipes into position on the hydrants.

After the design change:
Severn Trent worked with manufacturers Langham Industrial Controls Ltd to develop an adaptor so that the heavy standpipe could be mounted in the van both during transit and during the water flushing operation at the hydrants. This designed out the manual handling operation and provided risk reduction to the maintenance technicians, including Anthony, who carry out the operation. A further bonus of the design change meant that the process of setting up the hydrant for flushing was quicker and therefore more checks could be completed per shift, increasing productivity without compromising workers' health.

Commended Entry: Network Rail

Network Rail were commended by the judges in this year's competition. Their collaborative effort with Aquarius Rail resulted in the Aquarius Road Rail Vehicle Trailer and Crane Attachment.

Before the design change:
The task of renewing rail track points operating equipment involved a team lift of six people manually handling the track points which weighed 250 kg each. The challenge was how to eliminate the manual handling aspects during moving to the point of installation and during the installation itself while taking account of other competing railway safety restrictions and requirements.

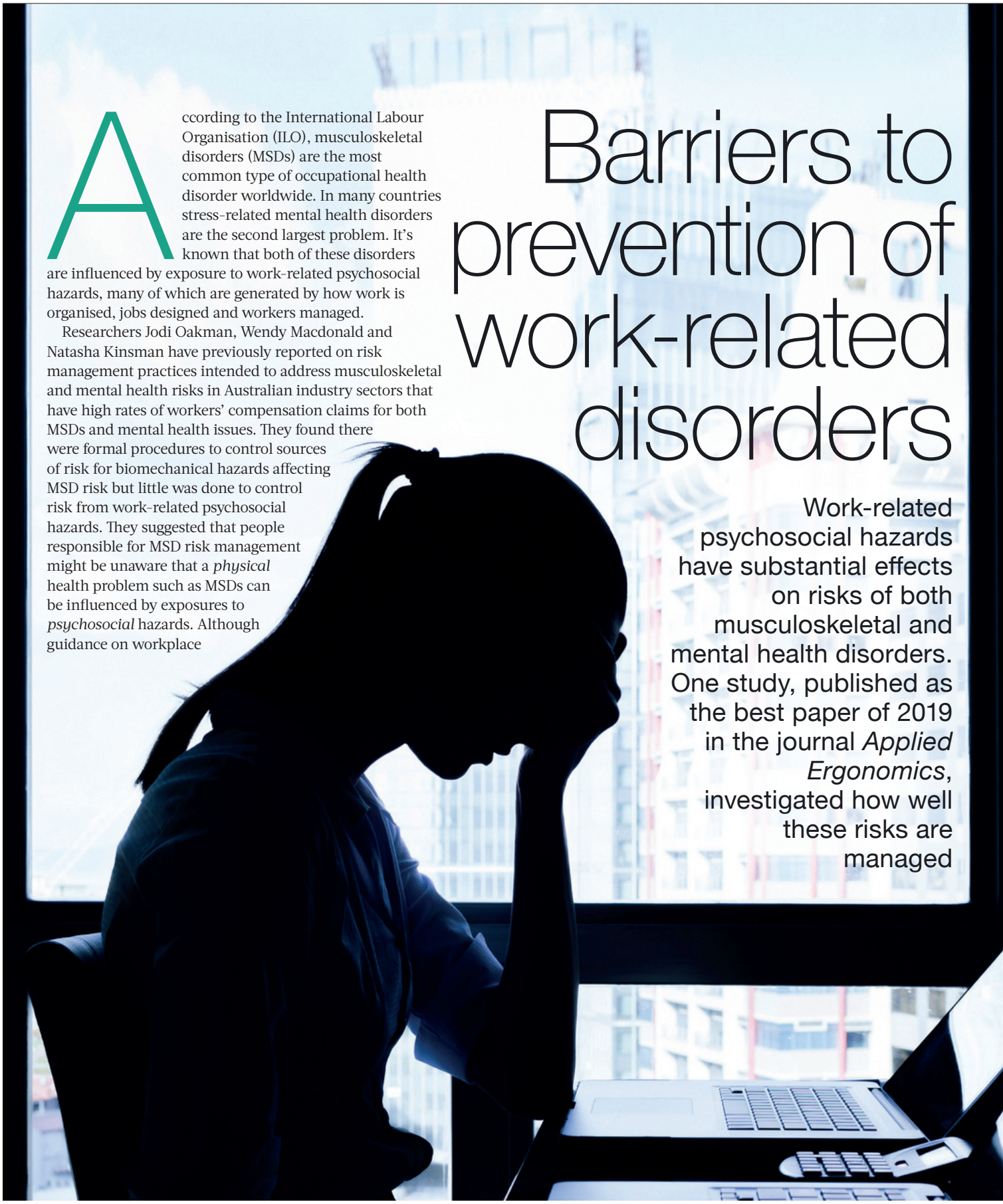
After the design change:
The innovative solution was to develop a bespoke trailer and crane lifting attachment which helped eliminate aspects of the manual handling of the track points equipment both in the depot and at track side. An added wider benefit is how the equipment is also now being used to reduce manual handling in the environmental clean-up of trackside rubbish.

BEFORE DESIGN CHANGE

AFTER DESIGN CHANGE

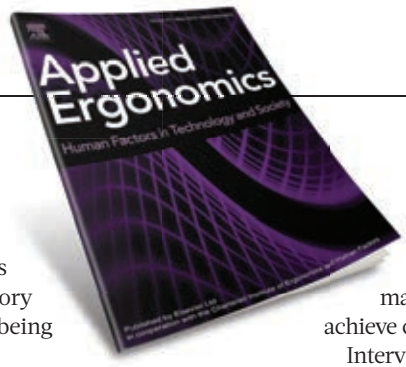
Barriers to prevention of work-related disorders

Work-related psychosocial hazards have substantial effects on risks of both musculoskeletal and mental health disorders. One study, published as the best paper of 2019 in the journal *Applied Ergonomics*, investigated how well these risks are managed



According to the International Labour Organisation (ILO), musculoskeletal disorders (MSDs) are the most common type of occupational health disorder worldwide. In many countries stress-related mental health disorders are the second largest problem. It's known that both of these disorders are influenced by exposure to work-related psychosocial hazards, many of which are generated by how work is organised, jobs designed and workers managed.

Researchers Jodi Oakman, Wendy Macdonald and Natasha Kinsman have previously reported on risk management practices intended to address musculoskeletal and mental health risks in Australian industry sectors that have high rates of workers' compensation claims for both MSDs and mental health issues. They found there were formal procedures to control sources of risk for biomechanical hazards affecting MSD risk but little was done to control risk from work-related psychosocial hazards. They suggested that people responsible for MSD risk management might be unaware that a *physical* health problem such as MSDs can be influenced by exposures to *psychosocial* hazards. Although guidance on workplace



The journal *Applied Ergonomics* is published by Elsevier

management of risks from psychosocial hazards is readily available from sources such as regulatory bodies and the ILO, there is little evidence of it being used effectively.

In this context, the researchers conducted in-depth, semi-structured interviews with employees in two high-risk industry sectors to identify issues as detailed in their paper, *Barriers to more effective prevention of work-related musculoskeletal and mental health disorders*. The 67 interviewees included 26 from nine aged care organisations and 41 from ten logistics/transport organisations. They represented a range of management levels, including executives from top management teams, site managers and other senior managers, as well as staff with specialist occupational health and safety (OHS) roles and workers' health and safety representatives.

Participants were asked for their opinions about the main causes of MSDs and of stress-related mental health disorders in their workplace, and about their existing risk management practices to control these risks. Other questions explored their beliefs and perceptions about factors limiting their own ability to take effective actions to reduce risk. Identified barriers to more effective risk management were categorised within an ergonomics systems framework, according to whether they related to: at-risk workers; task and equipment factors; job design, work organisation and management factors; or factors external to the organisation.

Interviewees were largely unaware that psychosocial hazards affect MSD risk, and of the need to manage risk from most of the work-related psychosocial factors known to be important determinants of occupational stress and associated health problems. They were also unaware of available risk assessment and control procedures for psychosocial hazards. It was concluded that this lack of awareness and knowledge constitutes a fundamental barrier to improving current risk management practices.

Barriers to more effective risk management were found to be distributed across all work system components, and many were categorised by the researchers as psychosocial. Most of these were considered by interviewees as largely or entirely beyond their control. External factors were also reported as important but largely uncontrollable. In both industry sectors insufficient funding and inadequate staff numbers were two of the most commonly reported barriers. In the aged care sector, the wellbeing of residents was seen as having much higher priority than workers' occupational health and safety. In the logistics/transport sector, the organisation's profitability was also frequently mentioned as a higher priority. People in both industry sectors also reported their ageing workforce as a factor that made MSD risk management more difficult.

Inadequate manager competence was frequently mentioned as a barrier (including self-reports of this), particularly concerning management of stress-related issues. The researchers noted that this is not surprising in view of participants' generally low level of OHS education with few having professional level qualifications. Australian OHS courses at sub-professional levels have typically focused mainly on physical hazards and on requirements to achieve compliance with regulations and legislation.

Interviewees also demonstrated little awareness of the OHS hierarchy of risk control. Poor worker attitudes were mentioned by participants from both industry sectors as a barrier to more effective MSD risk management, often because they were seen as causing workers to take risky short cuts rather than follow specified procedures. In the logistics/transport sector, such attitudes were often seen as due to a macho workforce culture which stigmatised people with mental health problems. Similarly, mental health issues were seen as mainly about worker behaviours such as bullying and harassment, and management strategies focused on provision of stress management support to victims rather than addressing related organisational and management factors. The researchers identified a need for managers to be aware that the most effective risk control strategies are those that address risks at their work-related sources rather than focusing primarily on worker behaviours.

A physical health problem such as musculoskeletal disorders can be influenced by exposures to psychosocial hazards

Finally, the researchers emphasised the need for more people employed as OHS specialists to have professional level qualifications and for ongoing professional development programmes for general managers to increase their knowledge of requirements for more effective MSD and mental health risk management.



Associate Professor **Jodi Oakman**, Adjunct Professor **Wendy Macdonald** and **Natasha Kinsman** work at the Centre for Ergonomics and Human Factors, School of Psychology and Public Health, La Trobe University, Victoria, Australia.

Further reading

Oakman J, Macdonald W & Kinsman N (2019). Barriers to more effective prevention of work-related musculoskeletal and mental health disorders, *Applied Ergonomics* vol 75, pp184-192

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Oakman J, Macdonald W, Bartram T, Keegel T & Kinsman N (2018). Workplace risk management practices to prevent musculoskeletal and mental health disorders: What are the gaps? *Safety Science* 101, 220-230. https://doi. org/10.1016/j.ssci.2017.09.004

International Labour Organisation (2015). Global trends on occupational accidents and diseases. Retrieved 9 February 2018 from https://bit.ly/2zlx8xV

IMAGE: ISTOCK

LEARNING FROM ADVERSE EVENTS

Chartered Institute of Ergonomics & Human Factors

A new White Paper from the Chartered Institute of Ergonomics & Human Factors

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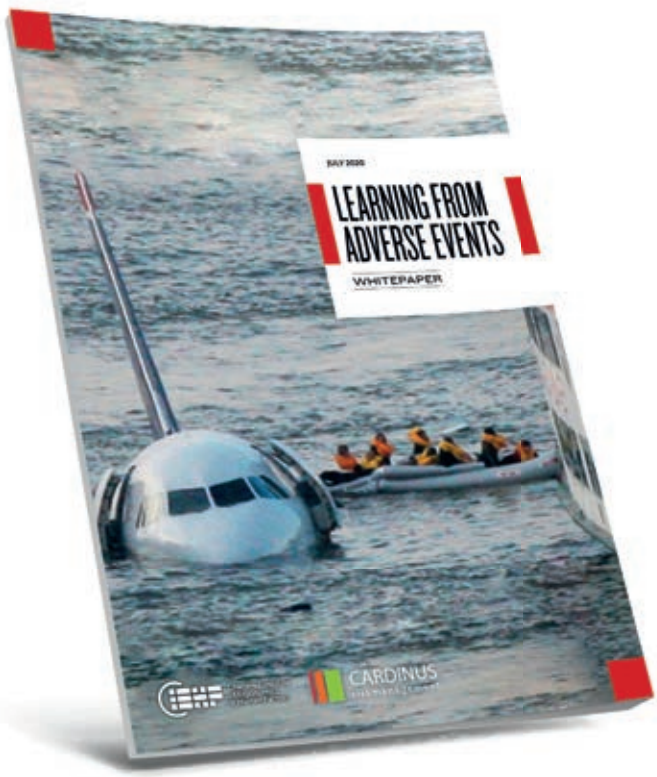
- Help organisations understand a human factors perspective to investigating and learning from adverse events.
- Provide key principles organisations can apply to capture the human contribution to adverse events.

Launched on 24 June 2020 following a webinar by its lead authors



What's inside?

The systems, tools, culture and expertise that support incident investigation largely determine the quality of the output and learning achieved.

- Find out why the value of an investigation is only as good as the quality of the learning achieved.
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OPINION

Bathroom battles

With hand-washing a more frequent activity for all of us in recent months, we've spent plenty of time at the sink. This has led **Bill Gall** to contemplate the design of bathroom facilities and controls and to wonder why some of them seem to put form before function

Is it just me, or does anyone else wonder if bathroom equipment designs are ever tested, or at least, end-user-trialled, before they go on sale? Let's for now confine ourselves to washbasins and showers. I know some 'fundamental' work was done many years ago on the humble loo, but the interface there is probably somewhat simpler. Unless you're in Japan where loo seats are high tech.

What's my problem? It's just the sheer difficulty some designs have presented us with.

Take for example, this shower control. What's going on here? It's a shower with two simple controls. On/off and temperature. Easy. But look closely. Look how nice and chrometastically shiny and smooth they are. There are dinky little indentations to provide some level of grip for the soapy hand. The problem is, they don't work. Unless you have a hulk-like grip or are, in fact, the Hulk (and angry at the slipperiness of the controls), there is no way you can apply sufficient torque with a wet, let alone soapy, hand to be able to turn them. Not good. There are worse examples where the design is beautifully dome-shaped. They give you a lovely hall-of-mirrors view of your steamy soapy body but don't actually meet the functional spec. Pretty? Yes. Practical? No.

Before we finish with showers, a special mention for the three-control version.

Seriously? You found it just too difficult to deconflict temperature, 'drench' and 'hose down' controls?

Washbasins. For washing hands – or feet if you're athletic and can't be bothered with smooth-control showers. This particular tap design has an on/off lever that also controls the hot and cold setting. Neat.

But do you trust it to deliver only fresh mains water even if the lever is thrust fully to the handily universal blue setting? I don't. Any more than I trust my French in France to avoid, *dans la nuit* (and almost pitch dark), not to choose 'C' for my nocturnal thirst-quencher.

Now here comes the icky bit. Plugs. These used to be well-designed rubber and metal gadgets attached to a useful chain. Or if you're flash, a plunger or lever, albeit often cunningly hidden behind the mixer tap. It seems that someone thought that this is so last century they decided we needed something different. So we now have a hinged thing that you simply flip to the vertical to drain the basin or a plug that needs a little push to make it open. Fab.

Except if you're a bloke and you've decided to eschew the designer-stubble look and have an actual wet shave. Task analysis: apply soap (gel or oil are also available), spread over the battlefield that is your face, steady your hand, apply razor, scrape, repeat. Now, what's that in the basin? Several circles of hell of yuck, that's what. Do I really have to put my hand in all that to get rid of it? Urghurgh!

There's also the pushy type of stopper arrangement that requires similar plunging into the abyss. Furthermore, if that type of design is in a bath, which this example is, and someone has thoughtfully put it in the geographical centre of said whole-body ablutionary receptacle, there is more than a risk, it's a nigh-on certainty – especially if you favour the recumbent walrus wallow method of bathing as I do – that the plug arrangement gets opened 'non-manually'. I call this the 'butt-on button' method of control operation. This can go unnoticed until nearly all the hot water you've lovingly added bubble or bath bomb to has all but gone. It's irritating.

I don't deny the designs are aesthetically beautiful, but I'm afraid they're also more than a tad annoying.

And don't get me started on light bulbs...

Bill Gall is a human factors consultant.

Success stories

The Institute recently celebrated the remarkable achievements of members at this year's digital awards ceremony. We recognised excellence in individual and group work in all sectors and from those just starting out to those with a wealth of experience. Here, three of the winners tell their stories.

ANTHONY BRIDGES, GROUP LEAD HUMAN PERFORMANCE, QINETIQ

The President's Award

I'm proud and delighted that our research and expertise has been recognised with the honour of the CIEHF's President's Award. I've been touched by the thoughtful comments made by our customers and grateful for all the opportunities they have given us to work with them over the years. The QinetiQ Human Performance team works for customers where mistakes may result in the loss of life or valuable assets. Our role is to help our customers understand how their systems could be enhanced to improve effectiveness, efficiency and safety.

Our customers tend to be in defence and security and include government departments and commercial organisations in the UK and overseas. Our work on mission-critical systems in fast-changing environments saves lives, provides better workplaces, creates new capabilities, and enables the military to operate complex platforms in high-hazard environments. We work across land, air, maritime, space and cyber. As a result of our work over the last 12 months, our customers are making changes that will increase diversity in UK defence, improve real-time engagement data, address previously unseen risks in aircraft seat design, define the physical characteristics necessary for safety-critical helicopter roles, enhance aviation security and save the lives of military divers and submariners.

Our customers cited a number of reasons why they supported our nomination for the award. The first is that they trust the team to use research, trials and experience to understand complex problems and deliver practical solutions to critical problems. The examples given ranged from submarine escape to aviation security. Secondly, customers value our deep subject expertise. With more than 80 people in the team, we are able to draw on a very broad range of human factors experts with domain expertise in areas such as cybersecurity, autonomous systems and organisational design. Customers have confidence in the professionalism of the team and have said they value the deep subject expertise of those team members.

Customers have confidence in the professionalism of our team and value our deep subject expertise

Finally, the team is flexible; they work around the world at short notice and adapt to changing customer requirements and the practical challenges of operational data collection and customer availability. Our

RAF Chinook helicopters landing on HMS Queen Elizabeth

human factors experts come with a range of backgrounds. The team includes physiologists, fatigue experts, engineers, modellers, medical staff, psychologists, thermal experts and statisticians, as well as those with a more direct ergonomics and human factors background. We actively encourage and support team members with further study, participation with working groups and progression to CIEHF Chartership. This helps to create a culture of continuous learning and development.

IMAGES: SHUTTERSTOCK / DEFENCE IMAGES / TFL

ZOË COOPER, HUMAN FACTORS ENGINEER AT MOTT MACDONALD

New Ergonomist of the Year

Winning this award was a complete surprise to me as I didn't know my colleagues had nominated me! I'm absolutely delighted and honoured to have received it and I'm very grateful to all those who have supported me in my career so far.

I joined Mott MacDonald in 2015 having graduated from Plymouth University with a Masters in psychology, specialising in behaviour change. In 2019, I achieved Chartership with the CIEHF. In the last five years I've had fantastic opportunities to work on a wide range of projects which have been key to expanding my experience in human factors technical areas, developing my consultancy skills and building my own network of effective relationships with both clients and colleagues.

I've provided human factors support to a number of large-scale railway engineering projects including the Northern Line Extension, HS2 and Waterloo International Terminal Upgrade. The wide variation of human factors technical support required on these projects has allowed me to develop a broad range of experience in human factors areas including accessibility, control and operation room design and workload management.

A highlight of my career so far was a three-month secondment to Transport for New South Wales in Sydney, Australia. This experience pushed me outside my comfort zone at an early stage in my career, enabling me to accelerate the development of my consultancy skills. I believe that my ability to listen, understand and engage with others, along with my passion for delivering practical, realistic solutions for clients and the end-user, supported my success in this role.

Both my technical experience and consultancy skills help me in my current role as Human Factors Integration Manager

Work on the Northern Line extension

for the development of the Crossrail Route Control Centre at Romford. This is a complex client-facing role which involves managing inputs from multiple suppliers and also leading the Mott MacDonald team's technical delivery.

Outside of my core work, I'm passionate about communicating the importance of human factors integration in the design and delivery of infrastructure and behaviour change projects. I've presented at several events including the Transport Practitioners' Meeting 2019 and the Chartered Institution of Highways and Transportation regional event.

I find working in human factors incredibly rewarding and I'm looking forward to seeing where the next five years take me.

A highlight was a three-month secondment to Australia which pushed me outside my comfort zone at an early stage in my career →

Shell's Perdido offshore drilling and production platform

RON MCLEOD, HUMAN FACTORS CONSULTANT

Lifetime Achievement

It's very flattering to be recognised by the Institute as worthy of this year's Lifetime Achievement Award. As an undergraduate at Stirling University, I was very engaged with the ideas of Gibsonian optics: how the information available to the eyes as we move around the world guides and controls our movement. The experiment for my final year dissertation was based on the use of what Gibson termed the 'optic-flow' in driving. The paper, 'Optic-flow and cognitive-factors in time-to-collision estimates', was published in the journal *Perception* in 1983 and has since been widely referenced. The experiment has even been replicated and extended and was also apparently one of the first laboratory experiments to show a clear difference in risk judgements between men and women.

After completing my PhD in 1986, I joined Yard, a naval engineering consultancy in Glasgow. I supported one of three consortia bidding for the contract to develop the command system for the then new Type 23 Frigate for the Royal Navy. This was the first major, not to mention fixed price, procurement required to include a comprehensive human factors programme. The human factors team at the then Admiralty Research Establishment had specified 110 human factors tests to be conducted as part of the overall system acceptance programme. Our consortium won the contract and I was retained as a consultant on the project for nearly ten years to deliver the human factors programme. I'm still very proud of the work we did, and especially that we passed all 110 acceptance tests with flying colours.

After I took on the position of Global Discipline Lead for Human Factors in Shell in 2007, I quickly realised that to be effective in delivering what Shell needed in terms of designing facilities that met the company's own emerging human factors engineering standards, I needed to try to get alignment across the industry. All of the 'majors' used the same engineering contractors and equipment suppliers but they all had slightly different approaches, if any, to applying human factors on capital projects. That led me to work through industry organisations, mainly the International Oil and Gas Producers Association (IOGP), to publish a number of guidance documents on what constituted best practice in human factors in the industry. These were, and still are, influential around the global process industries.

I'm also extremely proud of my contribution to the work Shell did to try to develop a culture of 'chronic unease' following the Deepwater Horizon disaster in 2010. Shell's safety team produced an animation based on a training pack I developed and delivered across the company covering some of the psychological background to the concept. That animation has been extremely widely used and has been influential across many industries. It's still available at https://youtu.be/I-7cWi4V8sQ.

I was keen to contribute to developing good practice where there were clear gaps and a need for guidance from a strong and influential voice

After I left Shell in 2014, I was still keen to contribute to developing good practice in areas where I could see there were clear gaps and a need for guidance from a strong and influential voice. I joined the CIEHF Council and realised that, although it had not previously published best practice guides, the Institute was actually in a powerful position to do just that. It's hard to disagree if the Chartered Institute publicly says something clearly within our domain of expertise is, or is not, best practice. This is why I volunteered to lead and write the Institute's first White Paper on *Human Factors in Barrier Management* that was published in 2018. I've just finished leading the team that has written a new White Paper on *Learning from Adverse Events.* I'm looking forward to that being published this year.

I'm also proud of my book *Designing for Human Reliability: Human Factors Engineering for the Oil, Gas and Process Industries,* published in 2017. Writing that book was hugely cathartic for me in getting stories and material I'd collected and been using in training and workshops for many years out of my head. I'm very pleased with the way the book has been received, and the influence I'm told it's having. Writing it created the 'head space' for newer interests, especially around the concept of complacency and risk awareness.

IMAGE: GETTY

Obituary

CARYS SIEMIENIUCH

A fair and forthright communicator, with a generosity of spirit, 1962-2020

Carys Ellen Siemieniuch was born Llangollen, North Wales. She attended Manchester University, worked in the manufacturing industry, moved into administrative roles in education, and eventually became a mature student at Loughborough University. She stayed within the University, first as a researcher in human sciences in the Advanced Technology Research Group and then in the BAE Systems-sponsored Systems Engineering Innovation Centre. Carys then joined the academic staff of the University, in the Wolfson School of Mechanical, Electrical and Manufacturing Engineering, where she eventually rose to be Professor of Enterprise Systems Engineering. Additionally, she was a Justice of the Peace in Leicestershire for 12 years.

I first met Carys when she applied for an MSc course at Loughborough University in the late 1980s. She stayed on after that course, and we worked together in a team from then on, for some 30 years. From those early days, Carys' professional skills were on display; her abilities as a thinker, teacher, researcher, project manager, negotiator and developer of theory were always evident.

Her professional output was prolific; as author of professional papers, book chapters and reports, she published well over 100 documents, all in the domain of socio-technical theory, systems engineering and systems ergonomics. There were no laboratory experiments in all this; it was all project work with companies and organisations, initially in the manufacturing, automotive and aerospace arenas, featuring all the main companies in the UK and the EU as well as smaller companies in the supply chains.

Carys was an outstanding teacher as well; her style was unique but also award-winning. In meeting new students in one of her modules, the first 15 minutes was all fire and brimstone about what was expected, sometimes terrifying a student or two. But after that, her teaching qualities came through; clear exposition of the content, lots of help when needed (including when students didn't know it was needed) and praise when it was due. Hers was a 'tough mothering' style. A student would get help but the student had to try; lack of the latter could result in a clear, pointed conversation about being a better student. By the end of a module, the students were almost always very appreciative of her contribution, leading to awards.

This reflected many of Carys' sterling qualities. Brought up in North Wales in financially stringent times, she took on fully the Welsh characteristics of hard work, thrift, togetherness, equality and concern for others and these characteristics were always on display. She was fearless in expressing herself in any company whenever she felt unfairness or injustice was being perpetrated, though she didn't always win against entrenched cultures. She could also be very direct when presented with false promises, evasions, poor excuses and prevarications.

Her fearless, up-front approach has given us many stories and memories

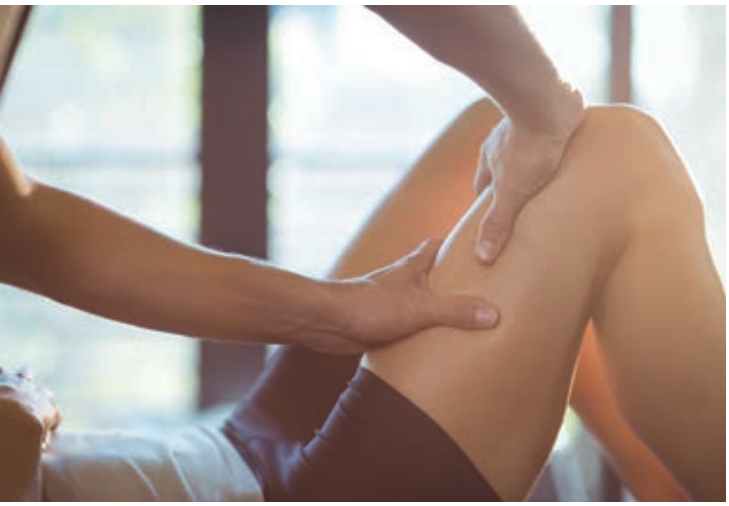
But throughout those 30 years at Loughborough, it was her generosity of spirit, her willingness and confidence to go into unknown fields, and her care for the people around her that will be remembered most. She was never selfish, occasionally crusty, and always a good friend. She improved the world around her, and her fearless, up-front approach has given us many stories and memories with which we may face the future. Carys will not be forgotten; there was always so much life in her that we could not forget.

Murray Sinclair is a Visiting Fellow in the Wolfson School of Mechanical, Electrical and Manufacturing Engineering at Loughborough University.

Q&A

MEMBER PROFILE

Val Noble talks to Tim Power about what led her into a career in physiotherapy and ergonomics



What interested you in physiotherapy as a career?

I was brought up on a farm on the Black Isle, near Inverness in the Highlands of Scotland and used to love sports like hockey, netball and athletics, often competing in county-level events. I was competing in a high jump, attempting the Fosbury Flop, when I injured my back as I landed hard on the ground because the mat had not been placed properly. Early treatment along with therapy for other minor sport-related injuries in the past, made me realise the benefits of physiotherapy. I wanted a career that was practical and physical and I've always liked problem solving so I felt physiotherapy would give me that kind of challenge.

How did your early career develop?

After qualifying from Grampian School of Physiotherapy in Aberdeen in 1982 and working in the Isle of Lewis for four years, I moved to Plymouth to work for the Royal Navy, specialising in upper limb and hand injuries. As a civilian, I was given officer status and lived and worked in a very male-dominated environment. It was a fun, challenging and enjoyable time.

What led to your interest in ergonomics?

In 1987, I left the Royal Navy to take up a Superintendent Physiotherapy post in Plymouth, managing services referred by GPs. Although I enjoyed the job, it had its frustrations as I found that following treatment, the individuals would return to the same work environment and, despite self-help measures, would come back to us later with the same problem. I thought this was ridiculous, so I contacted one of the big employers that had issues with its employees and asked them to let me come in and see the workstations to advise them. They were unsure at first but after suggested adaptions, lo and behold, their employees' work-related musculoskeletal problems went away.

I presented a proposal for a project to the Director of Public Health and worked with other local companies to explore the effects of occupational health and ergonomics input. This led to an Ergonomics Adviser post being created at Plymouth Hospitals NHS Trust within the Physiotherapy Department in 1993, which I filled, and where I was also released to study for an MSc in ergonomics at the University of Aberdeen.

Enthusiastic about a developing profession, with the support of Edward Lovesey and later, Bernie Masters, a local branch of the CIEHF was set up, meeting quarterly to expand interest in ergonomics.

How did you get into vehicle safety research?

While I continued my career in the trust, and going part-time following the birth of my son, my life was shaken up in 2008. My mother died in a tragic accident as a result of a car rolling down a gentle incline after its parking brake had been insufficiently applied. Although the Procurator Fiscal declared the accident a result of human error, I started to look into the issue of vehicle

rollaways. I was shocked to find out it was an issue with this particular car model where the gradual cooling of the brakes after a journey would release the car if the handbrake was not sufficiently applied.

In 2009, I joined Plymouth University as a human factors researcher but while working there I felt I needed to explore the still burning issue of parking brake failure. So, I approached Loughborough University who agreed to fund a PhD into the subject of human factors associated with vehicle rollaway. I looked at whether people were using enough force to pull the handbrake up but my research opened up a can of worms. In the end it came down to multiple reasons so the human factors systems approach really helped me explore the issue of vehicle rollaways more thoroughly.

What did your research show?

My research showed that 13% of drivers had experience of a vehicle rollaway at some point and that 50% of rollaway incidents reported in the media over a three-year period had resulted in pedestrian fatality.

I conducted my research in large NHS car parks around the country, peering in through side windows to count how many people had parked in gear, and I tested lots of different vehicles on various inclines to assess the performance of their handbrakes against established standards. All the vehicles with disc brakes I tested rolled on an incline after less than ten minutes of parking but those that were parked in gear as well as having the handbrake on, didn't roll.

I wanted a career that was practical and physical

Did your results change things?

My results were presented to the Department of Transport and were influential in changing the UK standards to instruct drivers to park in gear at all times. There was also a lot of interest from the car industry and I presented my research at a number of conferences. The most challenging was in Dresden, Germany, in front of an international audience of car brake engineering specialists. I was completely out of my comfort zone. I was used to speaking to groups about musculoskeletal issues and delivering training but here I was presenting a different approach to the problem of vehicle rollaway to people who knew braking systems inside out. However, I was really surprised by their reaction as they told me they don't usually think about the people that interact with their brake systems as they just focus on the engineering. They found my work useful and, even though many vehicles now have electronic parking brakes, they agreed that further research into the human factors aspect was needed.

IMAGES: SHUTTERSTOCK / GETTY / ISTOCK

What's your focus now?

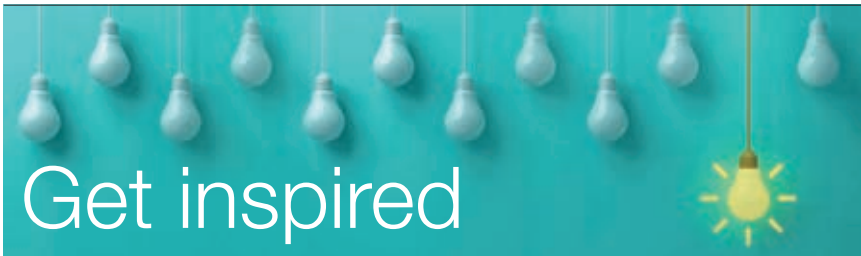
While I was researching my PhD, I was working part-time at St Luke's Hospice in Plymouth, initially as a Moving and Handling Adviser and now as its Ergonomics Advisor. St Luke's provides end of life care for people at home, in hospital and in their specialist inpatient unit, and it also has around 30 charity shops, two distribution warehouses and a furniture collections service. I've used my human factors skills to encourage a systems approach at the hospice and I actually found the accident taxonomy used in my PhD project a useful tool for the investigation of incidents in healthcare settings.

The hospice has really taken on board the human factors programme, and we've brought clinical patient safety and general health and safety together in a systems approach across both clinical and non-clinical services to promote a positive safety culture. The results of our safety culture survey have just been collated but our action plans are on hold at the moment while we address the current issues of home working, PPE, essential training and wellbeing.

So, no more interest in handbrakes?

Well, not completely. Handbrakes still crop up as an essential part of our vehicle safety training sessions for the domiciliary care staff who travel to support people in the community and the van drivers who collect and deliver furniture for the charity. I also conduct vehicle assessments as a freelance consultant for occupational health-related referrals. ●

Val Noble is an Ergonomics Advisor at St Luke's Hospice in Plymouth and a freelance consultant.

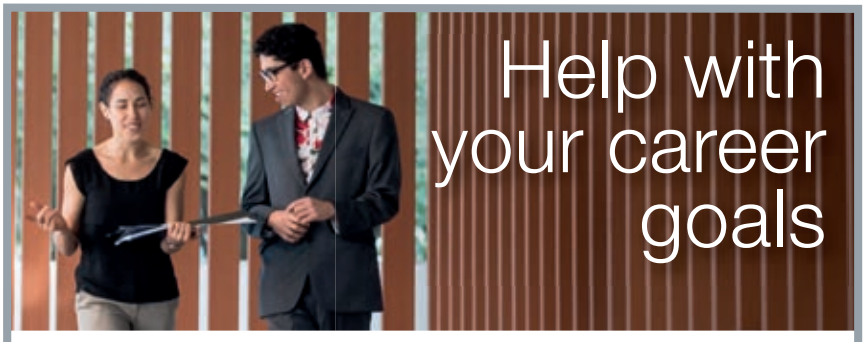


Get inspired

If you're looking for inspiration for input into your research project, for information to back up your recommendations for a report or you just want to learn something new, don't forget our range of support services.

Firstly, we're developing an exciting line-up of online events for the coming months from seminars to masterclasses, open to all and across a wide range of topics. Look out for news in your emails and on our events.ergonomics.org.uk website.

All members have free and full access to top journals in our discipline, *Ergonomics* and *Applied Ergonomics*, and a huge wealth of published papers, reports and news items in our Research Gateway. Finally, our online discussion forum, *Communities*, is the place to share ideas and opinions with other members. For more details and to access all these great resources, just log in to your MyCIEHF account.



Help with your career goals

No matter where you are in your career, having a mentor could help you find, target and achieve your next career goal. Whether you're a student or graduate looking for a potential route to your dream job in human factors or a specialist considering if working towards Chartered status is the right step for you, your fellow members and our Membership Team are available to provide guidance, support and motivation!

To make things easier, we've now launched our Mentoring Hub. It's a dedicated group within our online members' forum, *Communities*, where members looking for mentors and those who are available to offer mentoring can meet. In addition, it will provide information and resources about mentoring, as well as a platform where knowledge can be shared and questions will be answered.

Mentors should ideally be Chartered Members of the CIEHF as, having been through the application and CPD processes themselves, they have first-hand experience of what's required, together with knowledge and experience across the discipline. A mentor should also be a good listener and know how to provide constructive criticism to motivate others, as well as being willing offer their time to the person looking for help.

Now, you may be interested in becoming a mentor but might be wondering "What's in it for me?" Our mentors tell us it's highly rewarding to be part of another person's journey to success. It also offers you many opportunities to learn for yourself about alternative career paths and options. It counts towards your own CPD activities and also contributes to our collective professionalism as an organisation.

If you'd like to join the Mentoring Hub either as a mentor or as someone looking for help, please email me for more information and to register your interest to join!

Iris Mynott
i.mynott@ergonomics.org.uk
07702 542166

IMAGE: SHUTTERSTOCK

Election results

Welcome to our new Trustees, elected at our AGM in April.

Congratulations go to **Chris Ramsden** who has become our new President Elect. Chris has been an active member of CIEHF since graduating from Loughborough in 1981. He's served ten years on Council in the past and is currently co-lead for the Healthcare Sector Group with particular interest in medical devices.

Jon Berman has been involved with the Institute for many years - on Council, on PAB, as Chair of PAB, and as President. Last year he stepped forward for co-option as Treasurer and has now been elected to the role. Jon is keen to identify and secure additional streams to complement our current income sources, both to ensure delivery of our plans and to improve resilience.

We welcome back **Fiona Cayzer** for a second term on Council. Fiona is also Co-Chair of our Professional Affairs Board and regularly volunteers for the assessment of membership applications, course accreditations and conference submissions. And she acts as mentor and referee for those working towards Chartership.

Rebecca Charles has also been re-elected for a second term and is our Events Champion. She has been involved with the Institute for well over ten years as a Council member, head of secretariat, and she's been co-chair of the Annual Conference Programme Committee for the past four years.

Byron Edwards has also been re-elected to Council; he was our Graduate Representative on Council from 2014-2017 and is now proud to be a Chartered member. Byron has professional experience in a range of industries including transportation, energy and defence.

New to Council is **Mark Sujan**. He's keen to help grow our membership and foster external relations. Mark is co-lead of the Healthcare Sector Group and leads the Digital Health & AI Special Interest Group. He applies human factors across safety-critical industries and actively promotes professionalisation and best practice.

Kirsty Angerer is our new Graduate Representative on Council. Kirsty's aim is to enhance people's performance at work whilst encouraging them to thrive. She's lead of our new Workplace Sector Group and hopes to create a lively community by connecting like-minded individuals.

Chartered Institute of Ergonomics & Human Factors

ONLINE EVENTS

UPCOMING WEBINARS

COVID-19

- Learning from Covid-19
- Returning to work

SOCIAL MEDIA

- Lifting the lid off LinkedIn masterclass
- Using Twitter masterclass

SECTOR GROUPS

- Inclusive design
- Medication safety
- Resilience in defence

PROFESSIONAL DEVELOPMENT

- Human factors tools & techniques
- The route to Chartership
- Consultancy skills for human factors professionals

GREAT FOR CPD

ON-DEMAND EVENTS

- Ergonomics & Human Factors /ODAM 2020
- Wearable technology
- Creating a safe workplace
- Learning from adverse events

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events.ergonomics.org.uk

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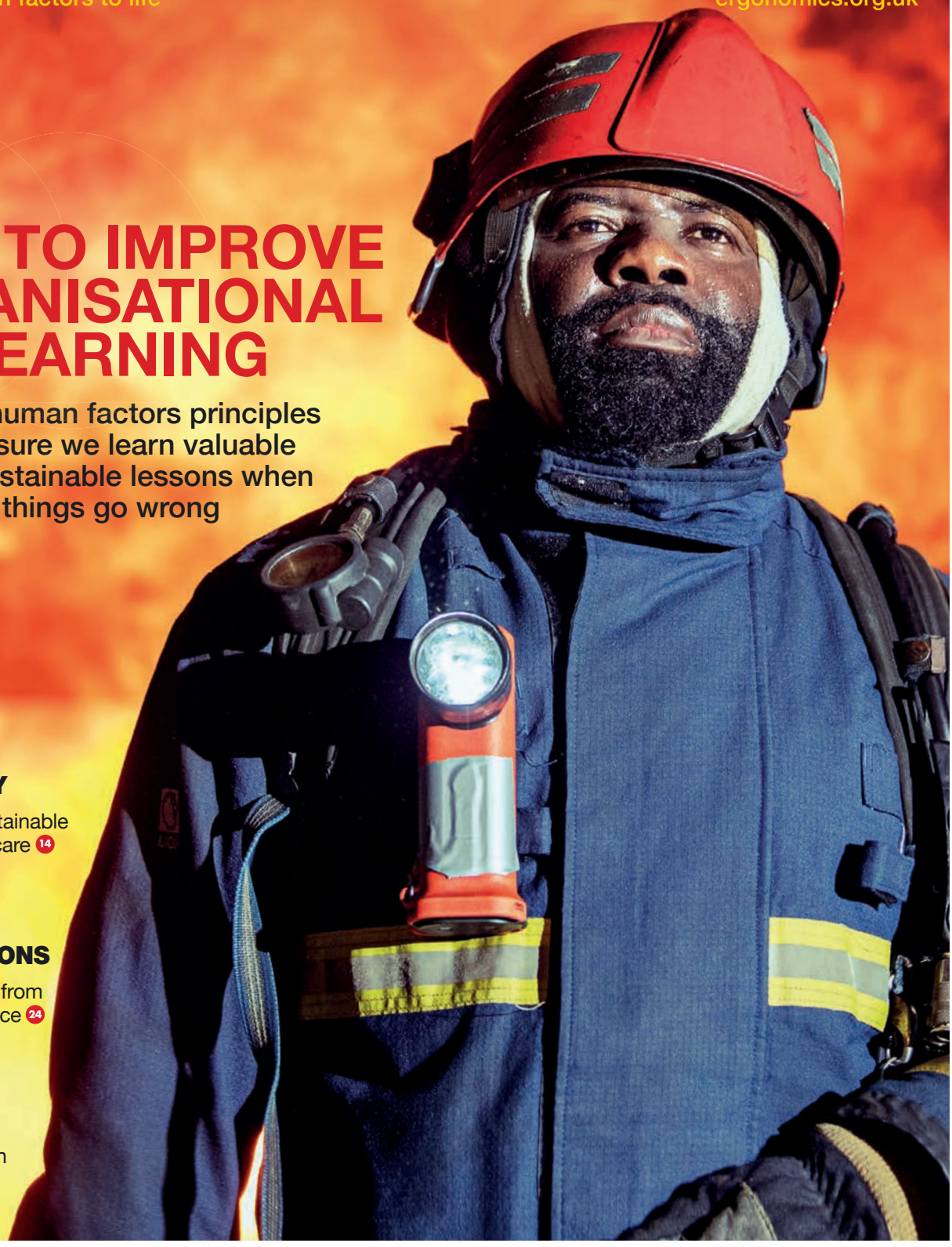

HOW TO IMPROVE ORGANISATIONAL LEARNING

Using human factors principles to ensure we learn valuable and sustainable lessons when things go wrong

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IMPROVING INVESTIGATIONS

Learning lessons from aircraft maintenance 24

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Cutting-edge tech for jet pilots 20

Chartered Institute of Ergonomics & Human Factors

Late April 2021, London
conference.ergonomics.org.uk

Ergonomics & Human Factors 2021

Call for Papers

Taking place over four days, the format of Ergonomics and Human Factors 2021 will reflect all that is best about events:

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- A day of face to face live lectures, discussion and debate on contemporary topics in a quality London venue.
- Social networking time including an online quiz and a face to face annual dinner.

Conference themes

We're now inviting written submissions in either short (4 pages) or long format (8 pages) covering (but not limited to) 6 themes:

Health & Social Care including human factors and Covid-19; PPE; medical device design; healthy ageing

Transport & Mobility including autonomous vehicles; novel transport systems; travel and the pandemic

The Future Workplace including occupational health; cybersecurity; workspace design

The Built Environment including teaching and education; social housing; complex use; smart cities

Sustainability including ecology and the environment; renewable energy; climate and pollution

The Future Human including robotics/ cobotics; wearable technology; AI; online learning

PRESENTATION METHODS

You'll be able to present your topic in one of a number of ways:

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- Podcasts
- Recorded slideshows
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All accepted papers will be published in the digital proceedings.

DEADLINES

Submission closes: 1 November 2020
Authors notified: 9 December 2020
Final submissions: 10 January 2021

How will you be involved?

For all details go to:
conference.ergonomics.org.uk

#ehf2021

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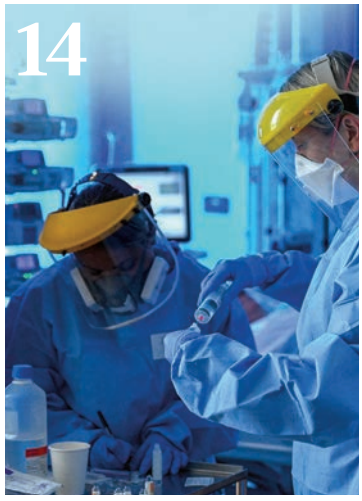

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FROM THE PRESIDENT

Learning together

Amanda Widdowson
CIEHF President

president@ergonomics.org.uk

Many of us adopted new ways of connecting during lockdown. In June, we held our Council meeting via Zoom. I received Twitter training to support the Institute's social media activities. Beforehand, I didn't use Twitter and only had a handful of followers but very quickly, by engaging with other people's posts, my following grew and I learnt a lot about the work and interests of others. In my first week I even had a conversation about my Design for Everybody President's Project with Caroline Criado Perez, author of *Invisible Women*, with a 102.3K following! She said she'd love to see the project report when it's ready. We're running some great courses about how to get the most out of Twitter and LinkedIn and improve your online presence. If you missed them, you can still access the recordings.

We launched the Learning from Adverse Events white paper, written by an impressive team, led by Ron McLeod. I thought the launch webinar succinctly explained the nine principles for human factors in incident investigation and learning. The recording and white paper are both available to download. And we've had a great response to our Creating a Safe Workspace guidance and webinar with Workplace Sector Group Leads Kirsty Angerer and Ed Milnes. Keep an eye on our events website and social media to see what's coming up.

On behalf of the CIEHF, former President Neil Mansfield and I joined the Scientific Committee for the IEA 2021 conference. The call for papers is open until 25th September but if you're interested in reviewing papers instead, please get in touch.

It's great to see a buzz of activity around our Communities forum too. At the time of writing, John Lovegrove's discussion about the gap (or not) between practice and research is particularly popular. It's proving to be a useful platform for sharing methods and papers, as well as views. I hope we continue to work together in this way.

It's great to see a buzz of activity around our *Communities* forum

FROM THE EDITOR

Adapting to a shifting future

As Covid-19 continues to dominate our lives and the world around us, we start to look at how and what we can learn from what has happened, how we reacted in the immediate aftermath and ongoing efforts to control the situation. Mark Sujan introduces our new guidance that aims to help capture valuable learning in the health and social care sector, Sue Hignett reveals the results of a survey into the challenges of PPE use and Siobhan Burns tells us first-hand, about her experiences as a trainer in patient handling in the last few months.

But of course, it's not just the current pandemic that continues to provide opportunities to learn, as our cover article featuring our newly released white paper on 'Learning from Adverse Events' explains. The paper focuses on nine principles that guide organisations towards sustainable learning. Courtney Grant describes his own involvement in giving emergency aid to those affected by the Grenfell fire, and Jo White focuses on where more could be done to learn from incidents in aircraft maintenance activities.

Looking to the future, Richard Bye and Andy Hawkes give us views into how human factors practices in rail and consultancy, respectively, are effectively adapting to new ways of working. Suzy Broadbent gives us an insight into jet fighter cockpit design and Clint Howells introduces a new framework that will provide cutting edge research in defence and security.

We also have a piece about work morbidity, a view of ergonomics in Finland and stories from four more of our award winners.

Enjoy the rest of the summer.

Tina Worthy
editor@ergonomics.org.uk
@ciehf

Gowns, face and eye protection and gloves have been deemed essential to stop NHS and social care staff getting infected with Covid-19 but criticism about the supply, use and functioning of these safety-critical items has been persistent, as a recent survey highlights

Protecting workers from infection

Healthcare workers have borne the brunt of the Covid-19 pandemic, and it's been a very tough battle for them. It has cost the lives of at least 540 frontline staff in England and Wales - a higher number than anywhere in the world apart from Russia. On top of this grim and sobering statistic, there's been controversy in the UK since the start of the outbreak about the supply and use of personal protective equipment (PPE).

At one point in April, the British Medical Association said doctors dealing with the virus were frightened and being left with difficult choices about whether they should risk their lives by treating patients because of a lack of appropriate equipment. In the inevitable future inquiry into the UK's response to the pandemic, the issue of PPE availability and suitability will doubtless be examined in detail. However, we now have an early indication of the sort of responses that will be presented for public scrutiny in this investigation.

An online study carried out by Loughborough University has been looking at the real-life experiences frontline healthcare staff treating Covid-19 patients have had with PPE. A team led by Sue Hignett, Professor of Healthcare Ergonomics and Patient Safety, used Twitter and LinkedIn to carry out a survey of those working in UK hospitals. The study received more than 400 responses when it ran from 4 April to 8 May - the peak of the epidemic, when there were more than 33,000 deaths.

The researchers wanted to gain a quick and preliminary understanding of the use of PPE for prolonged working. Rather than looking at issues over the supply of the necessary equipment or infection transmission, the survey concentrated on whether the kit was comfortable and effective and if it changed the way staff worked. Questions centred around the clinical areas respondents worked in, whether they knew what PPE they should be wearing, how well their face cover,

IMAGE: GETTY

apron, gown or gloves fitted, if there was any hurt or irritation, whether they could see to read, operate equipment or communicate, and their height.

Professor Hignett explains that the idea for the study came from a discussion with a colleague, Professor Jay Banerjee, who works as an emergency medicine consultant at a hospital in Leicester. He was having to wear PPE and was finding it difficult as it changed the way he worked.

"He felt we needed to explore this further. Staff in the NHS are used to wearing masks and aprons and so on, with a higher level of PPE for specific patients on an infection control ward, for example. However, the difference with Covid-19 is that once you're in the hot zone, you're wearing that kit all day. We're asking staff to work in quite complex PPE, and they haven't had the training to do that. Surgical masks can fog up your glasses and you might have a visor on top. And some of the Public Health England recommendations include putting on an apron, then a surgical gown, and then possibly another apron on top of those. That's going to be hot, as it's a lot of layers to wear."

Clinical staff wear personal protective equipment (PPE) while caring for a patient in the intensive care

We were surprised by how strongly respondents wanted to recount their experiences

Alongside this discomfort, staff were also needing to put on masks that left marks on their faces. Their patterns of working often also changed, with shifts being extended from eight to 12 hours. "We wanted to find out how people's tasks changed. For instance, we knew that they were starting to have to wear double or even triple sets of gloves. If you're doing a delicate job that involves needles and other sharp instruments and you've lost some of your haptic feedback because of these extra layers, then it makes it harder. It's not something you've been trained to do."

The survey contained simple tick-box questions with some boxes left for additional comments. "We intended it to be very quick as it was to be a snapshot to find out what the problems were. One of the things we wanted to check was if there was a difference between men and women. People were raising the issue on social media that they couldn't get their masks to fit their faces; they were all too big."

Professor Hignett and her team decided to evaluate the issue in four different ways:

- **Wearing PPE (anthropometry).** How well the PPE physically fitted the survey respondents.
- **Working in PPE (task analysis).** Did PPE alter what clinicians were doing and if so, how? Did any changes relate to wearing it?
- **Surviving PPE (injuries).** Did the kit injure people such as through skin breakdown, marks on the face or musculoskeletal neck problems caused by holding their heads in a certain position in order to see.
- **Supplying PPE (supply systems).** What was actually available and did it match up with the PPE they'd actually been fit tested on? Just how chaotic was it?

"They couldn't always order the PPE they had been tested for; it might, for example, have come from a different manufacturer. These problems have probably eased a lot now but it looks as if at the time, the government was sending kit out to different hospital trusts that may or may not have been what they needed."

Of the responses received directly relating to Human Factors/Ergonomics (HFE), 72% were from women and 28% from men. Nearly half (49%) reported communication and hearing issues with wearing masks and visors, with women flagging this up significantly more than men. 23% complained of visual difficulties with safety glasses, and for visors, the figure was higher at 27%. The fit of the equipment was reported as a problem, too.

One respondent said: "Apparently masks for smaller faces don't exist." Another reply was: "I'm quite short and overweight and find that the all-in-one suits do not fit me very well due to the proportions."

There were, perhaps predictably, also negative comments about injuries and overheating: "Two plastic aprons and a surgical gown as per guidance can get very sweaty and hot doing manual work which can make it harder to focus or continue to put the same effort in. It contributes to stress and exhaustion."

The survey report concluded that PPE acted as a safety barrier by changing the task interface. It said: "We suggest that more HFE research is needed to improve the functional design of PPE so that healthcare workers are better supported to carry out critical care and other medical treatment."

Professor Hignett says she was surprised by how strongly respondents wanted to recount their experiences. "Normally when you do this sort →

of a survey and you ask people for comments, you don't get many. But for this, we received more than 250. That's a huge number. People really wanted to tell us what was going on. And when you read through those comments, the pain would come through. People felt that they were trying really hard to do their jobs and look after their patients, but the interface and what they were being asked to wear – it was just raw emotion. I couldn't believe it was happening."

There were also comments about the gowns, with people remarking that they didn't properly cover them, so their levels of protection were compromised and they felt exposed to the dangers of the virus. "Some staff were so adversely affected by the PPE and suffered so much soreness" the Professor adds, "they wondered if they'd actually be able to wear face masks when they went back on their next shift."

"We were hearing that safety glasses were too big and kept slipping, that goggles applied pressure and that the area behind their ears was red and raw. People said they had been wearing FFP3 (the highest protection level) masks and their noses had become red and started to break down. I even heard anecdotally that people had actually decided not to wear the PPE, which is just dangerous."

More HFE research is needed to improve the functional design of PPE

The survey responses raise serious questions about the way in which human factors is integrated into the work of the NHS. "It's one of the big issues. HFE experts haven't been working within the healthcare sector at anything like the level of engagement of pretty much all the other safety-critical industries such as in energy or rail, where there's been a lot of focus on how people work. Many of the tasks and activities people carry out in healthcare have never had an HFE assessment. That's why at CIEHF we're having a big push to show people what we can offer and how we can help."

Medical staff transfer a patient

One really important point that concerns Professor Hignett is the fact that these issues with PPE were allowed to arise at all. "This was all foreseeable," she says, "it should all have been tested and planned and people should have had training, in the same way you'd have fire training every year. It's particularly true in intensive care units and emergency departments, as they're right on the frontline and where people come in. They should have been trained to the point where they could put on the required level of PPE and feel that their clinical abilities hadn't changed."

She believes that the publication of the survey will make a valuable contribution to the debate. But what comes next? "We've put in a research application to the National Institute of Health Research on their Covid-19 call for rapid research work. We're now waiting to hear the outcome."

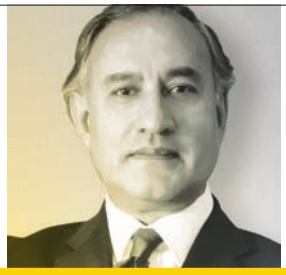
If successful, the grant will allow the university to work with University Hospitals of Leicester NHS Trust for 12 months, looking again at the four issues of wearing, working in, surviving and supplying PPE. "We'll have access to their intensive care units and they'll be a fantastic partner to work with. The aim is to redesign PPE so that it works. We want to create the design criteria around people's different shapes and sizes and that's particularly important for women. Really, this research should have been happening in healthcare for the last 30 or 40 years. This may be an opportunity to finally carry it out."

Sue Hignett is Professor of Healthcare Ergonomics and Patient Safety at Loughborough University.

Further reading

A paper on the survey conducted by Professor Hignett and her colleagues, *Human factors issues of working in personal protective equipment during the COVID-19 pandemic*, appears in Anaesthesia 2020, published by the Association of Anaesthetists. See https://onlinelibrary.wiley.com/doi/full/10.1111/anae.15198

IMAGE: GETTY



CHIEF EXECUTIVE'S PERSPECTIVE

Human-centred design and the next wave

The Achieving Sustainable Change guide explains the two key areas in achieving effective organisational learning: mindset and action

The CIEHF has without doubt made, and continues to make, a substantial contribution to the response to COVID-19. Professor Mark Sujan's guide on *Achieving sustainable change: Capturing lessons from COVID-19* is the latest in a series of documents we've published. The guide, available free from **https://bit.ly/HFSustainableChange**, provides templates for capturing learning that can be fed back into an organisation using systems thinking. An infographic to accompany the guide can be found at: **https://bit.ly/HFSustainableChangeInfographic**.

Our work has been reported widely in the national press, the leading general medical journal the *BMJ*, and celebrated by the International Ergonomics Association and other societies. Our members are being invited to speak on national and international platforms reflecting the impact we're making as the voice of the discipline and profession. As I write, we're arranging for speakers to address the UK Parliamentary and Scientific Committee on the topic "How human-centred design can make a difference to future crises".

We're all poised for what might happen next and when a likely second wave may occur. This backcloth is further exacerbated with other world issues from Black Lives Matter and the search for equality to the impact on industry and commerce that will lead to a recession. At the same time, technology firms continue to bring innovations to the market that will change the way we live and work forever. Our Special Interest Group on Digital Health and AI will lead research and debates in this area.

Working with PARN, the Professional Associations Research Network, the Institute will put in place a plan to ensure that we are a representative body and that diversity and inclusion is core to our work. After all, human-centred design is for everybody. The President's Project, *Design for Everybody*, is a good example of how we're being proactive. See **https://bit.ly/DesignForEverybodyGuidance**.

The CIEHF has made a substantial contribution to the response to COVID-19

IMAGES: GETTY

Right now, we're looking for international case studies that demonstrate how human factors can make a difference to business. These will be promoted to businesses throughout the UK to reinforce our role in an economic recovery from outstanding designs that contribute to revenue generation to new and different ways of working that will add value. Case studies or enquiries can be sent to emmacrumpton@yahoo.co.uk.

We've also launched training to help improve members' awareness and practical skills in using Twitter and LinkedIn. The purpose of this is to help members better promote themselves, their work and of course our discipline and profession. We're looking for individuals who would like to receive such training and coaching helping them to become Social Media Champions for the Institute. Anyone interested should contact me directly.

Noorzaman Rashid
Chief Executive of the CIEHF
Noorzaman.rashid@ergonomics.org.uk

noorzaman rashid

BAE Systems, Barrow-in-Furness

Building a secure future

With an invitation for organisations of all shapes and sizes to get involved, **Clint Howells** introduces the Human Social Science Research Capability framework, and explains how it will provide cutting edge research to address some of the UK's highest priority human science issues, helping to shape future defence and security strategy, policy and capability

In March 2019 the Human Social Science Research Capability (HSSRC) framework was contracted, with BAE Systems as its Prime Contractor. The framework enables human, behavioural and social science research to be commissioned by the Defence Science and Technology Laboratory (Dstl), the Ministry of Defence and other UK government departments including the Home Office, Departments for Education, Transport, International Trade and Work & Pensions, the Ministry of Justice and the College of Policing.

Cutting-edge research related to defence and security is commissioned across six technical themes:

- Personnel
- Training and education
- Humans in systems
- Human performance (physical and psychological)
- Understanding and influencing human behaviour
- Health, wellbeing and enhancing medical systems and capabilities

The future environment will present different physical and psychological demands which need to be identified, understood and managed. HSSRC-commissioned research will find innovative ways to attract and retain skilled people, maximise human performance and effectively integrate and exploit automation. The HSSRC also offers capabilities to analyse human behaviour and communication, including the use of social networks, which will be increasingly important to support understanding of the future information space.

The HSSRC framework can be used to commission short-term and multi-year research tasks, as well as facilitated workshops, sandpits, open calls and provision of expert advice. Outputs from the tasks are likely to include reports, data, prototypes, software, presentations, educational materials and recommendations. Some recent tasks include:

- Study of new techniques to improve cognitive performance under operational conditions.
- Development and evaluation of models of skill retention and decay.

The future environment will present different physical and psychological demands which need to be identified, understood and managed

- Research into the effects of human-machine interface design on training and human-system performance.
- Creation of a non-invasive cognitive workload assessment tool for use with individuals or teams in the field.
- Investigation into how society, technology and the nature of work are changing, to help defence adapt and reflect the workforce in 2030+.
- Review of literature and technologies relating to the use of exoskeletons to improve performance.
- Design of interventions and measures to enhance teamworking in newly formed teams.
- Exploration of ethical and philosophical worldviews relating to cyber operations, and how these can influence command and control and decision making.

The framework operates through a network of suppliers ranging from micro businesses to large organisations and universities. The vast majority of tasks are open to all signed-up suppliers who can view requirements and participate in competitions alone or in collaboration with others. New suppliers can join the framework at any time and the HSSRC welcomes interest from companies which have not previously worked in defence or security, and who can provide fresh perspectives from other domains.

IMAGE: BAE SYSTEMS

Suppliers contributing to this important work will help to shape defence and security thinking, policy and doctrine, underpin procurement decisions and improve the UK's operational capability. They will also have the opportunity to attend supplier events, develop links with other members of the supplier network and propose innovative, cross-disciplinary solutions to challenging and exciting research requirements.

The framework launched its first requirements in June 2019 and will run until March 2023 with a potential extension to 2026. Multiple defence and security-related tasks will be let each year, ranging from £20k to £1m+. The HSSRC is managed by a small team based at BAE Systems' office in Yeovil, Somerset. The team is supported by a group of experienced Research Theme Leads who provide technical assurance and ensure coherence between the research tasks. A pool of Technical Specialists is available to provide additional support and niche skills.

The HSSRC is led by Dr Helen Cole. Helen was a member of the Human Factors Research Group at the University of Nottingham and led research activities examining usability and user-centred design of novel technologies in educational settings. She worked as a human factors engineer in the defence industry before moving into project and programme management roles with a strong focus on leading research and technology programmes.

Dstl's HSSRC Strategic Lead Jim Squire commented, "In this time of crisis, as the whole world is united in its fight against the coronavirus, Human and Social Sciences have never been more important in supporting the defence, security and prosperity of the UK. It is critical that the MOD is able to work with the very best talent in academia and industry to address people-related opportunities and threats, and I have no doubt that the HSSRC framework will deliver high impact Human and Social Sciences research for years to come."

How to get involved

If you would like more information on the HSSRC or are interested in joining the supplier network, please get in touch with the team at hssrc@baesystems.com. We are also keen to identify additional technical specialists who can provide expert support to tasks on a flexible basis. ●

Clint Howells MSc C.ErgHF MCIEHF is an independent consultant with a background in human factors integration for large engineering projects. His current interests include future platform usability and strategic supply chain development for the HSSRC.

A no-touch future

An article on a website called strategy+ business delves into the urgent and growing need for contactless technology at a time when the coronavirus has spread around the globe with frightening speed.

The author explains how speech recognition, facial recognition and digital money are enabling us to move to a world where multiple people don't have to handle and pass between them physical items such as passports, menus and credit cards. Instead technology will allow us to reduce the risk of virus transmission by allowing us to say what we want instead of using a public touchscreen or pressing a much-touched button, for example. Millions of people are already asking things of Alexa, after all, so will the technology soon be used in public places?

Many are already comfortable with allowing their laptop or mobile device to recognise their face or fingerprint and activate, and airports are using facial recognition for passport checks. Perhaps it won't be long before our cars and houses will unlock when they recognise us approaching.

Contactless payments are becoming much more common and in many cases are already a necessity where retailers will not handle cash due to the potential contamination risk that comes with it.

For more details, see **www.strategy-business.com/blog/Technology-for-a-no-touch-world.**

An ergonomics perspective from Finland

In 1906, Finland became the first European state to grant all adult citizens the right to vote, and the first in the world to give all adult citizens the right to run for public office. Today, with its population of just 5.5 million, Finland ranks highly in quality of working life, as **Päivi Steffen** and **Arto Reiman** explain

Since its independence following the 1917 Russian Revolution, Finland has been known for its competitiveness in manufacturing, focusing first on basic industries like wood processing and metals and, in recent years, on telecommunications and electronics. The geographical position of Finland between two very different countries, Russia (the former Soviet Union) and Sweden, has significantly impacted the development of the Finnish economy. Finland has benefitted from trade with Eastern Europe but, as a part of the European Union, the country also engages in global business and has been among the best performing economies in the European Union.

Over recent decades, Finland has benefitted too from the success of Nokia and its subcontracting network but since the last recession in the 2010s, the role of Nokia has decreased. Meanwhile, a number of promising start-ups in information and communications technology, gaming, cleantech and biotechnology have been created but the largest public and private employment sector in Finland is the health and social and care sector. In recent years, there has been frequent discussion of the economics of this sector and the need for the reform of the system.

The Finnish economy recovered quite slowly from the recession and, in 2016, the government enacted a competitiveness pact aimed at reducing labour costs, increasing hours worked and introducing more flexibility into the wage bargaining system. The aims of this pact were only partially achieved and now the country, among many others, has suffered from the spread of the coronavirus. It's highly likely that Finland will continue to seek new ways to promote its future competitiveness although the general trend of an ageing population and workforce places further demands on the economy.

Various indicators show the long-term success of Finland when it comes to the quality of working life. For instance, the statistics of the European Foundation for the Improvement of Living and Working Conditions (Eurofound) show that the quality of working life in Finland ranks among the highest in Europe. The statistics of the European Agency for Safety and Health at Work indicate Finland's successes in occupational safety and health. From an ergonomics perspective, working life in Finland has changed significantly during the last few decades. Heavy, manual work has decreased, while, in many ways, the cognitive load at work has increased. Nevertheless, musculoskeletal disorders remain a high contributor to sick leave and premature retirement from work.

Finland is known for its unique occupational healthcare system within which, in principle, employers are required to provide occupational healthcare services to their employees. A common practice has been to source the services from a commercial partner, that is, from an occupational healthcare provider which has led to the success of the private occupational healthcare sector in Finland.

The role of the occupational healthcare provider has been to provide both preventative healthcare and medical care, with the latter being the more dominant service. In many ways, this arrangement has affected directly and indirectly the role of ergonomics in Finland. Traditionally, ergonomics has been considered as part of the Finnish occupational healthcare system but again the focus has been on medical care, leaving little scope for preventative ergonomics. However, in

Aurora Borealis seen in Tampere, Finland.

2018, a regulatory change modifying the national compensation system meant that the role of the occupational healthcare provider has shifted towards more preventative healthcare services.

It remains to be seen whether this process of change will initiate new openings for ergonomics. Ergonomics in Finland is, in a sense, at an intermediate stage where certain key actors or process owners are missing. At the workplace level, ergonomics is considered a service that's provided by the occupational healthcare provider but the services offered are general and rather limited when it comes to the broad spectrum of ergonomics. Also, other potentially relevant actors, such as occupational safety and human resources specialists, often lack a basic knowledge of ergonomics which hinders possibilities for company-oriented ergonomics development processes. In addition, the definition of ergonomics is, in many ways, unclear in workplaces resulting in a very low number of ergonomics consultants and European certified ergonomists in Finland.

Ergonomics education at degree level is provided at only one university, the University of Eastern Finland, where ergonomics is a major programme under the Faculty of Health Sciences but in Finnish technical faculties there are no direct ergonomics professorships or graduate programmes. This is somewhat surprising considering the design-oriented nature of ergonomics that calls for multidisciplinary approaches, including engineering, for the understanding of human factors in product and overall system design. This interpretation of the current state of ergonomics at the university level might still be too simplistic. Technical universities teach various topics that could be numbered among the broad concepts of ergonomics. At the University of Oulu, for instance, occupational safety and health, wellbeing at work, and productivity and sustainable organisations are taught to engineering students. The University of Tampere runs a master's degree programme in safety and security. So, although ergonomics as a discipline might be missing from the curriculum of technical faculties, the core principles of ergonomics system design and the dual optimisation of wellbeing and productivity are being taught to engineering students.

In Finland, ergonomics has been and still is challenged in many ways but there are certain signs that could be interpreted as indications that the role of ergonomics might be about to change. For instance, the role change for occupational healthcare providers towards preventative healthcare might open new possibilities for ergonomics services. Also, the government programme aims to promote a socially sustainable working life which has potential and possibilities for ergonomists in Finland.

Heavy, manual work has decreased, while the cognitive load at work has increased

A dentist and her assistant treats a patient at a practice in Helsinki.

IMAGE: GETTY / ALAMY

Päivi Steffen MSc works as an executive manager in the sports sector and is a member of the board of the Finnish Ergonomics Society. Her interests lie in organisational and cognitive ergonomics.

Adjunct professor **Arto Reiman** leads a research team focusing on wellbeing at work and productivity at the University of Oulu in Finland. He is the chair of the Finnish Ergonomics Society.

Further reading

Eurofound: www.eurofound.europa.eu/country/finland#actors-and-institutions

Learning from COVID-19

As part of the response to COVID-19, CIEHF developed a new guide to help capture some of the valuable learning created as staff and organisations in health and social care adapt to the challenges posed by the pandemic. Mark Sujan and Jess Wadsworth and colleagues explain how the guidance can help to achieve sustainable change

We know that learning lessons and putting them into meaningful change is a tremendous challenge for the NHS. In part, this is due to the well-intentioned but somewhat narrow focus on learning from incidents. This perspective has been too limiting, and often organisational learning has been reduced in practice to an administrative exercise of counting frequently occurring adverse events, such as patient falls.

With this new guide, *Achieving Sustainable Change*, we drew on insights from resilient healthcare and complex adaptive systems. We want to encourage people to think about how they navigate successfully difficult situations that are full of uncertainty and where there is always a lack of resources and seemingly endless demand. Looking at how people anticipate changes, how they monitor situations and how they adapt the way they work to the specific context, can help organisations to become more resilient.

The guidance provides prompts for organisations to reflect on what goes well even when situations are challenging, and how safe spaces can be created where staff can contribute to organisational learning, and where they can take ownership of improvement and change.

The red zone

Epsom and St Helier University Hospitals NHS Trust in South London was one of the first to experience the significant rise in COVID-19 patients requiring critical care (CC) and quickly enacted its pandemic plan to open a large, temporary CC unit at Epsom. This was an enormous feat as equipment and resources were pulled from across sites, staff were redeployed from multiple settings including community, and the new unit was open within weeks.

Suddenly there was a group of staff, of different professions, specialities and levels of experience, thrown together by circumstance. The redeployed doctors, nurses, physiotherapists, psychologists, healthcare assistants, administration staff, yoga teachers and project managers came from far and wide to help. Some took on roles in staff wellbeing, relative liaison, PPE support and behind-the-scenes organisational management, particularly if advised against working in red zones (the highest COVID-19 risk areas).

However, inside the red zones it felt like a different world, like a battle where nothing stayed still. All staff were now faced with a situation where they were

being asked to work completely out of their comfort zone and, in some cases, scope of practice. Many redeployed staff had never set foot in a CC unit, let alone looked after an intubated, ventilated COVID-19 patient, and had not experienced death on this level. Staff were scared, anxious and concerned about the blame culture that still prevails in healthcare. Even the most experienced CC staff had not seen this volume of sick patients at any one time, often with multi-organ failure, requiring a fine balancing act of ventilation and prone positioning to improve oxygenation, continuous inotropic drug infusions to support blood pressure and haemofiltration to replace reduced kidney function. Instead, CC nurses who normally look after one patient were being asked by NHS England to look after up to six, with the inability to give the normal standards of care causing all staff some moral injury.

Initially the simulation and human factors team became involved with the temporary CC unit to deliver just-in-time simulation training for redeployed staff. However, it soon became apparent from observing work-as-done and listening to staff feedback that we could use both our multi-professional clinical expertise and human factors perspective to work collaboratively with the senior CC team. Together we designed several systems and processes that could help staff to work better in this complex, emergent situation. This included three things. One was the development of new COVID-19 adapted staff role expectations and responsibilities to allow a safer and more equitable allocation of skills, resources and workload. Another was the streamlining of handover processes and allocations to encourage a more multi-professional and collaborative approach. The third was the introduction of a coloured hat system so critical care skills could be easily identified to improve communication and escalation processes. We also offered daily orientation and basic training for new starters and adapted the standards of nursing care to ensure the workload was realistic and achievable.

Staff could clearly feel the benefits of these interventions as the unit felt calmer and more organised and the clearer expectations for each role made staff feel they "knew what they were supposed to do", reducing cognitive load. However, this adaptation did not work as well during shifts when staffing levels were lower or where there was resistance to the new processes from some team members. This meant both bedside practitioners and CC nurses were focused on giving direct patient care and left a reduced number of CC staff with oversight of the bedside practitioners and department. These are some of the important lessons we will need to consider in order to cope with a second wave.

Available to download: *Achieving Sustainable Change: capturing lessons from COVID-19*

Organisational learning

We know we must learn from COVID-19 but how do we decipher the learning from such a complex and immediate situation and make it valuable? The temporary COVID-19 CC unit had closed by the time this new guidance was published but using the template retrospectively really helped us to organise events, guide reflections and illuminate key learning points from everyday work to take forward. Without going through this process, the events and interventions entwined within the COVID-19 chaos were likely to have gone unnoticed. They have now been captured, informing how we organise ourselves in the event of a second wave.

Learning the 'right things' is a problem in healthcare as we are overwhelmingly persuaded by our risk and governance systems to focus on what went 'wrong'. This is often addressed by a series of actions involving training or a revised policy, which seldom moves us forward. Working through the template took time and a level of understanding around the mindset and fundamental principles of systems thinking which in reality, people working on the frontline of healthcare may not have. Yet this process of understanding what happened and why has raised our gaze to systems level interventions that can be proactively utilised in the future, rather than a traditional retrospective style investigation of looking at what went wrong, which is far more likely to focus on individuals.

So how can we adopt this guidance into our safety toolbox? A huge amount of time and resource is afforded to incident investigation and quality improvement, so why not try to complete the template alongside a traditional report or before the implementation of a quality intervention? We also need to think smartly about the skills and resources already in our organisations; who are the people or departments that can take this template, use it to collaborate with those doing the work, and put the learning into practice? When we look through the lens of organisational learning and systems thinking, only then can we truly begin to understand what is happening in our organisation and use this information to strengthen and grow.

Dr Mark Sujan is founder of Human Factors Everywhere, a small company dedicated to helping people adopt human-centred approaches for running a safe and secure business. He leads the CIEHF's Digital Health & AI Special Interest Group.

Jess Wadsworth is a Senior Nurse Educator and the Deputy Lead for Simulation and Human Factors. She is a member of the Civility Saves Lives group and has an interest in inter-professional education and human factors.

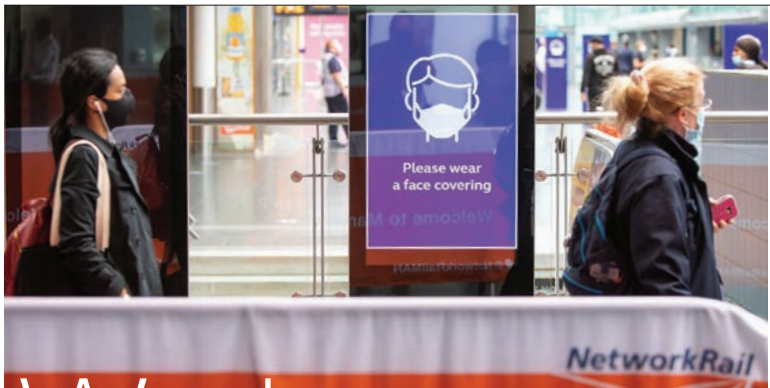
Dr Sabrina Vitello is a Senior Simulation Fellow with a clinical focus in palliative medicine and a particular interest in exploring human factors.

Dr Jennifer Blair is a Consultant Anaesthetist and the Director of the Centre for Simulation and Human Factors. She's passionate about the practical application of human factors to healthcare.

Further reading

Download *Achieving Sustainable Change: capturing lessons from COVID-19* from https://bit.ly/HFSustainableChange

IMAGE: GETTY



Work as (re)imagined

Overpriced sandwiches, queuing at the coffee machine, commuting and team meetings, are just some of the things **Richard Bye** never thought he'd miss, until, that is, lockdown reared its rather peculiar and totally unexpected head

As a member of Network Rail's Ergonomics team, I'm all too aware how lucky I am to have a pandemic-proof role. But although the team's jobs are secure, none of us have been immune to the effects of enforced home working. We entered lockdown with a sense of pragmatism; thinking through our collective risks, assumptions, issues, dependencies and opportunities, so that we could plan how to maintain the essential contribution that ergonomics and human factors work makes to the safe and effective running of the GB rail network.

What followed were several long days, as we tweaked tried and trusted techniques, and examined new and innovative methods, to ensure that work we were having to re-imagine would translate into work as it needed to be done. This necessary questioning of what we do, and how and why we do it, was an interesting experience and a valuable exercise in introspection. It highlighted the need for a systematic approach (based on good practice ergonomics and human factors methods) to understand the team's goals, scenarios and task demands following the highly volatile step-change in our operational context of use.

No/go-to methods

When lockdown was thrust upon us, some of our go-to approaches for improving human-centred performance were immediately rendered impossible, and even though we needed one very quickly, we had no plan B (or C, D or E). The need for contingency to cope with the complexities and uncertainty of a global pandemic brought to the fore the realisation that agility needs to be a state of mind as well as a practice.

To protect the vital staff who keep the railway running, a range of practical measures (such as the use of Perspex screens, PPE and new procedures) have been put in place. And crucially, access to frontline locations has been severely limited. After all, with just one ill-advised trip to a control centre, filled with people possessing specialist skills, expertise and local knowledge, someone could unwittingly pass on COVID-19 and in doing so severely limit the capacity of a large area of the rail network.

As such, our day-to-day and face-to-face interactions with signallers, controllers and maintainers have had to be put on hold, along with the hands-on activities that are necessary to inform changes to the design of work systems. Nonetheless, work still needs to be done to manage the human factors considerations emerging from perturbations in the socio-technical system that is the GB railway. To this end, a range of novel workshop, meeting and presentation technologies have been employed to deliver the analysis, design and evaluation interventions required.

Stationed at home

Four months in and a return to the office still seems some time away. Having spent over a hundred working days navigating our way through a situation none of us ever imagined being in, we now don't know what to think. Is this really our new normal? What is normal anyway? And in any case, given that pre-lockdown we often worked remotely with a heavy reliance on technology, how new is all of this in reality?

In practical terms lockdown working has been a success, albeit quite hard going at times. Ergonomics and human factors activity on all major rail projects has been able to continue in some shape or form, thanks to the dedication and diligence of the team and the numerous CIEHF Registered Consultancies and Chartered members who work alongside us. Indeed, it's a testament to the collective skills and experience of all the human factors professionals involved that there have been no significant delays or problems in the ongoing design and delivery of improvements to the rail network.

We tried to ensure that work we re-imagined would translate into work as it needed to be done

Next stop

We're currently in the process of a retrospective analysis of the team's response to lockdown working. Resilience engineering research prioritises the need for continuous learning so we need to understand the effectiveness and sustainability of any new ways of working. In doing so, we've begun a long-term process to redouble our efforts to build and maintain emotional resilience, interpersonal support and shared adaptations in the face of global chronic unease.

Richard Bye is a Principal Ergonomics Specialist at Network Rail.

Getting to grips with new technology to help enhance ergonomics services

Making virtual consulting a reality

The COVID-19 crisis has seen digital businesses thrive, with the likes of Zoom seeing phenomenal growth that's likely to be sustained. **Andy Hawkes** talks us through how consultants can adapt their business practice to keep up with the changing times

No one can predict how the business world will behave in 2021 and beyond. Let's face it, we probably can't even predict what the world will be like next month! What is certain is that traditional face-to-face businesses such as consultancies will need to embrace every aspect of connected technology and software to ensure that the face-to-face element is no longer the main competitive advantage. That's not to say that expertise and experience are redundant or that some elements of face-to-face contact will still remain but the future will see an acceleration of virtual relationships with clients.

Video conferencing has been around for 30 years with a slow and gradual usage, yet, within three months we have taken to it in our business and social lives without any issues. Even the older generation who have been brought up with and have the engrained belief that "face-to-face is the only way to do a deal" mentality have realised that this was a false belief. And, of course Millennials and Generation Z just see the virtual world as the norm.

Digitise now and find partners who can help

Consultancies will need to look at their proposition and look at how they can virtualise and digitise products and services. Clients will expect their trusted advisors to be able to flex their approach to fit into the new way of working; they will still want the expertise but the delivery will need to change.

It's likely that many firms will see employees remaining as remote workers whereas others will be looking at how they can operate while COVID-19 remains a threat. This is likely to mean on-site visits from consultants, sales executives, suppliers and partners will be limited at best.

Be the early adopter and offer your clients and prospects as many alternatives, even if you don't have the alternative ready to hand. We see clients who want us to find solutions for them currently and we are willingly sourcing them, even if the alternative reduces our revenue and margin. I would rather have a happy client long-term than no client.

Technology adoption is increasing rapidly

In the ergonomics space, we're seeing a significant demand for, and a move towards, software and the virtual delivery of assessments. Many major global organisations want these solutions yesterday! The use of e-learning, online self-risk assessments, cameras, AI and sensors will see accelerated usage, but behind the scenes there's still a need for expertise to help design the solutions and to virtually deliver the actions needed to mitigate risk and pain. In every threat comes opportunity and this crisis will see creative, market-driven individuals and businesses responding to the new demands and risks that have already emerged, and will emerge, in the future.

Look to your customers: what do they need?

It's vital that consultants talk to their clients and find out how their expertise can be delivered in the virtual world. Just because you have had a face-to-face traditional relationship doesn't mean that a virtual, digitised version will not be acceptable.

If you need to invent a new solution don't be afraid to talk to potential partners about how expertise and software can combine and create new solutions to meet new working practices. Become experts in the use of webinars and video conferencing and, if needed, get some training in the use of the brilliant tools that exist. I'm sure that the better trained you are in virtual technology, the better you'll appear to your clients and prospects.

So, look forward to the second half of 2020 and into 2021. Use this time to rethink your business, products and solutions and grasp the new opportunities that will undoubtedly present themselves.

Andy Hawkes is CEO of Cardinus and has worked in the insurance and risk management sectors for 30 years and is immediate Past President of IIRSM. He's written widely on business risk and insurance risk issues and has specific expertise in speciality commercial insurance as well as compliance and governance risk.ergonomics.

IMAGE: GETTY

By not taking human factors into account effectively after they experience incidents or other potentially serious adverse events, many organisations miss the opportunity to learn lessons and implement effective change to mitigate and avoid similar events in the future, as a new publication from the CIEHF explains

How to improve organisational learning

Every day, so the saying goes, is a school day. It's an excellent phrase, and it makes a lot of sense. Our experiences shape us, so by the time we go to bed each evening, we should be that little bit more experienced and wiser. The only problem is that in the case of learning from adverse events, it may not actually be true.

According to many leading human factors specialists, the truth is that despite all appearances to the contrary, and despite the best efforts of so many well-intentioned people, we might not be absorbing the lessons we need to learn in order to stop them happening again.

CIEHF's newly published white paper into this problem, *Learning from Adverse Events*, based on three years of work from senior professionals, examines how and why organisations fail to learn fully after adverse events occur. It offers invaluable guidance on how to improve learning and implement sustainable change through increased understanding of the human contribution to those events.

The key to turning things around and achieving success, it says, is effective learning. This means "identifying and implementing change in a way that supports and sustains long-term improvement". The paper is based around nine principles for how to incorporate human factors into better learning from investigations. Taken together, they provide a comprehensive blueprint for improved performance.

THE NINE PRINCIPLES FOR LEARNING FROM ADVERSE EVENTS

1. Be prepared to accept a broad range of types and standards of evidence.
2. Seek opportunities for learning beyond actual loss events.
3. Avoid searching for blame.
4. Adopt a systems approach.
5. Identify and understand both the situational and contextual factors associated with the event.
6. Recognise the potential for difference between the way the work is imagined and the way work is actually done.
7. Accept that learning means changing.
8. Understand that learning will only be enduring if change is embedded in a culture of learning and continuous improvement.
9. Don't confuse recommendations with solutions.

Apparently simple incidents often have a multitude of interlinked contributing factors from which organisations can learn

The CIEHF's latest white paper, a landmark publication

The lead author of the paper is CIEHF Chartered Fellow Professor Ron McLeod, an independent human factors specialist with almost 40 years' experience. As well as Ron, the core working group comprised Jon Berman, Claire Dickinson and Donna Forsyth. Ron says the paper is not aimed primarily at human factors professionals, but at those dealing with risk assessment, learning and improvement across business, industry and commerce who do not have a professional background in human factors. It was striking, he adds, how many CIEHF members wanted to contribute to the paper. "There were a number of themes that kept coming up. One was the reflex to find someone to blame – most obvious in the media – at the expense of understanding the systemic issues behind most complex events. Another was widespread concern about the continuing over-reliance on hindsight rather than trying to understand the situation and context at the time that individuals made decisions and acted."

Ron says that there was also concern among members about the widespread lack of awareness of the deep psychological motivations behind the way people behave, including the way they are incentivised and their goals and priorities. "Even when investigations were conducted well, there was a difficulty in coming up with recommendations that lead to genuine learning and improvement."

An adverse incident, he explains, can be of various types. It could be an event leading to actual loss or harm, or a near miss where nothing goes wrong but there's potential for serious failure. There's also the situation of what are often referred to as 'weak signals', where something is not operating in the way intended, nothing goes wrong but there is a potential for failure.

"It took a lot of work and some fairly brutal editing to get the white paper down to just nine principles," Ron says. "However, we now feel they capture the essence of what organisations need to know to improve. They're not in any order of priority but the principles should fairly readily lend themselves to self-assessment. Organisations should do a gap analysis and then implement the change." Few of the principles will be new to CIEHF members; they embody much of how most human factors professionals go about their professional lives nowadays. Ron says, "We were impressed by how often our contributors told us that, while the principles are well known to us as professionals, they are certainly not well known or applied by many people involved in investigations and learning, that need to understand and use them".

Professor Paul Bowie, Programme Director of Safety and Improvement at NHS Education for Scotland, spoke at a webinar launching the white paper. He said it contained a lot of information the health service could use. "These principles are particularly timely and highly relevant for what's happening in health and social care," he said. "It's unfortunate that in the significant minority of cases there is still so much of a blame culture; the way we report in the media around patient safety incidents, for example. The idea of adopting a systems approach often means something different in healthcare. There is a lot of work to be done there and so the guidance is particularly helpful in that respect. The whole idea of 'work as imagined' versus the way work is actually done is not well known, understood or practised across the NHS."

Ron McLeod, lead author of *Learning from Adverse Events*

The white paper is now being widely promoted and circulated among risk managers both in the UK and around the world. For example, the current edition of *The Sentinel*, the magazine of the 8000+ membership of the Chartered Institute of Risk and Safety Management, has several pages highlighting the importance of the document and giving readers an extract of its content.

CIEHF Chief Executive, Noorzaman Rashid, says that the document has an absolutely central role in how incidents are investigated and learned from in the future. It is, he says, an outstanding example of how human factors specialists are contributing their expertise to a huge range of subjects across the business, industrial, medical and social fabric of life. "Rarely has a white paper been given this level of detail and attention to research making it a landmark publication and must-read document. It tackles everything from the blame culture – which does nothing to support effective learning from incidents – to differentiating between recommendations and solutions.

The white paper offers invaluable guidance on how to improve responses and actions through increased understanding of the human contribution to adverse events

"As Ron McLeod has said, many of our experts were ready and willing to contribute to this outstanding piece of work. I would like to take this opportunity to thank each and every one of them for their time and effort in making this document the remarkable success that it is. I'm absolutely certain that it will become a bedrock for the way in which incidents are investigated and learned from in the future," he says.

The white paper shows just how successfully the Institute is now working alongside allied professional bodies to ensure that the way problems are challenged reflects a systems-based approach that's so important to achieving sustainable positive change. "You only have to look to our recent COVID-19 guides and manuals to see how our experts, working with others from different bodies, are contributing knowledge at the highest level; knowledge that is helping to deal with incredibly difficult situations."

To access the white paper, please go to https://www.ergonomics.org.uk/CIEHFLearningfromAdverseEvents

Further reading

To listen to the webinar which launched the white paper, go to https://events.ergonomics.org.uk/event/learning-from-adverse-events/

IMAGE: PA

Mission-critical cutting edge technology

Being a military jet pilot is one of the most exciting - and stressful - jobs on earth. When flying at more than twice the speed of sound, decisions made in tiny fractions of a second can mean the difference between life and death but human factors can help ensure the right decisions get made

A Royal Air Force Typhoon pilot enters the cockpit

IMAGE: CROWN COPYRIGHT

The g-forces in flight can be massive and adrenaline levels go through the roof. And while all this is happening, an enemy may be doing their best to shoot you down but as a pilot, you're not alone. Modern aircraft have the very latest cutting edge technology to keep you safe and these days, human factors is very much part of the equation.

The world's leading aircraft manufacturers are more aware than ever that cockpit layout and pilot comfort are hugely important in giving combatant flyers an edge that may make the difference between success and failure on a mission. The recognition of the importance of human factors is not new, though it is taken into consideration today more than it has ever been. It actually dates back to World War II, when new pilots had to be trained up at speed. Even then, psychologists at Cambridge University led by Kenneth Craik and Professor Sir Frederic Bartlett came to realise that a lot of mistakes aircrew were making were down to the layout of the cockpit.

The dials and controls at that time were fairly rudimentary and they weren't necessarily positioned so that the pilot could quickly and effectively understand and absorb the information being relayed to them through these instruments. A better cockpit layout, it was realised, would lead to a higher success rate. This was an important discovery, and human factors has moved on a long way in the last 80 years. One of the companies leading the way in human factors research is BAE Systems, which operates across the globe in the design, manufacture, upgrade and support of combat and fast jet trainer aircraft including the Hawk and Eurofighter Typhoon.

Suzy Broadbent, Engineering Manager for the Human Factors Shared Service at BAE Systems Air, says that whilst human factors has long been recognised as a valued discipline, understanding of its application for military aircraft and systems has been an evolving story.

"For a long time, military commanders were focused just on picking and training the right people," she explains. "Your skill as a pilot could be based on how good you were at horse riding. Over the years, that changed, and there was a shift in focus to the design of the aircraft. Research began to explore the stress of flying and what was affecting people in that environment. Then in the 1970s and 80s there were a lot of studies to analyse pilot error and what the person at the sharp end was doing wrong."

The Eurofighter Typhoon was the first military aircraft developed in the UK where human factors became a central part of the overall design from the outset. "The cockpit became a subsystem in its own right and had its own dedicated design team. Until then, designers hadn't considered the human factors of the cockpit so much. It was very much driven by functional need. No-one was in charge of the overall layout and making sure it was coherent."

With Typhoon, everything changed. "In the early days of the aircraft's development, mission analysis started, which involved trying to understand what tasks the pilot had to undertake. That meant that the designers knew exactly what information they needed. As aircraft have become more complex, the amount of data available has rapidly increased. It's our job as human factors engineers to ensure the pilot is getting the information they need, at the right time. You shouldn't overload the individual who is having to make all the decisions."

The virtual cockpit moves the information flow from the aircraft directly to the helmet worn by the pilot

Clearly, there is a critical balance to be struck in ensuring that the aircrew are not compromised by having either too much or too little data available to them at a particular moment in time. "It's understanding what the piloting task is and which bits are important at what stage. It's also about controlling the layout of the cockpit and the displays - how they look and how they work - and asking how we can help and what we need to do to ensure that the pilots are less likely to make mistakes and so more likely to succeed in their mission."

So how is this information actually conveyed? In the Eurofighter cockpit, a head-up display projects green imagery such as the horizon line in front of the pilot as a primary flight reference. There are also three different multi-function displays along with the stick and the throttle. "It's quite busy as there are lots of displays and lots of controls. The challenge really comes when the aircraft has to be upgraded to cater for a new weapon or a new sensor. We have to look at ways to incorporate new capability and ensure it's intuitive at the same time."

To address this problem in the future, BAE Systems is developing concepts for a virtual cockpit. Suzy explains, "Everything can be projected onto your visor and as you move your head, different displays will pop up around you. The technologies we have today mean we can have complete flexibility in the design."

The development of the virtual cockpit is ground-breaking, moving the information flow from the aircraft directly to the helmet worn by the pilot, which starts to be a cockpit in its own right. "They would look down and still see a traditional aircraft layout in front of them, but the reality is that it wouldn't be there. The display would all be in the software. That means that when you come to upgrade you have a lot more flexibility and people can set up the information display in the way they prefer. People these days want a lot more customisation and we're used to having information presented to us in different ways - on our mobile phones, for example."

This move to what amounts to wearable instrumentation creates challenges for human factors designers. The →

The cockpit of a Royal Air Force Typhoon jet fighter aircraft

We look at which functions we can automate, freeing up the pilot to do the things that humans are good at, like critical decision making

helmet of the future will contain a sophisticated colour display but it must also continue to service its original function as a head protector and life preserver. "It still has to be able to support pilots if they have to eject which means we have to take into account the comfort and the weight. We're also examining the possibility of building an eye tracker into it so that we can see exactly what the pilot is looking at. That would be useful for training; if we can see that they're looking at the right things when they land, that will help with the debrief. We'll also be able to gather information about how tired they were."

Suzy continues: "There's a lot you can learn from the eye and this technology means we'll be able to tell more about a mission than simply listening to the pilot's subjective view. We'll know if they were looking at the right thing or if they've been fatigued or overloaded. Might they potentially be pre-hypoxic? Are they suffering from g-forces and the risk of a loss of consciousness? This information can be fed back and evaluated in real time. We've long had warning panels telling us which bits of the aircraft may be having problems but we've never had the same thing for the pilot."

Suzy describes this as human-machine teaming. "You don't want the pilot to be the weak link. You want the technology to be able to step in and help them where necessary, especially as modern aircraft only have one person in the cockpit. What we're doing is looking at which functions we can automate, so freeing up the pilot to do the things that humans are good at, such as critical decision making and the ethics of a particular situation. The machine can take over a lot more of the flying, especially if the pilot does start to get overloaded."

Using this new technology, the mission becomes more than the product of a single machine and a single human. Of course, that's always been the case - the Battle of Britain was won by commanders and squadrons rather than lone Spitfires and Hurricanes operating independently - but the technology will allow more agents to get involved. One possibility is the future use of so-called loyal wingmen - unmanned devices such as drones flying alongside the manned aircraft that can be sent off to do other things.

"If the helmet fails and that's where all the displays are, then clearly there has to be some redundancy. In a worst case scenario, someone on the ground could take over your aircraft, or it could even fly you home itself."

Inevitably, given the complexity of modern military aircraft and the critical importance of getting the design of everything right, systems and technology take time to develop. The work being done now will probably not actually be seen in cockpits for at least another decade and possibly longer.

"We don't know what the missions will look like in the future or exactly what the aircraft are going to be like then but we can start to build in flexibility now."

This may all sound like science fiction, but so did autonomous cars and drone deliveries a decade ago, and while they're still in development, both are a reality now. It's not likely to be long before the intelligent helmet and the associated technology move out of the design and test phase into real world combat air capability.

"There are always technological challenges, and there are always hundreds of reasons you can give why something can't be done," Suzy says. "We also have to take the customers and regulators on this journey with us but it's all very exciting and we've got some great people on the teams involved. At the end of the day, this is all about using human factors understanding to help the pilots. They shouldn't have to fight against the systems to get the information they need. And the whole experience should be intuitive and engaging for them. We still want people to want the job." ●

Suzy Broadbent is Engineering Manager for the Human Factors Shared Service at BAE Systems Air.

Responding to a crisis

The need for civic authorities to meet the challenges of local disaster planning has risen, as highlighted by the current pandemic, recent terrorist attacks and natural disasters. With their experience in the aftermath of the Grenfell fire, **Courtney Grant** and **Mohammed Ali** describe how a human factors perspective can help

On 14 June 2017, 72 people lost their lives in an catastrophic fire. In the days after the disaster, we acted as volunteers for the National Zakat Foundation (NZF), a charity that formed part of the Grenfell Muslim Response Unit. We provided immediate help and support to the survivors and other affected local residents, and the experience allowed us to reflect on areas where human factors could play a key role in helping civic authorities respond to a crisis of this nature, and to mitigate the challenges faced.

The NZF is a Muslim faith-based charity, that primarily collects 'Zakat' and uses it to support local welfare initiatives. Zakat is an annual payment of 2.5% of a Muslim's accumulated total wealth over a one-year period that all eligible Muslims make under Islamic Law. In order to offer recipients dignity, independence and choice, NZF handed out cash sums to individuals affected by the Grenfell tragedy.

The NZF used crowdtasking to recruit volunteers, leveraging NZF's social capital influence within the third sector and the Muslim community. As a volunteer based at Al Manar mosque, located a mile from the Tower, Mohammed processed financial aid to survivors. Volunteers used spreadsheets to manage different funds available to survivors. (They also carried out health needs assessments via a smart phone app.)

The system used three pools of funds: the charity fund, the 'Zakat' fund and the *Evening Standard's* dispossessed fund that created a complex situation in which to manage the money. The Zakat fund had to be exclusively distributed to Muslims so volunteers had to determine a recipient's faith, which wasn't always easy. NZF could not distribute any surplus funds that the Al Manar mosque collected. And the *Evening Standard* allocated their dispossessed funds to two charities: NZF and Rugby Portobello Trust. Grenfell Tower residents had exclusive rights to this pool of funds but could only claim once from either of the two charities. Whilst a live spreadsheet was used to document and authenticate the status of each Grenfell resident's payment, it didn't always have the most up-to-date information. Having a simple one-pool system that provided immediate feedback on the status of claims would have eliminated any confusion and speeded up the process.

The cognitive tasks of volunteers were often complex too. Given the nature of the tragedy, some victims had no identity documents and volunteers had to make decisions about payments based on judgement and intuition rather than on verification. Volunteers also provided counselling services to victims whether or not they had the necessary skills, highlighting an important training gap. Journalists entered the mosque in an attempt to speak directly with survivors so volunteers had to divide their attention between helping survivors and tracking the movements of the journalists.

NZF had a help desk at the Westway sports centre located close to the Tower. Courtney provided survivors and other affected local residents with advisory support but simple solutions could have made this easier. For example, one family had very understandably left their mobile phone charger behind when escaping from the Tower. It took a lot of time to find the right charger for them to use but having a centralised system that allowed volunteers to quickly search for key items like this would have helped enormously.

Some people resided at the Westway, whilst others stayed elsewhere but visited the centre to receive support. Analysing these different situations would have helped to understand the various needs. Mapping the end-to-end process in a systematic way and looking at the patterns that emerged could have better informed the layout and arrangement of support desks to ensure those in need found what they wanted quickly and easily.

In the face of the disaster, the charities contributed in making a positive social impact and filled a void in the absence of wider coordinated support. Local authority initiatives have since been implemented which have been inspired by the work of such charities. This led to the establishment of the Coordinating And Mobilising Emergency Response Activists (CAMERA) across London boroughs. In such trying circumstances, it's no surprise that issues emerged and it shone a light on areas where human factors could help to respond to a crisis of this nature in the future.

Grenfell Tower in the aftermath of the fire

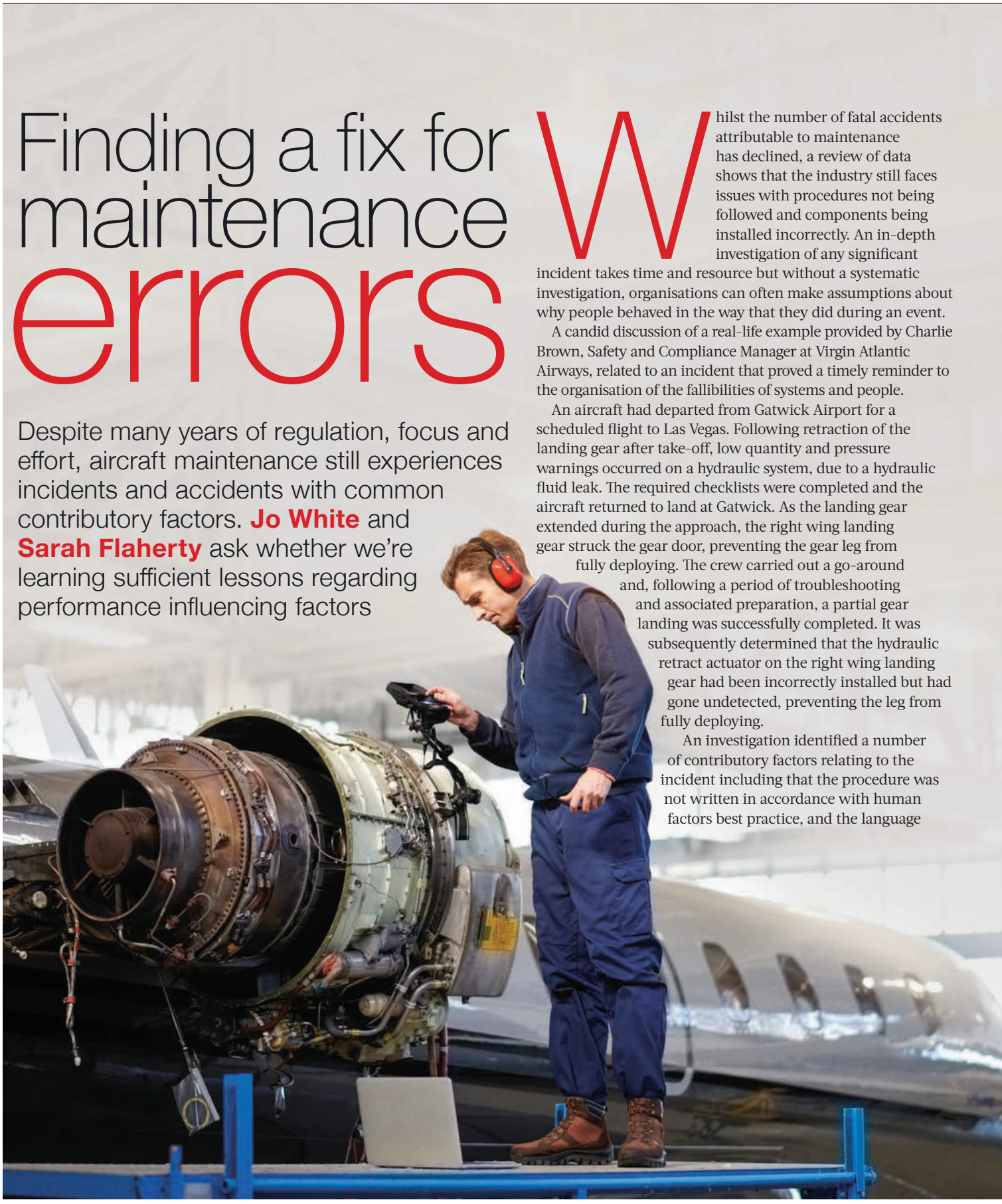
IMAGE: SHUTTERSTOCK

Courtney Grant has a BA (Hons) in Psychology, an MSc in HCI with Ergonomics and is a Chartered Fellow of the CIEHF and a registered European Ergonomist.

Mohammed Ali has a BA (Hons) in Accountancy and Business and an MSc in Global Health Policy. He's a member of the CAMERA Emergency Volunteer Team in Hammersmith & Fulham.

Finding a fix for maintenance errors

Despite many years of regulation, focus and effort, aircraft maintenance still experiences incidents and accidents with common contributory factors. **Jo White** and **Sarah Flaherty** ask whether we're learning sufficient lessons regarding performance influencing factors



Whilst the number of fatal accidents attributable to maintenance has declined, a review of data shows that the industry still faces issues with procedures not being followed and components being installed incorrectly. An in-depth investigation of any significant incident takes time and resource but without a systematic investigation, organisations can often make assumptions about why people behaved in the way that they did during an event.

A candid discussion of a real-life example provided by Charlie Brown, Safety and Compliance Manager at Virgin Atlantic Airways, related to an incident that proved a timely reminder to the organisation of the fallibilities of systems and people.

An aircraft had departed from Gatwick Airport for a scheduled flight to Las Vegas. Following retraction of the landing gear after take-off, low quantity and pressure warnings occurred on a hydraulic system, due to a hydraulic fluid leak. The required checklists were completed and the aircraft returned to land at Gatwick. As the landing gear extended during the approach, the right wing landing gear struck the gear door, preventing the gear leg from fully deploying. The crew carried out a go-around and, following a period of troubleshooting and associated preparation, a partial gear landing was successfully completed. It was subsequently determined that the hydraulic retract actuator on the right wing landing gear had been incorrectly installed but had gone undetected, preventing the leg from fully deploying.

An investigation identified a number of contributory factors relating to the incident including that the procedure was not written in accordance with human factors best practice, and the language

used was confusing. Following the occurrence, a number of recommendations were made including that all future retract actuator replacements require the addition of a fluorescent tape strip affixed to the down facing side of the actuator, clearly annotated in black permanent marker with the words 'THIS SIDE DOWN' once the correct orientation of the actuator is established. This was to be carried out during the 'bench' preparation stage when all the hydraulic hardware is installed and checked, and is an ongoing requirement.

In addition, there was an immediate but temporary requirement for full gear retraction functional tests (swings) to be carried out after the hydraulic retract actuator replacement to prevent a further incident. The delay gaining access to sub-assembly stores, a lack of information explaining how to best utilise manual handling aids such as a sling and hoist which resulted in aids not being considered, a lack of readily available correct tooling, the handover of the task to the night shift, manpower concerns, and the failure of the Strike Board to position correctly, all in turn, lead to the partial gear landing.

The investigation further concluded that the task became so physically demanding that the maintenance team had become entirely focused on just attaching the actuator to the aircraft, in order to relieve themselves of the 85kg weight they'd had to manually support for over 30 minutes. As such, they had no remaining capacity to ensure they installed the actuator in the correct orientation. It was subsequently determined that they had rotated it 180° about its long axis during installation, effectively installing it upside down. A difficult lesson learnt which was recommended to be shared.

The Royal Aeronautical Society (RAeS) Human Factors Group: Engineering (HFG:E) is an active subgroup of the RAeS Human Factors Specialist Group, with the purpose of promoting and influencing the reduction of risks to airworthiness resulting from human performance in engineering. Last year, through a conference at Cranfield University, HFG:E posed the question to industry about whether or not we're learning from maintenance error.

At the event, it was suggested that commercial pressures can impact the depth of human factors investigations as well as any subsequent investment in corrective actions and interventions. CAA Airworthiness Surveyor Dr Marie Langer described an analysis of Mandatory Occurrence Reports and CAA Airworthiness findings over the past decade that suggested trends remain largely unchanged in terms of the number and types of findings and occurrences. She noted that the industry understanding of human performance, the quality of investigations and proposed corrective actions varies considerably, particularly the ability to identify underlying issues.

Dr Langer said that investigations often stop after the first visible cause is identified, rather than seeking the root cause. With 44% of all CAA findings raised in the previous five years relating to recurring incidents, a CAA root cause analysis identification road map was proposed to assist organisations in establishing a suitable process for investigation. Investment in the tool should lead to operational efficiencies in the long term, provided it is used effectively, reducing the recurrence of incidents. Fundamental to the CAA's suggested process was monitoring the outcome of any preventative actions to assess whether the intervention has been effective.

An aircraft engineer repairing and maintaining a jet engine

Andy Evans, Director of Aerossurance, said that just sending people through more human factors training is not always the answer to improving maintenance. He suggested instead, "we have to share the knowledge currently locked away in safety reporting databases more widely and engage our workforce more proactively to create improvement rather than just passively waiting for safety reports". More recent Military Aviation Authority regulated human factors facilitation courses also provide a forum to share some of this valuable information.

Evans advocated a more enlightened and holistic 'Psychological Safety' approach that encourages open discussion and confidence in the reporting system and management approach to investigating and understanding events. Humans are normally not 'hazards' to be managed and disciplined but are 'heroes' who can help our organisations learn and so we should treat them accordingly using 'Just Culture'.

Humans are normally not 'hazards' to be managed and disciplined but are 'heroes' who can help our organisations learn

The HeliOffshore Human Hazard Analysis process, that gets designers talking with maintenance personnel, and the Flight Safety Foundation Maintenance Observation Programme, that looks for improvement opportunities with maintainers before errors occur, are both examples of proactive safety management.

The conference speakers highlighted that as an industry, we are learning but perhaps not at a speed nor to a depth and consistency to create a step change in the safety performance of maintenance organisations. There is clearly more to be done.

Joanna White is a human performance specialist with experience across army and aviation projects and has spent her career working with both civil and military organisations. She has a first degree in psychology and an MSc in Research Methods in psychology. She is a Chartered member of the CIEHF and sits on the Royal Aeronautical Society Human Factors Working Group: Engineering.

Dr Sarah Flaherty is Director of Lux Consulting and is a human performance specialist with a broad experience across the aviation, rail and petrochemical industries. She has a first degree in psychology and is a Chartered member of the British Psychological Society and the CIEHF.

Further reading

CAP1760, Effective Problem Solving and Root Cause Identification: https://bit.ly/38WVVG5

IMAGE: GETTY

The wrestler, the bus driver and the soldier

In the developed world, health and safety interventions have been very effective at reducing workplace deaths. In the UK, the rate of fatal workplace injuries has reduced by 85% between 1974 and 2019. But, as **Pat Jordan** discusses, workplace injuries are not the only way that work can kill us

A friend who was a professional wrestler invited me to a show. That evening, along with 18,000 others, I watched muscular men and athletic women throwing each other around the ring. My friend won her match after hitting her opponent over the head with a chair! It seemed violent and dangerous at the time but professional wrestlers are highly trained 'sports entertainers', working together to ensure that, while everything looks spectacular, they take care of each other's safety. Nevertheless, an alarming number die young.

WrestleMania is wrestling's annual flagship show. Thirty-nine wrestlers took part in the 1990 event. By 2015, fifteen had died. To put this in perspective, of the 44 American footballers that took part in that year's Superbowl only one had passed by 2015. That gives these wrestlers a death rate of 17 times that of the footballers. But no WrestleMania 1990 participant died while wrestling, training for wrestling or of a wrestling injury.

Studies have shown that the Standardised Mortality Rate (SMR) of pro wrestlers is much higher than that of the population as a whole. In other words, a wrestler is far more likely to die in any given year than the average person of the same age and gender.

STANDARDISED MORTALITY RATE

Standardised Mortality Rate (SMR) is a measure of deaths per 100,000 person-years adjusted for age and gender. It provides a meaningful comparison of the death rates of different professions, even if the age and gender composition of those professions differs.

Having made such progress in reducing workplace deaths, perhaps the next stage is to engage with a wider measure of safety and embrace broader approaches to prevent people being killed by their jobs.

Current health and safety analyses define a work-related death as one occurring from injuries sustained in the course of work. On this basis professional wrestling might not be regarded as an especially dangerous job. But while they were not killed at work, lifestyle factors surrounding the job might explain these deaths. These include using steroids and painkillers, and hard-partying associated with touring.

When assessing the dangers of work, SMR can be a complimentary measure to workplace fatalities. The latter are at an all-time low but are apparently safe jobs killing people in other ways? For a government study, I investigated occupational hazards and workers' health. A memorable visit was to a bus company. No bus drivers had been killed or injured at work but they had a noticeable problem with obesity.

Bus driving is very sedentary, without even the movement that an office worker might get, for example when they get up to make tea or chat with colleagues. One employee remarked, "A number of mechanics have moved into driving and you just see them expand."

Most recent figures for male bus drivers show about two workplace fatalities per 100,000 person years, as compared to one for the male workforce as a whole. The SMR of male bus drivers, meanwhile, is 445 per 100,000 person-years compared with 384 for the working population. Taking these figures together suggests 61 additional deaths, only one of which is caused by a workplace fatality.

This SMR figure comes from a paper in the *Lancet*, which

SELECTED OCCUPATIONS BY MALE SMR	
Armed Forces personnel	162
Doctors	225
Teachers	262
Engineering professionals	282
Electricians	333
Farmers	402
Sales assistants	429
Bus drivers	445
Hairdressers	492
Professional wrestlers	708

SMR (DEATHS PER 100,000 PERSON-YEARS)
NOTE: *THE LANCET* DATA COVERS 63 OCCUPATIONS BY MALE SMR, 43 FEMALE.

analysed mortality rates for 63 separate occupations. Occupation-based SMR figures used to be published by the UK government every decade, but this stopped in 1970, since when work has changed enormously. Figures have been produced in other countries but usually based on broad occupational categories rather than specific jobs, limiting their usefulness.

The only organisation that uses SMR as their main measure of hazard is the Ministry of Defence. Their data shows that even during the Iraq and Afghanistan wars, military personnel had low mortality rates. Currently these are 40% of that of the UK population as a whole. Traditional health and safety analyses would suggest that being in the military was by far the most dangerous job in the UK. Between 2001 and 2014, 689 UK military personnel were killed in conflict and there were also fatalities during training. Even now the military has by far the highest number of deaths caused by accidents at work, at around 14 per 100,000 person years, way ahead of agriculture in second, which has eight.

Having made progress in reducing workplace deaths, perhaps the next stage is to engage with a wider measure of safety

Given these figures, why do military personnel have such low mortality rates? The answer may lie in lifestyle. Military personnel lead active lives, stay fit and have regular medical check-ups. Camaraderie reduces loneliness and mitigates other issues effecting longevity. The military has also got better at addressing conditions such as Post Traumatic Stress Disorder. Having said that, people need to be fit and healthy to join the military in the first place.

This last point illustrates the limitations of SMR as a measure. It helps flag jobs where people have high death rates but doesn't show causes or even whether there is a causal effect at all. For bus drivers we might expect that the sedentary nature of the job leads to increased mortality but further investigation would be required to know what proportion of additional deaths are associated with it.

For example, male hairdressers have high mortality rates, however this may mainly be due to high numbers of gay men in the profession rather than anything to do with the job. Research by LGBT organisations has shown that gay men have shorter life expectancies and, coincidentally, are overrepresented in hairdressing.

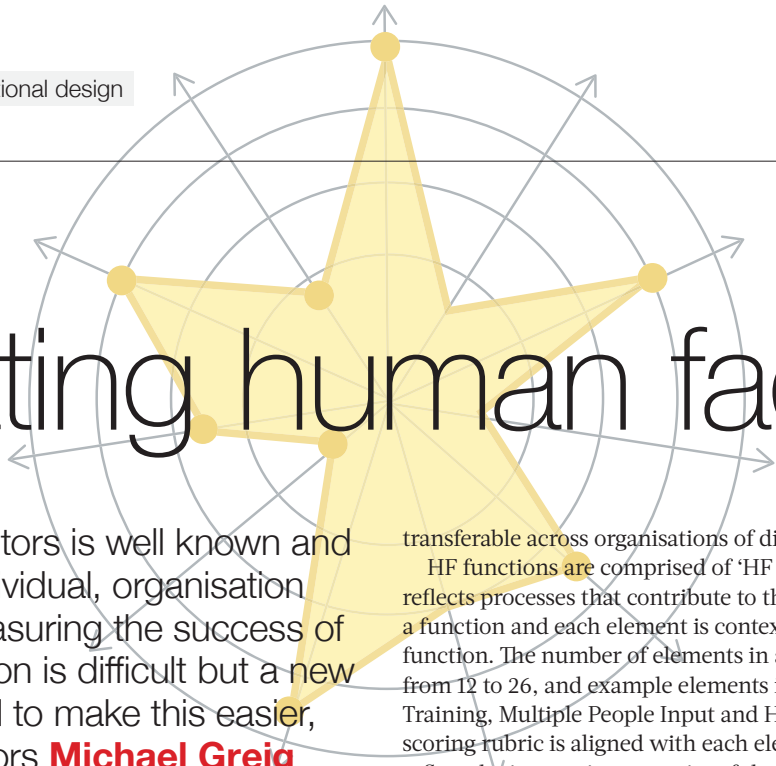
For all professions, there will likely be other correlating factors, such as socio-economic status, which SMR doesn't control for. Whether this should be seen as job-related is debatable. Arguably, a person's socio-economic status is conferred by their job but it's also a predictor of job opportunity.

Despite its limitations, SMR is a valuable measure. Accidents and injuries at work explain a tiny fraction of deaths associated with particular jobs and SMR can show us where to look to help us understand the others. As ergonomists it's our responsibility to press for the reintroduction of the gathering and publication of this data by government. In the meantime, the *Lancet* article, while not covering all occupations, is a valuable resource.

Pat Jordan is an ergonomist working in the private sector, government and academia.

Further reading

Katikireddi, S V et al, 2017. Patterns of mortality by occupations in the UK, 1991-2011: a comparative analysis of linked census and mortality records, *Lancet Public Health* 2017; 2:e501–12



Integrating human factors

The value of human factors is well known and benefits exist at the individual, organisation and societal levels. Measuring the success of human factors integration is difficult but a new tool has been designed to make this easier, as award-winning authors **Michael Greig** and **Patrick Neumann** explain

The application of human factors in organisations is not always ideal and often limited to health and safety domains and retrofitting of equipment or workstations; rarely is human factors applied at the design level. Audits and standards provide some guidance on how to measure the effectiveness of human factors but nothing has been available to know how well it's been integrated across the whole organisation.

The Human Factors Integration Toolset (HFIT) has been created to address this issue, enabling a macroergonomics approach to quantifying the level of integration of human factors throughout an organisation.

The measurement of the extent to which human factors has been integrated and applied in an organisation is based on the principle that decision-makers manage using quantitative indicators and therefore need an approach that allows measurement of human factors integration. Outcomes from this novel approach provide tangible information which can create avenues for discussion on human factors and the associated benefits.

The HFIT was developed with contributions and feedback from an electronics industry partner. Public workshops were held to provide a venue for the content, format and usability of the tool to be verified by subject matter experts. The workshops included participants from the human factors profession, industrial engineering, as well as graduate students, with backgrounds in consulting, healthcare and manufacturing, among others.

To facilitate the review of an organisation, the tool is structured so that an organisation is broken down into 16 'HF functions' to make analysis of an organisation more manageable. Examples of functions are Environmental Health & Safety, Tooling, Finance and Quality. Dividing an organisation in this manner allows for a description of roles in an organisation as compared to using explicitly defined departments since a small company might not have a 'shipping department' for example. This choice was to allow the approach to be transferable across organisations of differing size and structure.

HF functions are comprised of 'HF elements'. An HF element reflects processes that contribute to the ideal human factors for a function and each element is contextualised to the associated function. The number of elements in a given function ranges from 12 to 26, and example elements include HF Specific Training, Multiple People Input and HF Culture. A five-level scoring rubric is aligned with each element and is scaled to reflect the integration maturity of the element from nothing to the perceived human factors ideal of 'world class'.

The HFIT can be completed individually or in groups using self-reflection, interviews or a consensus approach to the scoring. The tool is modular, meaning a single function can be assessed in isolation. Users review each element, choose the appropriate rubric score and then sum the element scores for the function to determine the percentage of the human factors ideal in the current situation. A radar plot shows how the scores of the functions relate in all functions across the organisation.

The tool outcomes can provide an external benchmark for comparison with other organisations which will hopefully spur on 'friendly' competition between organisations and drive the overall work experience to a better state. The scores can also be used internally to track continuous improvement goals over time. Consultants could use the approach and apply the information to demonstrate and/or measure project outcomes and improvement at the organisational level and the tool can provide a platform for discussions around the contributions of human factors in the broader scope of an organisation.

The tool is ready for broad testing to understand how well the approach transfers across different organisations and how well the scores relate to organisational success. For more information about this innovative approach to measuring the quality of your organisation's human factors capabilities, please contact **m2greig@ryerson.ca.**

Michael Greig and **W Patrick Neumann** work in the Human Factors Engineering Lab of Ryerson University in Toronto, Canada.

THE AWARD-WINNING PAPER!

The description of the development of the HFIT has recently been awarded the 2020 Liberty Mutual Award for best paper in the journal *Ergonomics*, and is available at

www.tandfonline.com/doi/full/10.1080/00140139.2019.1572228.

The tool is available for free at **www.researchgate.net/project/Human-Factors-Integration-Toolset.**

Getting engaged

We all have different personalities and some of us are more courageous than others, especially when it comes to sharing knowledge or asking questions. During our latest annual conference and numerous other virtual events since then, we've seen a huge demand for exchanging opinions, making connections or simply saying "nice to see you around". Some members reconnected after having worked together in the past, others are actively looking for new links. Whatever your motivation may be, our organisation provides lots of opportunities to get engaged so if you haven't done so already, please explore what's on offer.

Whether you're getting started in a new discipline, seeking collaborators for a new project, you'd like to learn from other sectors or hear more about human factors in other countries, you'll benefit from networking. It may help you to complete the paper you're working on, find a new project or gain another perspective but it can also contribute to making your career more resilient and open up new opportunities.

Our discussion forum Communities is available to all members and has seen a huge increase in posts over the last few weeks. Time zones are not an issue as discussions can easily ping-pong across the globe, so please join in wherever you're located. The forum not only addresses immediate questions but also creates a reference resource which all members can benefit from at any time.

Other engagement opportunities for members are being created by our Regional Network Leads who are planning virtual and (as soon as possible again) in-person events, so you can make contact with other members in your area. If you'd like to get in touch with your Regional Network Lead go to www.ergonomics.org.uk > Get Involved > Regional Networks.

Our online events programme is building up and all events have a chat function so if you can attend you can get involved this way, by interacting with the presenters or other participants.

Find out more on our website or contact me for any further information.

Iris Mynott
i.mynott@ergonomics.org.uk
07702 542166

MEMBERSHIP

Our latest accreditations

Congratulations to the following members whose applications for accreditation by the CIEHF over the past few months have been successful. Registered Members and Fellows also have Chartered status.

Fellowship

- Laura Lewis
- Somnath Gangopadhyay

Registered Membership

- Paul Isherwood
- Kate Shield
- Isabel Burrows
- Linton Seabrook
- Evanthia Giagloglou
- Ane Merino Guevara
- Harry Conway
- Katie Plant
- Pak Ho Plato Chan
- Jonathan Mason
- Jody Burley
- James Bunn
- Anisha Tailor

Technical Membership

- Rachel Bennett
- Mark Benton
- Andrew Wright

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
Postural Analysis Tools Masterclass	Wed, 26 August, online	Learn, explore and practice use of human factors tools to measure and analyse posture. First in a new series of expert-led masterclasses.
Aviation Safety	Wed, 23 September, online	Launch and discussion about CIEHF's upcoming White Paper containing visions of 15 thought leaders, showing how they believe aviation evolution will unfold between now and 2050.
STAMP Masterclass	Fri, 25 September, online	Find out about this human factors tool that looks into causes of incidents by analysing complex processes and unsafe interactions among system components.
IEA2021	Sun-Fri, 13-18 June 2021, Vancouver	Learning and networking opportunities for the human factors and ergonomics community around the world. Call for submissions closes 25 September. Visit www.iea2021.org for details.

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

IMAGE: SHUTTERSTOCK

Q&A

MEMBER PROFILE

Tina Worthy talks to Ergonomics Advisor **Siobhan Burns** about her career in healthcare

IMAGES: SHUTTERSTOCK / ALAMY

What's your background?

Like many who find a career in ergonomics and human factors, I didn't follow a planned route. I started out as a Healthcare Assistant working in a nursing home specialising in patients requiring palliative care. No patient handling training was given to staff at this time and within two years I had a significant back injury due to the weight and number of patients that I moved every shift.

Through that, I developed an interest in safe patient handling and completed local training to become a manual handling trainer specialising in patient handling. I worked in this role in a variety of settings for just over six years until I became a Manual Handling Trainer at University Hospitals Birmingham NHS foundations Trust (UHB) in summer 2013. This was the turning point for me, as I suddenly had a manager who was very proactive at developing her staff. Within no time I was booked onto a Postgraduate Diploma in Ergonomics for Health and Community Care and was feeling nervous about being back in an academic setting after so many years.

But I found the experience enlightening and interesting, and I particularly enjoyed the Human Factors and Systems module. I was also very lucky to work alongside, for a day or two each month, an inspirational colleague, Frances Ives, who was the Ergonomics Adviser for UHB at that point. Her down to earth humour and obvious dedication to integrating good ergonomics into everything she touched (including her Christmas gift list), helped me through the difficult times and motivated me to study harder.

What made you apply for your new role as Ergonomics Adviser?

Working alongside Fran enabled me to see some of the elements of her job and gain a deeper understanding of how an Ergonomics Adviser can help to improve the working lives and environments of staff. It ignited a desire to continue on my ergonomics journey and, whilst I continued to have a passion for manual handling, I was keen for a new challenge.

Fran was also moving on and, as this coincided with the conclusion of my postgraduate qualification, she encouraged me to apply for the job. The thought of taking on such a challenging role and following in the footsteps of someone I admired was certainly daunting but such an opportunity rarely comes along and I felt that I had nothing to lose in applying.

How did the outbreak of Covid-19 affect your work?

My first day in the Ergonomics Adviser role was 1st March 2020, and the ominous rumblings of Covid-19 were approaching. Three weeks in and lockdown was announced which completely changed the landscape of my job. Virtually all requests for ergonomics input dried up and I was forced to cancel all my booked appointments, as staff were either sent home to shield or re-purposed into different roles.

The atmosphere at work was tense and nerve-wracking as nobody knew what the next day was going to bring. I was pulled back into the manual handling team and assisted with the training of

over 1000 staff in preparation for the possible opening of the Birmingham Nightingale Hospital. For about ten weeks I worked in a weird limbo of mostly manual handling, with occasional dips into ergonomics work. Finally, in June I was able to start picking my ergonomics work back up and have been venturing out into a changed environment. Assessments that used to be a relaxed chat have morphed into a masked and gloved odyssey, with the participants nervous about sharing airspace, and disinfectant wipes our constant companions. Many face-to-face meetings are now performed via webcam or phone which brings with it new difficulties when connections are unreliable and private workspaces are at a premium. Working in this way, although undeniably necessary in the current climate, can reduce the quality of information I get from the person being assessed.

What projects have you been involved in so far?

Whilst delivering patient handling training at the Nightingale Hospital, I had an insight into the behind-the-scenes work involved in putting the facility together. I was able to offer support and guidance to staff who were feeling overwhelmed and tired. Due to the speed at which everything moved, very little consideration had been given to the comfort of staff working with display screen equipment. Most were sitting on hard, non-adjustable seating at tables that threatened to give them splinters every time they moved their hands. It gave me an enormous sense of satisfaction when I was able to source some basic operator's chairs and give them to the worst affected workers. I was also involved in ensuring that the battered tables were replaced with proper desks. I've also been heavily involved in the management of homeworkers. For UHB, homeworking wasn't the norm prior to Covid-19, so as a Trust we weren't prepared for the mass migration of staff home. I've been involved in ensuring that the Trust is meeting its legal duties for staff and also supporting workers who are finding homeworking difficult.

Three weeks in and lockdown completely changed the landscape of my job

What challenges do you see in the future?

One of the challenges is the management of homeworkers when they have workstation concerns. Pre-Covid I would have face-to-face meetings with staff who were struggling and see their workstations, observe postures and how they interacted with their environments. This made it much easier to identify problems and suggest changes, whereas now, such visits are not a viable option in many cases. While we use applications such as Vidyo and Microsoft Teams, it's not the same as being there and makes it harder to observe 'work as done'.

With so much money having been poured into the management of the Covid-19 situation, it's almost certain that there will be a reduction in funding for human factors work. For the uninitiated, incorporating good ergonomics into a project can seem like a luxury, especially if easier, cheaper options are readily available. I'll need to be convincing in my arguments around the value of the ergonomics service.

Have you got any advice for others in healthcare who'd like to follow the same path?

Find yourself an approachable, experienced mentor. Having someone that you can turn to when you have questions, who's happy to answer the most basic queries is so helpful. Sometimes tasks are very daunting and it's hard to know where to start. Having someone who's been there before is absolutely invaluable.

Compared to other sectors such as nuclear and aviation, healthcare lags behind in its application of ergonomics to working procedures. This often means that people don't see the value in the application of good ergonomics, but don't give up! The pleasure in seeing people working more comfortably and in safer environments is worth all the hard work. ●

Success stories

In our second set of stories from this year's amazing Institute award winners, we celebrate the achievements of members for their work in using virtual reality to prepare for real-life scenarios, for their creative approach to communicating reports and for generously volunteering their time to maintain professional standards.

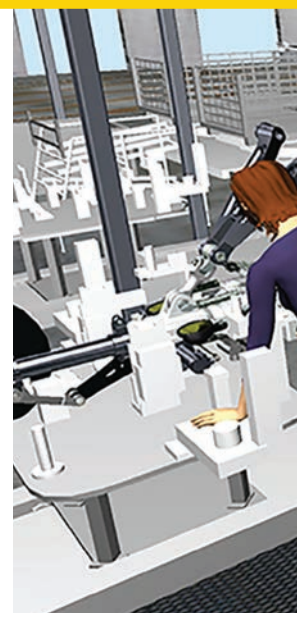
JOHN LOVEGROVE, FOUNDER OF CANARY DESIGNS

Outstanding Communications Award

John Lovegrove's ergonomic design studio is one of only a handful in the UK to use 3D environment software together with digital manikins which can model human interactions within a CAD design framework. This enables John and his team to immerse themselves in the design and test out all the human factors criteria in a physical space simulation and to quickly propose ergonomic enhancements.

This ability to work quickly and visually has shaped his communications with clients. Instead of providing large hefty reports, John creates video summaries of written reports, which allow his clients to understand the key findings quickly and effectively. Canary Designs' website also hosts a growing selection of video tutorials which explain human factors concepts and the benefits of virtual simulation and using digital avatars. As a result of this innovative approach, Canary Designs has been recognised with CIEHF's Outstanding Communications Award for 2020.

John has taken this approach over several years following client feedback that they were suffering from information overload. He said: "People have not got the time to read big in-depth reports, so we break down the elements of our report so clients can pick out what they need, and creating video summaries is a good way of getting your message across as quickly and concisely as possible. And secondly, it's a good way of showcasing the kind of work we are doing to the rest of the HF community, particularly with the computer modelling techniques. Once you have the CAD model for a project you can look at the design from a human factors perspective before you meet anyone from the project or visit the site. This means I can go to the first client meeting with a whole set of pertinent questions and potential solutions, saving everyone time.



John said the modelling technique is also a powerful way to put human factors arguments across at meetings, as he explained: "This approach allows you to put your ideas across in the universal language of design to multiple stakeholders. I've used it in a room full of officers for a military vehicle project showing the ergonomic adjustments required to create a more effective emergency escape route for occupants. It required significant engineering changes but it's the first time I've ever had full agreement across the entire room. That's the beauty of this visual method."

Creating video summaries is a good way of getting your message across as quickly and concisely as possible

John and his team are working on other communication projects to enhance the

Using computer-aided design to demonstrate workplace layout and work processes

business: a linked website that provides online ergonomic self-assessments for organisations with tutorial videos, and eight new videos to enhance his current website to explain his services in more detail.

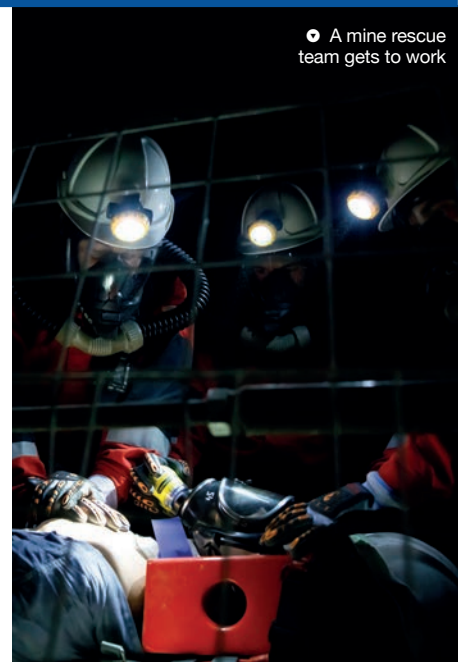
Commenting of the award, John said: "It's great to win the award, and to be recognised by my own community as communications is so important to all of us. I hope other human factors professionals will look at using the types of techniques we use at Canary Designs.

IMAGES: ISTOCK / GETTY

MIKE GRAY

Volunteer of the Year Award

The young Oxford physics graduate, Mike Gray, was first introduced to ergonomics in the 1970s when designing breathing equipment for mine rescue teams, and his interest in this new discipline helped launch his career in ergonomics which has now spanned over 40 years. During his time working at the Health and Safety Executive (HSE), he has also been heavily involved in the Institute, working on its various panels and boards. This long service has been recognised and celebrated by Mike being named as the recipient of the CIEHF's Volunteer of the Year Award for 2020.



A mine rescue team gets to work

Mike said: "It was when we were trialling the new coal mine rescue equipment underground, and looking at what heat tolerance people could take, that I became interested in human factors. The HSE could see that they needed to take account of this discipline so they supported me to study a Masters in ergonomics, and that became my new profession."

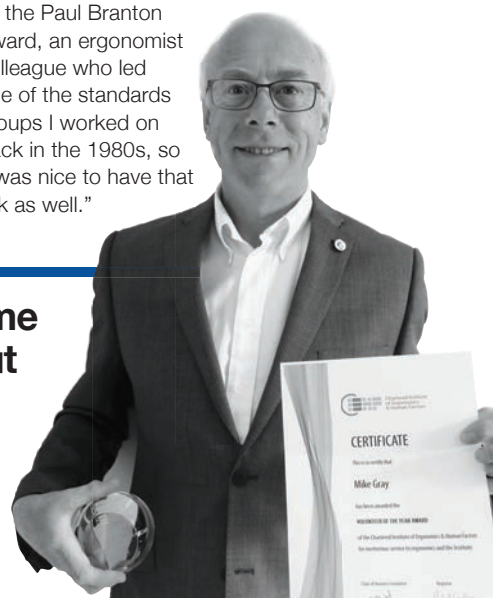
Mike helped to establish a new team of ergonomists at the HSE and later worked as an ergonomics specialist inspector, building up a team of frontline specialists across the country. He has also been involved in accident investigation, providing technical guidance to industry and helping to establish international standards.

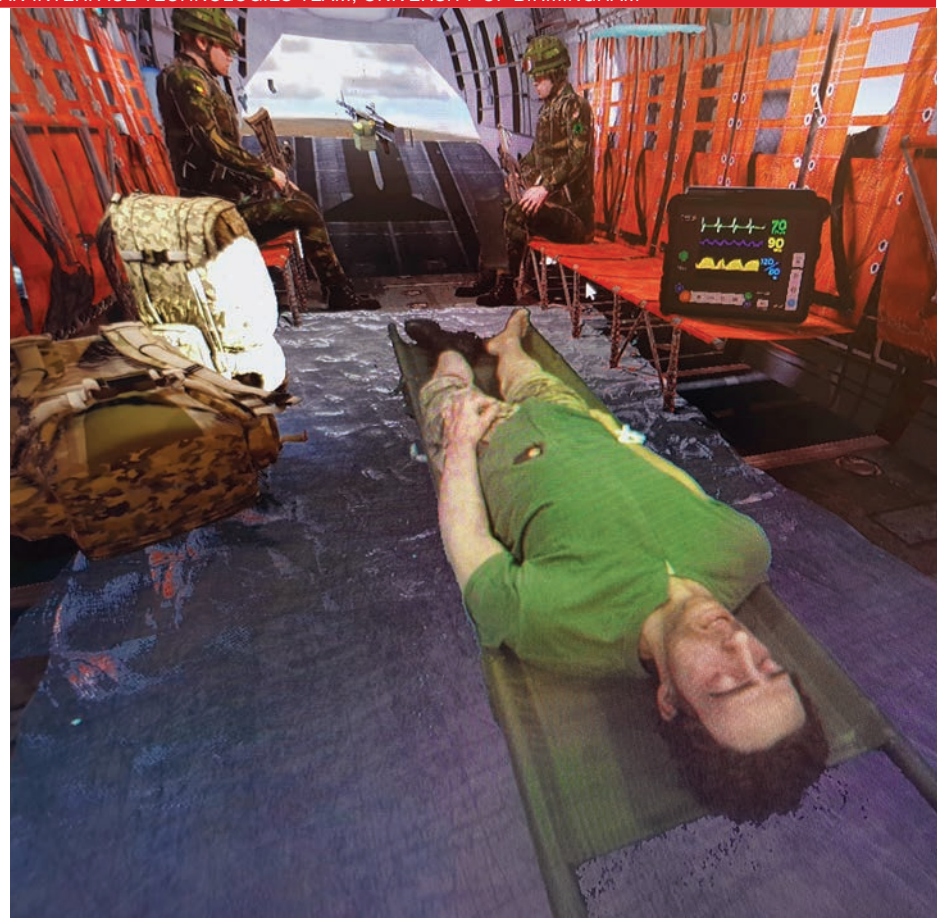
He first joined CIEHF in the early 1980s (when it was known as the Ergonomics Society) and got involved in the Institute's health and safety Special Interest Group set up to provide guidance on various government proposals and standards. He was also involved in organising the Institute's 50th anniversary event at the London Science Museum and has subsequently served on the CIEHF Council, Professional Affairs Board (PAB) and as the UK representative on the Council for the Registration of European Ergonomists (CREE).

Although Mike retired four years ago, he still volunteers on PAB and CREE. He said: "I give my time as it helps to keep me involved in my profession but to also allow me to pass on some of my experience. I think that the Institute could make more use of retired members as we have a little bit more time on our hands and great experience, which I think is a valuable resource to capitalise on."

Commenting on his award, Mike said the announcement came out of the blue: "I really had no idea and so I feel very privileged to win, particularly as the award was previously known as the Paul Branton Award, an ergonomist colleague who led one of the standards groups I worked on back in the 1980s, so it was nice to have that link as well."

Volunteering helps to keep me involved in my profession but also allows me to pass on some of my experience





Example of real and virtual integration in a MR Simulator

PROFESSOR BOB STONE, DIRECTOR OF THE HUMAN INTERFACE TECHNOLOGIES TEAM, UNIVERSITY OF BIRMINGHAM

The Innovation Award

The quality of the emergency treatment that can be given to a critically wounded soldier from the extraction point in the conflict zone en route to a hospital base can be the difference between life and death. That's why Medical Emergency Response Teams (MERTs) are put through a range of pre-deployment training scenarios to condition them to the difficult conditions they could encounter working in the field.

In the past, this relatively expensive training has been carried out on static structures in military bases across the UK but now, thanks to Professor Bob Stone and his Human Interface Technologies Team at the University of Birmingham, pre-deployment training has the potential to become more cost effective and more 'real'. That's why they have been awarded CIEHF's Innovation Award for their Mixed Reality Project for the Medical Directorate of the UK's Joint Medical Command.

The team has developed a low-cost redeployable training concept for MERTs which uses 'mixed reality'. This involves using real physical objects – such as realistic human manikin – within a 'blue screen' virtual reality (VR) enclosure. By using VR headsets, medics can believe they are providing life-saving medical procedures in a number of military transport scenarios, such as the back of a Chinook helicopter, on the floor of an armoured personal carrier, on the deck of landing craft or even inside a hovercraft.

The mixed reality technology allows them to interact with a virtual patient, but at the same time see and touch the physical manikin, while being surrounded by the sights, sounds and smells of that particular vehicle, including moving avatars of other crew members.

The instructor is in constant contact with the trainees, observing their medical procedures but also recording their reactions when he decides to throw in some gunfire, an engine failure or even a dust storm. The VR headsets also track eye movements, showing what the trainees are focused on and when they are being distracted.

Professor Stone's team is currently developing an augmented reality tool designed to portray the sudden appearance of wounds on the manikin, such as bleeding or burn blisters, so that medical crews will have to react immediately.

Our concept is a cost effective way to expose medical personnel to incidences they could encounter in the theatre of war

Professor Stone said: "Evidence from Afghanistan and Iraq shows the importance of preparing medical personnel for the events they could encounter in the theatre of war, so our concept is a cost effective way to expose them to some of the incidences they could encounter in a realistic setting. Throughout the whole project we have taken a human factors approach, and at every stage involved the trainers and medics to ensure the concept is right for their needs. It obviously has many civilian applications too but the next stage is to carry out intensive trials at military bases around the UK to find out what medics learn under these conditions and, more importantly, what they retain and transfer into a real world setting."

Commenting on the award, Professor Stone added: "I'm fantastically pleased to get the award and so proud of my team. We want to prove that by adopting a human factors approach at the outset that you can deliver a technology-based training system that's fit for purpose." ●

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FROM THE PRESIDENT

Engagement on all fronts

Amanda Widdowson
CIEHF President

president@ergonomics.org.uk

As lockdown started to ease, more people progressed from working at home to working in offices. Questions have been raised as to whether the pandemic will result in permanent changes to the office environment. Many organisations have had to adapt to facilitate working from home and can realise cost savings by sacrificing office real-estate. These savings may be necessary in the future economic climate but we need human factors input to ensure the new ways of working are safe and efficient. With the help of our volunteers, the CIEHF has issued guidance to support different working environments. In a joint webinar with the Indian Society of Ergonomics, we identified shared issues with working from home, such as the close proximity of family members, and a lack of separation between work and non-work time.

Interestingly, whilst some professional bodies have seen a decline in membership numbers during the pandemic, CIEHF membership is at an all-time high. Perhaps this is because we have continued to engage with each other through a series of webinars and the *Communities* discussion forum. We've also increased our presence on social media platforms and it's been great to hear feedback from members and non-members.

Our new CIEHF Defence Sector Group has also been active. I presented the President's Project, Design for Everybody, featuring an anthropometric survey, at a methods webinar organised by the group. I also discussed the project at an inclusive design webinar with Dan Jenkins and Eddy Elton. The survey is still live and a new video demonstrates how to take the measurements. If you haven't already done so, please take part and encourage your friends, family, colleagues and/or students to do so too; just go to https://bit.ly/DesignForEverybodyGuidance for details. We hope the results will help enable human factors professionals to ensure products and equipment are designed to represent a more diverse range of people. I believe our members are uniquely positioned to benefit society in this way.

CIEHF membership is at an all-time high

FROM THE EDITOR

Insights, challenges and animal antics

Musculoskeletal health features strongly in this issue, with Bob Bridger's discussion of the perils of sedentary work and Anastasia Vasina's exploration of the use of technology to assess risk. We have an insightful case study by Dr Stephen Hoole, who explains how he realised a need, and designed and brought to market an aid for positioning sedated patients, greatly benefitting the posture of both the patient and the healthcare provider.

We continue to report on how we might learn from our Covid-19 experiences and adapt to permanent changes that the situation will inevitably bring. Colin Drury and Michelle Robertson share their perspectives from the US, and Michael West explains the importance of showing compassion at this time.

Michael Brown talks about the challenges of design research when the brief directs you to 'design for everyone'. A much narrower user population but no less challenging were the early human factors requirements for military aircraft cockpits, as Jo Davies testifies.

Nigel Heaton gives the lowdown on going solo in consultancy and Angela McLean shares her enthusiastic journey into the oil and gas sector.

The life of Bob Muffett and his contribution to rail human factors is recognised in an obituary notable for the input from many of his colleagues and those he mentored.

And finally, in probably one of the more unusual articles we've published – and this issue's cover story - Neil Mansfield and John Lovegrove talk us through their work to determine whether or not the mythical story of the Trojan Horse and the attack on the city of Troy could actually have happened.

Tina Worthy
editor@ergonomics.org.uk
@ciehf

The CIEHF's rapid response to the coronavirus pandemic showed policy makers what human factors can do in a crisis. We examine the impact the Institute's work has had and what it could mean for the future

Rising to the challenge

One clear, brutal message has emerged from dealing with Covid-19: that he – or she – who hesitates is lost. The UK Government's failure to lock down quickly enough is said to have cost a substantial number of lives, while in the United States, prevarication and poor messaging was blamed for sending case numbers and deaths soaring.

Perhaps it's easier for human factors experts to see the full potential effects of a crisis than politicians but CIEHF's reaction to the pandemic was comprehensive, decisive and rapid. Response teams were organised by Chief Executive Noorzaman Rashid to provide other professionals within the healthcare sector with vital information.

The service has proved to be hugely useful. "Basically, we followed a military-type command structure, with gold, silver and bronze levels," explains Professor Paul Bowie, Programme Director for Safety and Improvement with NHS Education for Scotland and a Chartered Ergonomist.

Members of the gold team overseeing the strategic response of CIEHF included Noorzaman, Paul and their CIEHF colleagues Sue Hignett, Chris Ramsden, Mark Sujan and Peter McCulloch, who is professor of surgical sciences at the University of Oxford. They were able to call upon the expertise of other colleagues and clinical experts via the silver and bronze teams. "The immediate ask for our service was around the need for guidance for new UK manufacturers of ventilators for Covid-19 patients," Paul recalls.

"There was an expectation at the very start of the pandemic that there would be a need to produce these very quickly because there was going to be an absolute deluge of patients. The companies traditionally manufacturing them were at full capacity so the country had to go out to other industries. It seemed that the ventilators needed to be produced rapidly and the Institute's role was to provide guidance to those making them who had never done it before. We gave them the minimum specifications from a design point of view so they would be usable by staff who were required to operate them." The team were able to provide the necessary information in an extremely short timescale.

Mark Sujan, founder of his own Human Factors Everywhere consultancy and a governing Council member of CIEHF, recalls: "We really hadn't planned the ventilator intervention, but the way it came about was that an official guidance document was issued for rapidly manufactured ventilators. From our

IMAGE: GETTY

perspective, it lacked a lot of essential information and it couldn't ensure that these ventilators would actually be safe to use. The whole thing was driven by Noorzaman when the issue came to his attention. We had two main aims: firstly, to help the NHS and secondly, to promote the Institute and to make it more visible."

Amazingly, the team managed to produce the guidance in just 48 hours. "It was a pretty challenging task but we managed it," Mark says, "I produced the first draft, incorporating the views of around 60 of our members who were supplying information by email. It was then issued as a guidance document to the Medicines and Healthcare Products Regulatory Agency (MHRA), who made it available to manufacturers."

As it turned out, the number of seriously ill Covid-19 patients did not rise to the level where newly produced ventilators from non-clinical manufacturers were required. This obviously came as a huge relief to the team and the guidance, while ultimately not needed, received considerable praise. "I think we were all happy about that," Mark adds. "But I don't think there's any doubt that had the devices been produced, our guidance would have made them safer. We did get anecdotal feedback from one manufacturer with no previous experience of medical devices that said it was very useful. And someone else who was working within policymaking mentioned the importance of being able to obtain human factors guidance."

The CIEHF achieved national publicity and performed an important function. "I don't actually think the biggest impact was what happened with the ventilators," says Mark. "It was the raising of the profile of human factors as a discipline. My feeling is that if similar things happen in the future, then the Institute is now very much on the radar of policymakers. Next time they might approach us upfront. That's the ultimate goal."

In parallel with the ventilator initiative, the wider CIEHF group was also working on other Covid-19 responses. It was recognised, for instance, that health and social care teams would have to rapidly adjust how they worked to the new situation, and information was provided around this. Paul Bowie explains: "That meant looking at how things are done and how healthcare staff interact with colleagues, patients and others. There are a lot of protocols that dictate how the work is carried out, and health and social care teams are sometimes not very good at properly designing procedures to reflect this and to get these things to be usable and sustainable."

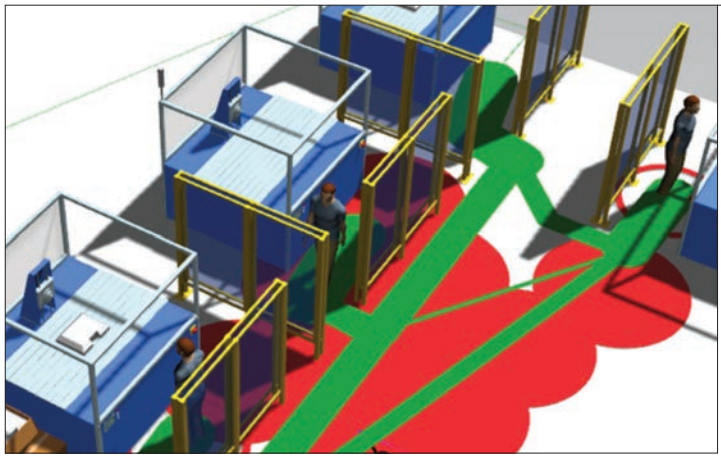
If similar things happen again, the Institute is on the radar of policymakers

The CIEHF team was a multi-disciplinary body with more than 60 senior clinicians and human factors specialists involved, so it was able to provide assistance with this. "The guidance is now out there and we are promoting it not just for Covid-19, but beyond that, too", Paul says. "We've used our international networks so there have been people from a number of countries involved, ranging from New Zealand to Canada. That includes about 15 human factors people. I think it's probably unheard of to get so many experts in this field working on one job at the same time, over such a short period, all coordinated by the Institute."

Paul's work with the group has also included assisting GP teams in Scotland with what is known as re-mobilisation. "They never actually shut down during the pandemic but now that things are beginning to ease slightly, there will be a deluge of patients coming in with other conditions or who are out of kilter with their treatment. The GPs now have to see these patients as quickly as possible. This means practices need to be re-designed to accommodate new ways of working to minimise infectious spread. The Institute has worked to provide guidance on risk assessment of premises and to co-develop a Covid-19 checklist involving our user-centred design principles. We've contributed to the creation of a package of interventions to be implemented nationally."

The whole CIEHF process, Paul says, has provided compelling evidence for health and social care policymakers of what human factors can do in a crisis. "This will hopefully help with future recognition of that. We really stepped up to the mark here and did our bit for the country."

Mark Sujan echoes this. "All the feedback we had on the ventilator document was positive. It also gave us the ability to network with other institutions, which was useful, and I think this will filter down into the everyday work of the Institute. We set a precedent, and others can now look at our guidance and aim to produce similar documents for their sectors - defence, for example, or pharmaceuticals. We've illustrated how the Institute can make a difference, and it's now a matter of embedding it into the way that CIEHF works." ●



JACK software shows design, layout, movement flow and space envelopes

Modelling manufacturing

During this Covid-19 pandemic there are wide ranging impacts to different sectors of manufacturing and human factors consideration is needed for all aspects of production to facilitate requirements for compliance with current government guidelines. The UK government guidelines acknowledge that manufacturing can go ahead "in accordance with the social distancing guidelines wherever possible". Unite, Britain and Ireland's largest worker union, is one of many organisations scrutinising this issue closely on behalf of their membership.

In many cases, companies must redesign production facilities to ensure safe and efficient working whilst at the same time answering the business need for managing production throughput and supply chain logistics. Decision making can be difficult and is driven by managerial strategies, technological implications and layout constraints. Simulation modelling can help to rapidly assess options for compliance and to achieve production requirements through review of worker pool and skill sets to optimise the ideal configuration of labour and expertise required. Modelling requires a combination of understanding the worker, the task, health and safety, changing shift patterns, staggered start times and supply chain logistics to provide answers to the question 'how do these changes impact production?'

Simulation also helps with reviewing the use of automation to investigate if this may be deployed to deliver more value under the adjusted working conditions. In this scenario the requirement to analyse the human task and the interaction between the human and the equipment is crucial. Plant simulation and ergonomic modelling enables the examination of human performance and the synchronisation with any automation and/or robotics. To achieve quick results a 'digital twin' – an exact replica of the operation in the virtual world – allows assessment of changes before they are implemented, setting of key performance indicators to monitor in the real world and refinement of the solution away from the shop floor.

Simulation software, JACK, enables users to position biomechanically accurate digital humans of various sizes in virtual environments, assign them tasks and analyse their performance. The software is now integrated into Plant Simulation and Process Simulation tools and provides more capability for human factors engineers to deliver quick and timely solutions to their company's Covid-19 strategies.

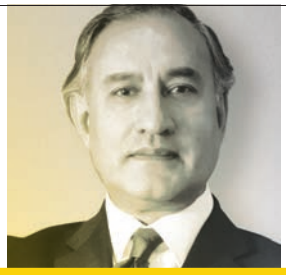
Simulation Solutions Ltd, the UK specialist in support and delivery of the Siemens Tecnomatix JACK software are offering a free 30-day trial of JACK/Process Simulate Human. Visit their website at **www.simsol.co.uk** or email Robbie.Birrell@simsol.co.uk for more information.

How work has changed

Technology is now part of almost everything we do, at home and at work and it's hard to imagine life without it. From mechanical to digital technology, it's all designed to make things easier for us, isn't it? Perhaps not in all cases.

In BBC2's *Britain's Biggest Dig*, a Victorian cemetery at Park Street in Birmingham was shown being excavated to clear the route for HS2. The work has uncovered skeletons showing signs of severe wear on their wrist bones, so much so that in some cases, no protective cartilage was visible at all. The cause was traced back to factories in the Jewellery Quarter where workers would stand for hours using mechanical machines to punch out shapes from small metal sheets. The repetitive actions caused the musculoskeletal damage even though the machines had been especially designed for the job. Obviously, they had not been designed for the operator. (See https://**tinyurl.com/y44tkcgj**)

Developments in technology usually follow a need, so things like search engines developed to help us trawl through vast amounts of information on the internet, but some advances seem less useful. Take a robot shop worker, for example. A humanoid robot has been created to demonstrate its ability to carry out repetitive and mundane tasks like filling a shelf with bottles of soft drinks. The robot 'works' in a shop in Tokyo and is controlled remotely by someone with a robot's eye view provided through a virtual reality headset. But this transfer of manual effort via 'telerobotics' doesn't quite seem to stack up…unlike the soft drinks. (See **www.bbc.co.uk/news/business-54232563**)



Two very popular recent White Papers written by our members

CHIEF EXECUTIVE'S PERSPECTIVE

CIEHF: the place for human factors professionals

This has been an unprecedented year so far for the CIEHF and I'm so very proud to be working shoulder to shoulder with Tina Worthy, our COO, and Iris Mynott, our Membership Manager, to make the CIEHF the place to be if you are or want to be a human factors professional!

In March, we agreed priorities arising from our new five-year strategy. The key elements included member engagement, promoting the discipline and profession, and working in collaboration to create a world-class membership body we can all be proud of.

We've started the journey by adding 200 new members and there are more to come this year! In the autumn, we'll launch a campaign to recruit experienced human factors professionals from academia, industry and business to join the CIEHF and share their thought leadership. We're proving to be an outstanding platform for helping members. Joseph Smyth's work at Warwick University on motion sickness is a great example of how we have collaborated with a member to push their thought leadership and our discipline to both the public and allied professions.

As a result of lockdown, we postponed our planned Human Factors Road Shows this year that were to take place in the regions but immediately replaced them with a series of online events. These began in April with our most successful annual conference with nearly 500 participants registered from across the globe. Next year's conference, EHF2021, will be even bigger with three days of online content and one day face-to-face in London, conditions permitting.

As the months passed, we've increased our online events to one a week on average. Some are small and very focused, aimed at specialist groups like the MOD HFI (Defence Sector Group, thanks to Laird Evans and Steve Harmer). Other events build on thought leadership pieces written by members. These included two extremely successful White Papers and online events "Learning from Adverse Events" (thanks to Ron McLeod for his leadership) and "The Future of Aviation" (thanks to Barry Kirwan, Don Harris, Suzy Broadbent and the CAA's Kathryn Jones).

Members have rallied together to produce guidance that has seen thousands of downloads

To support personal and professional development, we're beginning to run sessions on technical subjects like STAMP as well as social media training to help members engage more effectively whilst promoting the discipline. (See ***https://events.ergonomics.org.uk***/ for all details of our on demand content)

Members have rallied together to produce over a dozen pieces of guidance on Covid-19, that have seen thousands of downloads. Working with other allied professional bodies, we've written guides on "Creating a Safe Workplace" with the British Occupational Hygiene Society, Chartered Society of Designers, Chartered Institute of Personnel and Development and Royal Academy of Engineering (thanks to Kirsty Angerer and Ed Milnes and the Workspace Sector Group), and our guide on tracheotomies led by Sue Hignett was written with the Intensive Care Society at Oxford and others. Our members have been speaking at international conferences as a result of this, have been invited to write for other journals, and have had an invitation to speak at the Parliamentary & Scientific Committee.

We're beginning to respond effectively to government-related consultations using our influence as the voice of the discipline. This includes a very full response to the proposed Patient Safety Syllabus and the consultation paper on Automated Lane Keeping Systems (ALKS) on GB motorways. Get in touch if you spot something we should be contributing to or influencing!

Other ergonomics societies want to collaborate with us, from the HFES in the USA to the Indian Society of Ergonomists – and we are doing so!

In December, we'll launch our Learning Pathway aimed at the NHS and social care sector and begin working on a UX/service design Learning Pathway led by Chris Ramsden, our President Elect.

Later this year too, we'll see a paper from Professor Sarah Sharples on diversity and design, which will complement the President's Project on inclusive design, aimed at influencing the creation of more up-to-date body measurements (see **https://bit.ly/DesignForEverybodyGuidance**).

Noorzaman Rashid
Chief Executive of the CIEHF
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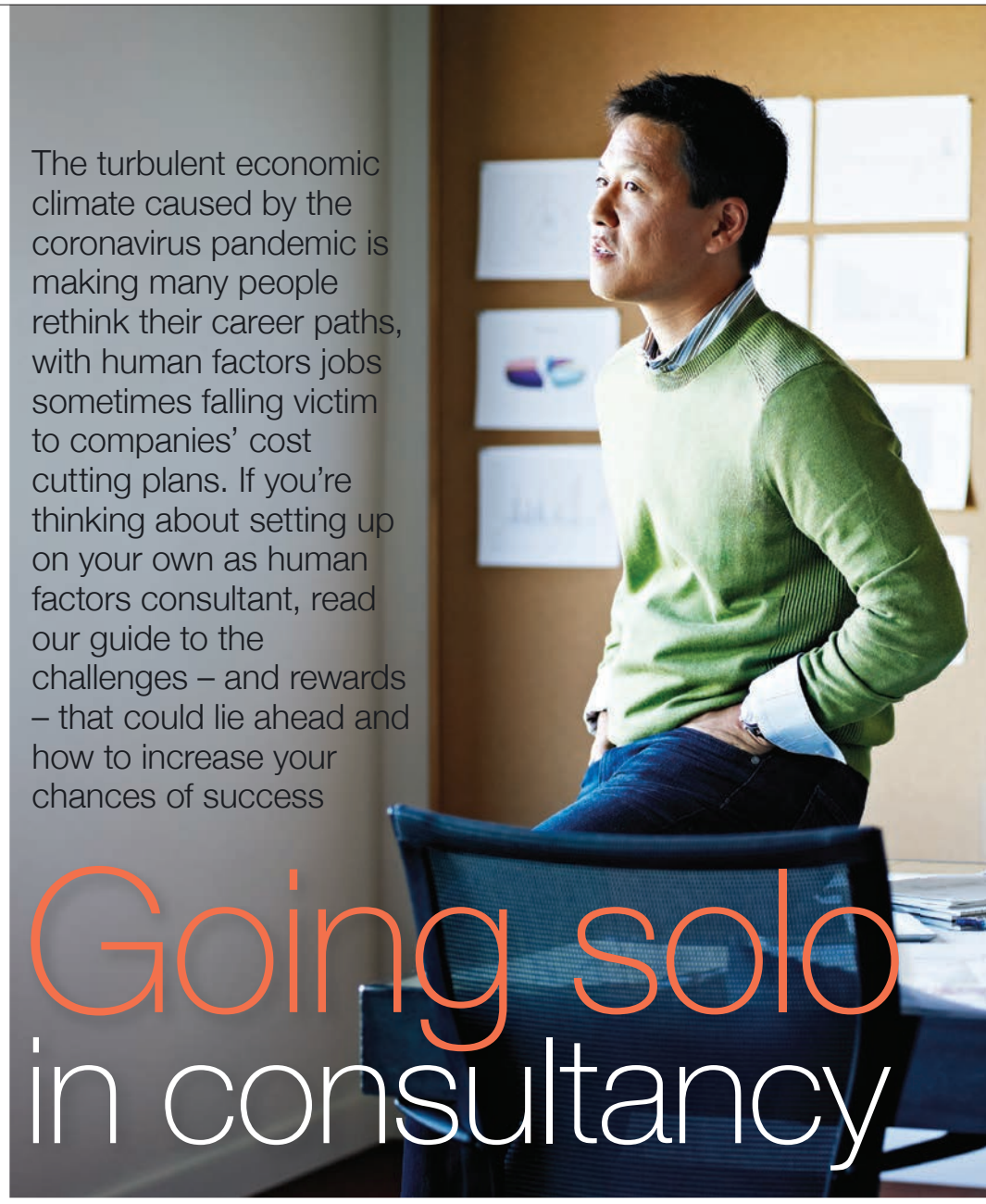
noorzaman rashid



The turbulent economic climate caused by the coronavirus pandemic is making many people rethink their career paths, with human factors jobs sometimes falling victim to companies' cost cutting plans. If you're thinking about setting up on your own as human factors consultant, read our guide to the challenges – and rewards – that could lie ahead and how to increase your chances of success

Going solo in consultancy

Setting up your own consultancy with the flexibility to work for yourself and pursue the projects that really spark your interest can be incredibly rewarding and may seem like the perfect route for anyone faced with the threat of redundancy. However, it's vital to go into the process with a realistic view of the challenges involved in starting out on your own and be aware of the potential pitfalls and problems that can cause new businesses to fail.

It's also important to take an honest and objective look at your own personal strengths and weaknesses and make sure you understand your reasons for wanting to make the move into self-employment. Nigel Heaton, Founding Director of Human Applications, describes making the choice about working for yourself as a "measure twice, cut once" decision to make sure you're ready for the switch – especially during the current economic climate.

"There a lot of great reasons why you'd do it," he said. "You might become self-employed and discover it's what you've been waiting for all your life. But it can be deceptively simple and you have to ask yourself if it's really for you."

One of the common mistakes new human factors consultants make is saying "yes" to every offer of work that comes their way or selling their services too cheaply in a bid to secure clients. Even when times are tough and you're working in a challenging climate, make sure you know your worth and be prepared to turn down projects that don't work for you. Always ensure you check contracts carefully and beware of vague terms that could help clients evade payment if any disputes arise in future.

"It's increasingly hard to make a good living in ergonomics and human factors," warned Nigel. "A lot of people are being forced into jobs which are ludicrously cheap. It's the McDonald's test – if you would make more working for McDonald's, you probably shouldn't do the work."

New businesses can often seem like easy targets for organisations hoping to exploit inexperienced consultants who are starting out in a tough climate. It's important to keep your focus on the long term and not be tempted to cut your price in a panic when you're worried about landing contracts. Setting your fees can be a tricky task but it's well worth taking the time to figure out what you're prepared to work for, the amount of time you're able to work and how much that time should cost.

Nigel explained: "When people are starting, they sometimes think, "I'll do this this for a discount" but that sets an expectation for the next piece of work. An old boss told me that if you lose 100% of work you're too expensive and if you win 100% of work you're too cheap. You have to decide how much work you're prepared to lose."

Working for yourself means you don't only need technical skills and knowledge, you also have to find enough business to make it viable. Being able to sell yourself is vital and if that's something you find difficult, it might not be the right path. It's important to be able to communicate clearly to potential clients about exactly what you do and how your work could benefit them and their business.

IMAGE: GETTY

You might become self-employed and discover it's what you've been waiting for all your life

"Almost always, what we do is an optional purchase," said Nigel. "Very few organisations mandate that you have to do the sort of things we do in human factors so it's hard to stimulate demand, even if you have a really great idea. It's got a lot tougher recently and it doesn't matter how talented you are, you have to be really good at getting work. You have to be able to get yourself in front of people and say, 'I'm the bee's knees, this is what you can get from me'."

Despite the challenges, running your own successful consultancy can give you the freedom and flexibility to work on the projects that excite and inspire you the most. Nigel added: "Just be prepared to kiss a lot of frogs before you find your prince or princess."

We also spoke to two other consultants about their advice on starting out and what they wish they'd known earlier in their careers.

LAURA MILNES

Do your research

Make sure you're actively involved in the specialism or sector of the job you're applying for, so that you can showcase your knowledge, expertise and past experience. And be prepared! Do your research to find out about the company and if it's a good match for you. What sectors does it operate in? What major projects has it recently completed? What are its culture and values?

Consultancy work is varied which is what I really enjoy. There are always new projects to adapt to, challenges to tackle and insights to offer. You need to be a good listener, understand the client's issues and their business needs and work with them to help make a positive difference. A good consultant is knowledgeable, pragmatic, trustworthy, articulate - and knows their limitations.

It's a very rewarding profession; knowing that you've helped improve someone's workplace and made their job easier and safer is a great feeling.

Laura Milnes is Head of Ergonomics at System Concepts Ltd

ANDY BRAZIER

Consider the long term

If I could go back in time and give myself some advice it would be "don't stress about the quiet times". In my best years, there's probably been ten weeks of the year where I haven't made any income and you have to factor that in straight away. You have to be prepared for the fact there will be peaks and troughs and your workload can change on a daily basis.

You also need to keep an eye on the longer term. It takes five years to get properly established and by then you'll know if it's working or not. In the early years, it's easy to get sucked into just looking at the current work and to waste time chasing apparent opportunities that are unlikely to come to anything. It's also really helpful for freelancers to have their own niche; there's a lot less competition and the rates are higher.

Pricing is probably the hardest thing, but the only price that really matters is what the client will pay. You don't need to get too hung up on pricing formulas, you just need to understand what's important to you.

Andy Brazier is Founder of AB Risk Ltd

Nigel Heaton co-founded Human Applications in 1992 and has been working during the pandemic providing advice to Central Government on their response, as well as undertaking audits, both virtual and physical, and delivering virtual training.

Further reading

Nigel and other members of the Institute have shared more tips about starting out, including advice on setting fees in our *Communities* discussion forum. If you're a CIEHF member, go to bit.ly/3b43WtC to read their tips and join the discussion.

Leading with compassion

We've faced really difficult times through this pandemic: tragedy, pain, fear, anxiety and uncertainty. But, during times of difficulty there is an opportunity for learning, as leaders, to do what's going to be most effective. Managing the difficult, rather than the inevitable, as **Michael West** explains

IMAGE: GETTY

We've seen compassionate and collective leadership burst out across our health and social care system with health staff working across boundaries, developing new models of care, at extraordinary pace and at extraordinary scale.

People freed themselves from the constraints of job titles. We've seen the emergence of clinical leadership; doctors and nurses stepping forward to take control, show direction and ensure alignment of efforts in difficult circumstances. We've seen a blurring of organisational boundaries; people working across health and social care, supporting each other at scale and in ways we wouldn't have imagined was possible just four or five months ago.

In particular, we've seen a softening of hierarchies so that formal status has been less important than the contribution that people can make. It's the teams that people have been working in on a day-by-day basis, which have supported our healthcare staff and enabled them to respond effectively to meet the needs of the people across our countries. That team working has been characterised by camaraderie, by support and a real commitment to valuing everybody's contribution, regardless of professional or demographic differences. National bodies have also loosened their control on inspection, to play more of a supportive, collective leadership role.

We've seen a real increase in the quality of communication; time out taken to quickly review and see how we can adapt in order to respond to the crisis effectively and deliver high quality care and prevent the spread of the virus. This has involved a focus on problem solving, with lots of 'huddles', debriefs and after-action reviews. These are hugely important lessons for leaders.

We've also seen, of course, an outpouring of gratitude and compassion from the public and the communities that our healthcare services serve. It's

important to remember that prior to the pandemic, the experience of staff within our healthcare services was already very difficult. Stress levels were high, vacancies were high, and the rate of intention to leave the health and care services was high.

I believe that there are three key themes to this crisis that leaders can learn from: the importance of compassion, teamworking and reflection.

Compassion

Compassion is a core value of our healthcare system and it's a key factor in our ability to deliver effective healthcare. For example, when an anaesthetist shows compassion to a patient before surgery they have a 50% lower requirement for opiates after surgery and a shorter length of stay in hospital. When patients with terminal cancer are randomly assigned to compassionate palliative care, they live much longer. When clinicians working with HIV-positive patients are compassionate, they adhere to therapy much more effectively and there is a lower likelihood of the incidence of the virus in the bloodstream. Compassionate interactions between clinicians and patients don't take any longer. When clinicians are compassionate, subsequently they are less stressed. Compassion is also associated with fewer unnecessary interventions and lower healthcare costs. The challenge is how do we create a culture within our organisations where staff can deliver high-quality, compassionate care? It's about inclusivity, arriving at a shared understanding of what's needed and removing the obstacles to people doing their jobs effectively. Leaders need to embody compassion in the way they lead, they need to understand the challenges people face, and they need to empathise. To use Nancy Kline's phrase: "Listening with fascination". The four key behaviours are attending to those we lead, understanding the challenges they face (through having a dialogue), empathising with them, and then helping them. Helping is about removing obstacles or ensuring they have the resources they need (including knowledge and skills).

Compassion is associated with fewer unnecessary interventions and lower healthcare costs

Teamworking

We've known for many years the importance of teamwork but never has it been more important than in this crisis. Probably more important than our technical skills are our teamworking skills. Teams are most effective when they have a clear, shared vision which is translated into a limited number of very clear objectives. We've seen the importance of people being clear about their roles in this crisis and eliminating hierarchy and professional boundaries. There's also a fundamental lesson in valuing diversity, be it professional or demographic, so that we use the knowledge, skills, abilities and experience of everybody in our teams. Effective teamworking is core to high quality care, to innovating and to the mental health of staff. We need to take forward that lesson from this crisis.

Doctors treat a patient suffering from coronavirus on an Intensive Care ward

Reflection and learning

The third theme that I believe has been reinforced, and is really important from a leadership perspective, is the importance of taking time out to reflect and learn. Research over many years shows us that leaders, teams and organisations are more productive, effective and innovative when they take time out to pause, to have some space and silence. It's so important for all our wellbeing and our mental health. Even during a busy working day, just to pause, be still and take a breath. We know that those times of stillness are associated with wellbeing but also with productiveness and innovation. Busy healthcare teams that take time out on a regular basis, to stop to debrief to review, to have after action reviews, or huddles, on average, are between 35 and 40% more productive than teams that simply keep spinning that hamster wheel ever faster. Research shows that organisations where there is a culture of reflection and learning are more effective and innovative.

So, these three themes are, I believe, critical for us in learning about how we can develop our leadership based on our experience during this dark time. But in order for leaders to lead effectively, it's vital that self-compassion underpins their leadership; as leaders, they must also pay attention to themselves and take action to care for themselves. The most powerful way of doing that is spending time with the people we love and who love us. This is when 'the light can come in' to meet the challenges that we face. We have to develop our understanding of how to build belonging and trust, and to develop organisational cultures of compassion. It's people who make up teams, organisations and networks. We must come to see ourselves, the people we work with and the people we lead, as caring and compassionate.

Michael West is Senior Visiting Fellow at The King's Fund and Professor of Organisational Psychology at Lancaster University.

Becoming socially safe

International responses to the situation have varied widely across the globe. In ergonomics terms, the control of the Covid-19 pandemic is a medical problem wrapped in a behavioural one, with some equipment problems thrown in, hence right up the ergonomists' alley, as **Colin Drury** put it. Here, he and **Michelle Robertson** give their perspectives from the USA

The USA is hardly a beacon to lead the world towards better pandemic control but some observations from here may help ergonomics contribute to this, and in particular, future pandemics.

The medical problem is in diagnosis, treatment and eventual medical control of the novel coronavirus. For diagnosis, we know about balancing false negatives and false positives in decision-making but so do the medical and epidemiological community. For the treatment, we have a long history of medical device interface improvement but much of the

Social distancing dividers for students in a classroom at St. Benedict School, California

IMAGE: REUTERS

current effort is in getting the medical devices and supplies to those who need them, with redesign of interfaces as a longer-term issue.

For the behavioural issues and putting the response into ergonomics terms, the measures we as individuals within a society can take personally have outcomes that range from selfish to altruistic. Some outcomes such as hand washing and disinfection of surfaces you touch, benefit the person directly, some, such as social distancing, give reflexive rewards for both self and others, and some, such as mask wearing, are altrusitic where others have the primary benefit.

These issues of individual decisions have been the province of psychologists, sociologists and behavioural economists but are also a standard part of ergonomics practice. In this pandemic, they also have an overlay of the political as they often involve government action.

An older British example of successful government persuasion on PPE is when motorcycle crash helmets were being introduced in the 1960s. Advertisements showed coal miners, as examples of toughness, proudly wearing their mine helmets. It appeared to work (at least to me as a rider of a Lambretta scooter!) and was backed up by police randomly stopping bikers without helmets for routine inspections. Word got around rapidly but a mandatory law waited almost a decade to be passed in 1973.

In the USA, we have had no national plan on PPE or indeed on many other aspects of the pandemic, relying on local jurisdictions to devise and implement government action. This has led to widespread disbelief concerning, for example, mask wearing. We are also running a deliberately unplanned natural experiment across jurisdictions, which will require some interesting measurements and statistical analysis, again specialties of ergonomists. Finally, there are strong sentiments here against looking beyond our borders for policies that have and have not worked.

Making sure that the right thing to do is also the easiest, is a foundation of ergonomics

At a non-personal level, anything we can do to make social compliance easier will be a help, such as better fitting PPE, effective area sanitising, floor markings to indicate a two metre social distance. Making sure the right thing to do is also the easiest is a foundation of ergonomics, and even of behavioural economics. Ergonomics has science and data as part of its name, and a long tradition of following the science rather than hunches or political party affiliations. ●

Colin Drury is Distinguished Professor Emeritus at the State University of New York and CIEHF Honorary Fellow

DR MICHELLE ROBERTSON

Going back to the workplace

How companies are preparing for a return

What are the main workplace challenges in the US right now?
The main challenge is creating dedicated team workspaces so people feel comfortable with the hygiene levels and the employee density. Companies are having to schedule meetings so that half the attendees are there in person and the rest are joining by Zoom or a similar technology. As people are coming into the building they want to be informed and see the cleaning schedules regarding their workplace. This has always been a big part of the ergonomist's work – working with Environmental Health and Safety to effectively communicate to employees how the company is taking their wellness seriously.

Whose advice are companies following?
Many of the companies I've spoken with are following the Centers for Disease Control and Prevention recommendations regarding minimum distance rules and cleaning protocols, and then they respond to other jurisdictions. For example, if they have global headquarters outside the US, they may have to comply with World Health Organization guidelines and potentially local guidelines as well. This can be a lot of work, having to consider three levels of regulation, and companies want to be thoughtful in implementing these recommendations. There may be many phases of a re-opening process and it takes time.

What adaptations are companies making?
A lot of companies have tried to create contactless environments, with automatic doors and body temperature monitoring considered. There then has to be a protocol developed for when an employee's temperature may be high and what happens if someone feels ill during the workday. An isolation area and health protocols need to be established. All these are important ergonomic practices to ensure the safety, health and wellbeing of employees.

The main task for businesses in the US is managing the risks and providing confidence that proper safety and health precautions are being implemented. Companies are trying hard to use a positive tone and make their policies clear. I've seen a 'welcome back' video where the company has explained the new safety and health procedures.

It varies by state, but in general, many knowledge workers are working from home. When they do go into the workplace, new protocols regarding assigning workspaces will be in place. Multi-user workspaces will not be available, and instead, employees are going to be assigned a designated space which will have strict cleaning protocols.

Air conditioning is much more common in the US than in the UK, is it causing a problem?
Companies are paying close attention to their air conditioning systems to ensure adequate air circulation. It's essential now that companies tell employees that they are providing safe air filtration systems. These systems are critical given the current situation and companies need to invest in proper, efficient equipment.

What effect is school closure having?
In the US, we don't have a clear idea of when schools might reopen. Overall, they're trying to teach a flex mode of education, a mix of Zoom meetings and maybe low density, in-person meetings. Many teachers are concerned about going back into the classroom. Many people are also very worried about the public transport system and when will it be safe to commute.

Dr Michelle Robertson is Executive Director for the Office Ergonomics Research Committee

The UK government's new strategy to tackle obesity was announced recently in response to findings that being overweight increases the risk from Covid-19. There's nothing new about these sorts of initiatives, nor about the obesity 'epidemic' itself, as **Bob Bridger** discusses

Moving towards healthier work

Since 1975, in English speaking countries, mean body mass index (BMI) has increased in men by about 1kg/m^2 per decade, and slightly more in women, although there is evidence that the trend pre-dates the 1970s by about 15-20 years. So, what's changed in the interim and what can we do about it?

According to the government strategy, "Overconsumption of calories is one of the most significant contributing factors in becoming overweight". Unsurprisingly, some of the interventions outlined in the strategy concern how food is marketed and sold and human factors can contribute to this.

What else has changed since the 1960s? It's clear that dietary changes have had a major impact. Another big change has been a reduction in physical activity in everyday life with a smaller percentage of the population engaged in extractive industries and manufacturing and a shift to service industries. Other factors include increased car ownership and a wider range of affordable labour-saving devices for use in the home. One of the founding fathers of ergonomics, Professor E Grandjean, published a book entitled *Ergonomics of the Home* in 1973, describing the physical demands of housework in the preceding decades, such as beating rugs with a paddle in the days when many people didn't have vacuum cleaners.

For those working in offices before the arrival of desktop computers, few were 'tied' to their desks. It was essential to leave your desk to do your job to go to a filing cabinet to get files, take a handwritten letter to a typing pool and so on. One of the arguments for investment in 'office automation', as it was described at the time, was increased productivity because most tasks could be completed without leaving the desk. Desktop

computers marked the arrival of the 'electronic office' and the beginning of what I call the age of 'hyper-sedentary' office work. Although correlation does not imply causality, it's noteworthy that the prevalence of overweight and obesity increased rapidly at this time.

Reference to the MET (Metabolic Equivalent of Task) tables published by the American College of Sports Medicine suggests that the physical demands of sitting in an office chair all day are scarcely greater than staying in bed all day. Staying in bed all day (on Earth) has been studied extensively by NASA in order to understand the effects of physical inactivity on astronauts during long space flights. The term 'metabolic inflexibility' describes some of these effects, which include insulin resistance and lowered capacity to utilise fat as an energy source. The main conclusion appears to be that physical inactivity is harmful in itself, that is, the presence of inactivity is harmful, not just the absence of exercise.

Sedentary office work became the norm in the 20th century partly because the technologies needed to support it were immobile (phones with land-lines and heavy office machinery) and were implemented using Tayloristic principles of job design. Such constraints no longer apply and many people have spent the recent lockdown working at home using laptops. Laptops were never intended to replace desktop computers but for use 'on the move'. CIEHF has responded rapidly to these developments by publishing guidance for office workers working from home.

Whether working at home or in the office, the long-term health risks of physical inactivity and sedentary lifestyles have been demonstrated in several large-scale epidemiological studies over the last 20 years. Daily sitting of more than 11 hours brings increased mortality risk and is worryingly achievable in hyper-sedentary office workers, if a two-hour daily commute, eating at the table and television viewing are included. Lack of exercise and sedentary time have been shown to be independent risk factors for adverse health outcomes in several studies (even people who exercise a lot will benefit from sitting less). Importantly, for office workers working from home, prolonged periods of sitting appear to be more harmful than shorter periods, even if the total time spent sitting is the same. Sedentary time saved not commuting may bring real health benefits for those now working from home if it's used wisely to space periods of sedentary work with non-sedentary activities throughout the day.

Calls for office work to be more active have led to the introduction of sit-stand desks, pedal desks and other new products. But will their long-term use make a difference to obesity? To date, the evidence is weak, partly because it takes time to demonstrate long-term benefits. Alternating standing with sitting in previously sedentary jobs has been shown to have beneficial effects on blood glucose control, lessening back pain in those prone to it and reducing foot swelling. However, it's not sitting per se that's harmful but the lack of skeletal muscle activity when sitting.

A recent physiological study concluded that standing at work for two hours per day (as opposed to sitting) would be unlikely to have any useful effect on reducing body fatness or in the treatment of obesity but at a national level, it might slow the rising trend in obesity. Active office work will lower health risks by reducing the physical inactivity associated with sitting but the effects on obesity are likely to be modest, if there are any at all. Office workers wishing to increase their daily activity levels might consider using the stairs instead of the lift, cycling to work, not drinking coffee or eating at their desk and so on. Home working hacks include leaving your phone away from your desk and standing when you use it.

The presence of inactivity is harmful, not just the absence of exercise

Our discipline has had great success in tackling short-term adverse outcomes such as accidents and injuries and has, arguably, focused less on the long-term implications of job design on the health of the population. One key requirement for successful human factors integration is to optimise whole-life costs through the use of people (while not externalising these costs to society). This brings to mind Pat Jordan's discussion in the previous issue of *The Ergonomist* of standardised mortality rates as indices of health risks associated with jobs, or, as was put more bluntly in the introduction to Pat's article, "workplace injuries are not the only way work can kill us". ('The wrestler, the bus driver and the soldier', *The Ergonomist* Sep-Oct 2020)

Prior to the industrial revolution, most people worked at home or close to their homes. Is hyper-sedentary office work just a passing phase in history that has now been overtaken by events? Maybe it's time to change the default. ●

Bob Bridger is a Fellow and Past President of the CIEHF. He is author of *A Guide to Active Working in the Modern Office*, published by CRC Press, and is a qualified fitness instructor and personal trainer.

Further reading

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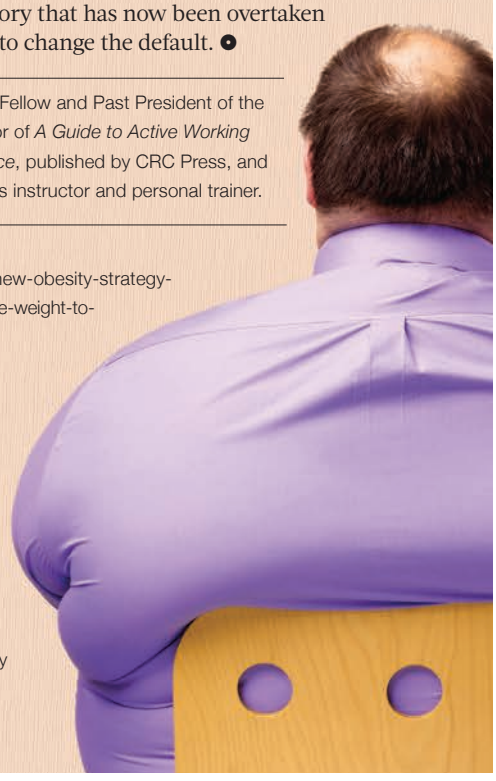


IMAGES: GETTY

Fit to fight

It's one of the most famous of war stories. The Greek mythological tale of Troy and the Trojan Horse has captivated humanity for centuries with its boldness, daring and ingenuity, but could it really have happened? A human factors investigation came to some intriguing conclusions after examining the myth for a new TV documentary

In the myth, the main sources for which are Virgil's epic Latin poem *Aeneid* and Homer's *Odyssey*, the city of Troy had been under siege by the Greeks for ten years. The siege was finally broken and the Trojans beaten by using a huge wooden horse as a ruse. The Greeks pretended to give up the quest and sail away, leaving the model horse outside the city gates. After two days, the Trojans decided to pull it inside as a trophy, not realising that there were men hidden within. That night, the Greeks quietly crept out of the huge device and unlocked the gates for their soldier colleagues, who had returned under cover of darkness. Troy fell, and the rest is history – or at least myth.

Of course, the story isn't thought to be true, or at least most of it isn't; the horse may actually have been a battering ram or siege engine. But theoretically, could it have happened? Might a small group of clandestine warriors have been able to hide inside a wooden horse and help to capture a city and end a war? It's a question that's as much about ergonomics and human factors as anything, and it's one that a new television documentary has attempted to solve. The programme, *The Search for Troy*, has been made for the Science Channel, part of Discovery TV, for its Unearthed series.

The production features two prominent CIEHF members who bring their skills and experience to discover if what happened at Troy was physically possible. Fascinatingly, they concluded that it probably was. Those involved were Professor Neil Mansfield, a past President of the Institute and Head of Engineering at Nottingham Trent University, and John Lovegrove, a digital modeller who runs his own company, Canary Designs, based in St Asaph in Denbighshire.

The ruse using the horse would have pushed the limits of human endurance.

The soldiers – and the myth recounts that there were about 30 of them – would not only have been crammed into a small space but they may well have had to survive the searing Mediterranean heat.

The programme wanted to test if surviving this environment was plausible. Neil Mansfield picks up the story: "I'm a physical ergonomist with a background in extreme environments. The producers got in touch with John and I through the Institute, and the project sounded really interesting. We've been asked to look at new designs before but never something from the ancient past! It was great to be able to learn so much about the history, and we went into it not knowing what the answer was in terms of whether the myth was actually viable."

Neil and John didn't actually go to Anatolia in modern day Turkey where Troy is said to have been but used simulation tools to study the wooden horse. "We were able to create it through digital modelling, with John using computer-aided design to build it virtually."

They quickly realised that cramped conditions inside the horse were not likely to have been a problem. "We initially thought they would be," Neil explains, "but we soon realised you can package a lot of soldiers in a small space; we're still doing that in modern military transport. The main issue was going to be heat stress. The men needed to be fit to fight. When we did the calculations, we released that being locked into a small wooden cavity for a couple of days in the heat of the sun wasn't going to be very pleasant."

A fundamental requirement would have been water to drink in order to avoid dehydration, and adequate ventilation would have been vital. "But they were great engineers and they knew what they were doing. They could build quickly and they would have understood this. They could construct boats and they had a history of transporting armies across the sea. However, it would still have been a big challenge."

To test his theories, Neil ran a real-life simulation exercise using a standard van. He felt the dimensions would be similar to the mythical structure. A number of volunteers were asked to sit on the floor, as they would have done in the horse.

"They were pretty cramped. We found we could get just over 20 people into the available space. We then tracked them with thermal imaging to see how quickly the temperature would rise. We saw it going up within ten minutes. It became clear that the heat would have been the issue."

With his expertise in digital modelling, John Lovegrove worked on creating the virtual horse. "According to the myth, the gates of Troy were only five metres high and four metres wide, so they weren't actually that big", he says. The mission of those inside the horse was only to open the gates for the rest of the army to come in. But they would still have to keep cool, and the best way of doing that would be to have a good flow of air, as one of the best ways of losing heat is to allow it to evaporate through sweat."

We've been asked to look at new designs before but never something from the ancient past

John (pictured left) and Neil discuss the story of the Trojan Horse during filming

Another potential challenge would have been humidity, created by moisture in the soldiers' breath. "That isn't good for your thermoregulation either. The onset of heat stress leads to confusion and an inability to think clearly, so we also looked to see if they would have been fighting fit when they came out of the horse. The occupants would also have to drink, communicate and go to the toilet if they were in there for two days. They would probably have had enough supplies but there would also have been people outside, so did they have to keep completely silent? We don't know."

At the end of the day, though, would physics and human endurance have allowed the story to happen? John believes it could have. "When you look at their engineering prowess, you do realise that it wouldn't have been beyond them to do something like that." But did it happen? Is it possible there is a grain of truth behind the legend? "Well, it could be that an event of some sort occurred, and they did hide inside something. It's simple enough for it to work."

Neil Mansfield takes much the same view. "When we look at these historical myths, we shouldn't just write them off. People achieve remarkable things all the time, and we understand very well that record keeping had different goals at that point in history. People love stories, and we know very well that historical stories might have changed over time. Clearly an event happened and a story has been passed down the centuries. Very few records then were written by scientists for scientists and with the knowledge we have today.

"One thing we learned from this project is that the problems of human factors and ergonomics are nothing new. It was a fascinating thing to do, and it really made us think."

IMAGE: GETTY

The radial revolution

Ensuring patient comfort during a procedure is important but so is the comfort of the caregiver. Serious neck and back strain experienced by clinicians during one cardiac intervention surely wasn't inevitable or sustainable in a busy practice, was it? There had to be a better way and necessity was the mother of invention as **Dr Steve Hoole** explains

Historically, we had always used the leg artery to access and image the heart arteries invasively with x-rays to guide key-hole heart surgery. There were some clear benefits to the operator this way; larger arterial target to hit with a needle for one, and secondly, a convenient and stable work area on the top of the legs with a handy gutter between the legs that stopped equipment falling on the floor. But the patient experience was too often lessened with increased recovery times due to the need for prolonged bed rest afterwards and an increased risk of bleeding and bruising.

Using the wrist artery for this procedure was well under way 10 years ago as I completed my training in interventional cardiology in Canada. I was an early adopter of this new way to access the heart and was keen to incorporate it into my everyday practice in the catheter laboratory to benefit my patients. Going radial and accessing the wrist artery for this procedure solved many of these patient issues; a compressive wrist band at the end of the procedure potentially allowed the patient to walk out, aiding a swift recovery from keyhole heart surgery, as well as making the procedure safer.

However, stooped over my eighth radial case of the day with gnawing lower back pain, the sacrifices required to achieve these clear patient benefits was already taking its toll. Operating on the left wrist whilst standing on the customary right side of the patient at the catheter laboratory table was particularly awkward and frustrating. The patient's arm would constantly fall away from me, particularly when the patient was sedated, and with it any equipment dangling from the wrist. Manually holding wrist and equipment in place, whilst balancing on one foot to operate an x-ray machine to precisely guide the delivery of a stent into the heart artery, was the interventional equivalent of a one-man band.

Compounding the problem, in adopting radial access our flat work area on top of the legs was gone. Equipment was often precariously perched in mid-air or slid from the side of leg - the now default working position when using the right wrist artery - onto the floor. The work height afforded by arm board inserts positioned the patient's wrist at a level that was far too low to be comfortable for the operator, exacerbating neck and back strain.

Light bulb moment

In the coffee room between cases, and after another couple of ibuprofen, I mused that if only the arm could be suspended higher and nearer the patient's leg, we could get back to the favourable work area we once enjoyed, without the need for work arounds we had all toyed with to improve matters. A wearable sling seemed to be a logical solution, somehow wrapping around the arm and wrist and fitted to the patient to provide comfortable and passive positioning, negating any effort required on the part of the often-sedated patient, to maintain the perfect wrist position for the duration of the case. A more comfortable patient and physician would make the whole procedure easier and more efficient.

Taking inspiration from restrain holds around the thumb to present the wrist in a dorsiflexed position (bringing the radial artery to the surface and making first time puncture success more likely), I experimented with crepe bandaging bought from the local pharmacy to construct a rough and ready prototype. It could work. I doodled some very basic sketches and submitted a quick check of prior art and it seemed the field was clear. It was only on serendipitously discovering keen innovators working at a local medical devices start-up in Cambridge UK a few years later that the impetus to complete the journey from doodle to CE-marked medical device – the *Radial Cradle* – was realised.

Stooped over my eighth case of the day with gnawing lower back pain, the sacrifices required to achieve clear patient benefits was already taking its toll

Prototyping and testing

Assembling a small team of a medic, medical-device engineer and human-factors engineer, we set to work, initially wrapping each other in bubble wrap to importantly confirm from a patient's perspective that it felt good - like an embrace - before exploring different designs and materials to optimise the experience for the operator too. Despite being initially labelled as "essentially a belt" by patent attorneys, three distinct and patentable key features emerged:

1. **An adjustable support** that wrapped around the arm at the elbow, stuck back onto itself with adhesive and secured at the other end to a bed board. This supported the entire weight of the arm at the required height, level with the top of the patient's legs.
2. **A cushioned thumb strap** to allow the wrist to adopt a supported dorsi-flexed position, ideal for accessing the radial artery.
3. **A soft restraining arm strap** to stop the arm or patient inadvertently moving and which couldn't be overcome with half-hearted effort.

Many prototypes were constructed and trialled; the thumb cushioning alone had more than 20 iterations before we were satisfied. Sizing was informed from a mix of anthropometric data, 3D simulation of percentile extremes and practical experimentation. We settled on two device sizes, a 120cm and 140cm arm support length that would fit 95% of Europeans, with the option to go to a larger 160cm length in the future if needed. The Velcro™ hook and loops were carefully positioned so that the same device could be used for either left, right or bilateral radial procedures interchangeably.

A single use application to minimise cross contamination and infection control issues was a key requirement and now particularly pertinent in the current world of pandemics. →

A patient in position and supported with the 'Radial Cradle' and ready for treatment

Many prototypes were constructed and trialled; the thumb cushioning alone had more than 20 iterations before we were satisfied

We opted for the wearable parts of the radial support to be made from the familiar drape material, polypropylene, as it was strong and could be laser-cut without fraying or linting. The device was designed so it could be stored and dispensed as a roll with perforations that allowed it to split into three pieces ready for assembly. Surprisingly, polypropylene also served as the ideal polymer for the rigid bed-board accessory as early acrylic prototype parts were too brittle.

Other novel design features emerged as we tried to solve other problems, one being how to transport a patient efficiently and safely from the catheter lab to the lounge after their radial procedure. An ingenious perforation line was included in the arm support that didn't affect its strength but allowed the device to be split open to form a head-hole so it became a sling. This supported the surgical site and acted as a reminder to the patient not to use the arm prematurely. It could also avoid the risk of complications from the wrist compression band moving and speed up turn-around times.

Thumb straps that went through extensive design and testing

CE-mark and first-in-man use

The now protected *Radial Cradle* was deemed a class 1 medical device and self-certifiable after diligent completion of a detailed technical file. Manufacturers in the UK and China were sourced, and the first batch of product released after rigorous quality control testing of the component parts on a rig. In preparation for launch, a website was built (www.radialcradle.com) with carefully designed training illustrations and videos to demonstrate application of the device in four simple steps that could be completed in 30 seconds.

The product was launched at Royal Papworth Hospital in October 2019; the culmination of three years of planning, iterative design and testing. Early usability patient level data confirmed that the *Radial Cradle* was indeed very comfortable to wear (and much better than using an arm board), it put patients at ease as it encouraged early interaction and cooperation with the catheter lab staff and once applied, it allowed patients to fully relax. The wrist was held in the ideal position to achieve first time puncture success of the radial artery and with slight medial rotation, facilitated by the thumb and wrist support, catheters and equipment naturally fell securely on the patient's lap. This higher work area made for a more comfortable experience for the operator too. Clever hacks for other radial procedures materialised with use.

Unanticipated additional benefits

Radiation protection is a hot topic in interventional cardiology and despite adherence to legal dose limits, which is required for regulatory compliance by all radiation safety programmes, increased incidence of radiation-induced cataracts is seen in high volume operators as well as left sided brain tumours – the side closest to the x-ray source when standing table-side in the catheter lab. The medially held, adducted position of the arm achieved by *Radial Cradle* has enabled more effective use of personal protective equipment (PPE). Positioning of lead Perspex shielding past the centre line of the patient, as well as using the table lead underskirt has resulted in reduced scatter and a 70% reduction in operator eye-dose.

The device also prevented inadvertent arm movement and equipment becoming dislodged mid-procedure when ventricular fibrillation was treated during an emergency operation to unblock a heart artery. It could also prevent falls from the narrow catheter lab table when the patient is sedated.

The future

Consideration is now turning to the next iteration – a device made from fully biodegradable material to minimise the ecological footprint and improve the green credentials of this game-changing disposable device.

Dr Stephen Hoole has been a consultant interventional cardiologist at Royal Papworth Hospital, Cambridge since 2011. Trained in Oxford, London, Cambridge and Vancouver, he now specialises in complex coronary and pulmonary interventional procedures with a particular interest in treating chronic total occlusions and performing balloon pulmonary angioplasty. He's an expert in minimally invasive keyhole heart surgery via the radial (wrist) artery.

Jo Davies, now a Chartered Ergonomist and Chartered Engineer, with a test navigator in the F3 at Warton around 1987 where she ran simulation assessments with pilots, navigators and system design experts

Creating the cockpit

Jo Davies, who worked on the Tornado GR1 and F3, sets the record straight on the history of military aircraft design and reflects on the key role played by human factors

The design of the Tri-National Tornado GR1 started in 1969 and the organisational structure illustrates the importance that the Tornado customers placed on human factors.

NATO Multi-Role Combat Aircraft Management Agency Military Factor was tasked with chairing the Panavia Cockpit Committee who delegated the management of human factors to the Panavia Human Engineering Panel (HEP). This panel comprised representatives from all the partner companies with human factors specialists and responsibilities and was chaired by Dr Rudiger Seifert of MBB.

The responsibility for Tornado avionic system development human engineering was lodged with the EASAMS Central Design Management Team's Systems Engineering Co-ordination Group under George Ward. The group included sections responsible for systems operation and control, on-board checkout and maintenance, and human factors.

Human engineering was treated as an integrating function within the design process under command of the Panavia HEP and control of the Cockpit Co-ordination and Control Committee. Human system integration was undertaken as prescribed by Mil-H-46855B and a human engineering programme plan was produced. This preceded a MANPRINT-style approach by some 20 years.

The design process could not benefit from the advanced CAD/CAM simulation facilities that are now common. Instead, wooden mock-ups were used, varying from simple dimensionally correct frameworks to a fully representative wooden cockpit manufactured to aircraft drawings and fully equipped wired metal mock-ups.

One of the first tasks of the Cockpit Committee was to establish satisfactory vision envelopes that allowed a view over the nose for weapon aiming on low pass attacks and visibility for high incident approaches to landings. Low profile drag was required for high speed flight and canopy strength to withstand bird strikes.

The process in defining cockpit layouts was iterative and all the standards associated with colour, lighting, panel and instrument dimensions, letter and engraving, switches, warnings, etc., needed to be complied with. The layouts were initially based upon theoretical assessment of use of controls and displays making best use of the mission information available. The first ergonomics study took place in 1970. Operating procedures for laydown, dive and missile attacks were used and 'flown' by four crews. In addition, five pairs of system specialists evaluated the procedures to update the knowledge on information requirements. Theoretical work was then carried out on system design and crew workload during late 1970 and early 1971. Detailed operating procedures were produced for an agreed 'forcing mission' which was then used for the next series of workload studies.

The equipment used consisted of an elaborate mock-up with functioning models of the required displays and controls. A time-lapse camera was used to record crew actions. Touch sensors on the index finger allowed an assessment of work sharing between left and right hands. An intercom provided communication between pilot and navigator and with the workload team. It also provided pre-recorded cues of events to be sent to the crews. The aircrews filled in questionnaires after completing the mission and these were assessed with the recordings. The outcome was the agreed baseline cockpit layout definition.

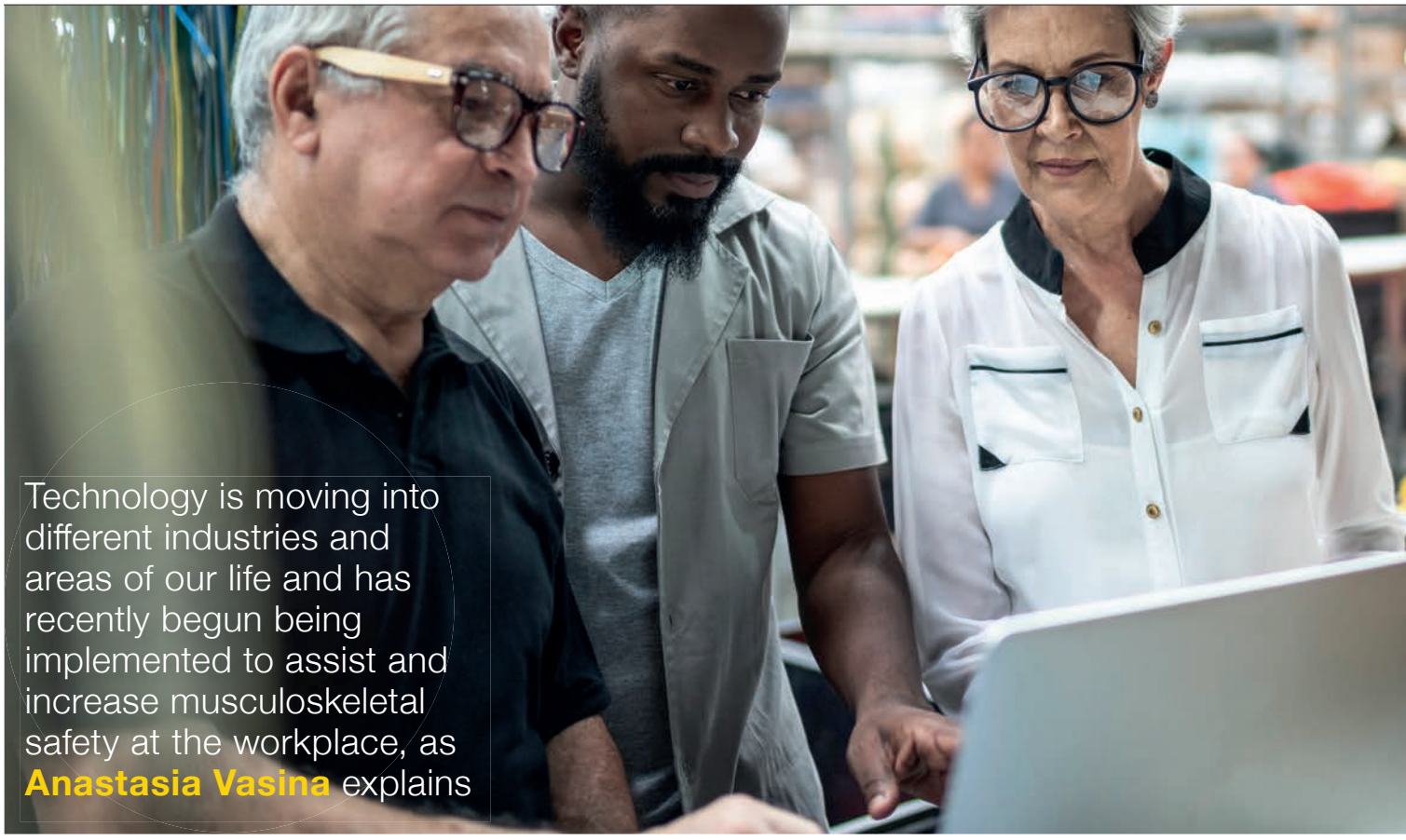
As equipment was further defined, the aircraft mock-up was converted to a full metal structure of all the panels and displays. The application of mandatory human factors standards (MIL-STD 1472) was checked by rigorous examination of all cockpit panels for compliance. All deviations were only released by Cockpit Committee concession.

Complex labour-intensive timeline analysis methods were developed by Jake Jacobs using time motion units covering all aspects of the tasks. These were then validated through the workload trials and the design process continued through flight trials in the 1970s.

While this article focuses on the Tornado GR1, similar endeavours were ongoing at other British Aerospace Military Aircraft Division sites with the Tornado F3, Harrier and Hawk aircraft programmes. It's important to recognise that while the weapons, navigation, autopilot and radar sub-systems may form the bricks of the design, it's the human factors input that cements them together.

Chartered Ergonomist and Chartered Engineer **Jo Davies**, of ESE Associates Ltd, spent five years working on the Tornado GR1 and seven years running simulation assessments with with pilots, navigators and system design experts at EASAMS on the Tornado F3.

This article is in response to a piece in the previous issue of The Ergonomist (Sep-Oct 2020, "Mission critical cutting edge technology") which inferred that there was little human factors input to cockpit design before the development of the Typhoon.



Technology is moving into different industries and areas of our life and has recently begun being implemented to assist and increase musculoskeletal safety at the workplace, as **Anastasia Vasina** explains

Assessing risk through technical standards

Risk assessment nowadays can be performed with the use of technology and technical measurements offer the opportunity to collect accurate data in the workplace with high validity and reliability. Particularly with dynamic work, the variability of tasks and locations are best quantified by means of technical measurements.

It's easy to see that ongoing technical development has led to miniaturisation, simplified application, widespread availability and greatly diminished costs of equipment. Wearable devices based on accelerometers and gyroscopes are technical tools that have received a wide application in ergonomics recently. This has increased the feasibility of objectively assessing movements on larger populations during in-situ work settings with minimal effect on workflow, performance and productivity.

One purpose of taking measurements in ergonomics is risk evaluation. Usually, use of guidelines allows us to translate exposure variables measured by technical means (quantitative results) to qualitative evaluations, that is for example, "low risk of physical complaints, no action is needed" or "a high risk of physical complaints, preventive measures are needed".

A lot of manual handling guidelines and task assessment tools were developed for assessing risk in the workplace: National Institute of Safety & Health (NIOSH) lifting equation, Washington Industrial Safety and Health Act calculator, Rapid Upper Limb Assessment (RULA), Rapid Entire Body Assessment (REBA) to name a few. These guidelines were developed before the technological burst in ergonomics came about and when risk assessment was based on observations. The selection of angles in scientific studies and their subsequent inclusion in guidelines date back to the visual observation era where it's easy to divide an angle into two or

Observational standards often take into account a complexity of factors that can't be evaluated with technical tools

three approximately equal parts, noted as 45˚, 30˚, 60˚ or 90˚, and generally assessed with sufficient precision.

It should be noted that the guidelines suggested in the International Organization for Standard (ISO) and European standards (EN) are based on a consensus of experts and that the numeric characteristics of postural angles or time aspects are not based on epidemiological evidence.

In observations, the quality of the collected data depends highly on whether the observed work is clearly visible, and on the observer's motivation, alertness, education and experience. The variability both between and within observers in estimates of risk may be substantial. The assessment of highly dynamic or complex activities and activities with frequent changes of location may cause misjudgement, even with video recordings of good quality. Moreover, depending on the observational procedure used, observation can be time-consuming. But observations do have the advantage that information on the context, such as tasks and activities, weight of the load, breaks and factors such as arm support, can be included in data collection.

Despite the variety of manual handling guidelines and task assessment tools for observational methods, no standard procedures and recommendations are currently available for technical measurements. Measurements from a technical tool could give bending angle, twisting angle, time in this angle and repetition but we need a set of thresholds to enable us to make a qualitative evaluation of 'high risk activity' vs 'low risk activity'. Guidelines and standards used for observational assessment can't be completely extrapolated for technical measurements for a few reasons.

IMAGE: GETTY

First, numeric risk limits in the guidelines are based on less detailed and less accurate measures than those obtained with the use of technical devices, and angles provided in standards act as cut off points for high or low risk. Another reason is that observational standards often take into account a complexity of factors that can't be evaluated with technical tools, such as arm supports for example, that can't be detected. And lastly, technical tools can measure parameters such as acceleration or velocity, that don't exist in observational standards and so don't have thresholds in the standards recommendations but these parameters are still important and can impact the risk of the task.

Existing standards often give an overall assessment of the musculoskeletal risk. However, when performing measurements with technical tools, often certain thresholds for what is dangerous for a specific body part are needed. For example, no consensus exists in the scientific community on which specific arm elevation variables should be selected for the evaluation of expected consequences for health. Limits for arm elevation angles from observational assessment methods range from 20-150˚, with the severity of shoulder load growing with increasing angles. None of these limits are validated.

Take the RULA assessment tool as an example: an observer first detects the positions of the hands, forearms, trunk, legs and head so as to get an overall score that indicates whether change is needed or not. Technical tools however, usually need specific cut-off points to indicate risk level for each body part. When we try to define it based on observational tools, we find different numbers apply.

Since numeric risk limits in the guidelines are based on less detailed and less accurate measures than those obtained with the use of technical devices, the figures stated in standards should, therefore, be interpreted with care, and not used directly as strict cut-off-points for decisions based on technical measurements.

So, practical guidance on technical measurements is needed. Besides, standards developed based on epidemiological data will help in understanding the exposure-outcome relation and interpreting the measurement result of technical tools in a universal way. Observational methods can be used as a supplement to technical measurements and assist in providing contextual information helping to interpret the results.

With advances in safety technology, the development of a task assessment tool combining the accuracy of technical measurements of an accelerometer and gyroscope with additional information received by observation is a necessary solution to assist in measurement of hazardous movements. Continuous usage of such a product will enable the development of universal technical standards based on epidemiological evidence which can then be matched with existing tools to create a powerful and accurate method to assess musculoskeletal safety.

Anastasia Vasina is Product Manager at Soter Analytics, a global safety science company producing AI-supported wearable solutions. Anastasia is a medical doctor and has a Master's degree from Maastricht University in sport and physical activity interventions.

A common saying in both design and human factors is that "if you design for everyone, you design for no-one". The principle is sound; the more you focus on the specific users of your product or service, the better you can refine it to meet their needs. But what happens when you're designing something that does need to be used by everyone? **Michael Brown** explains

Digitising government services

Over the last four years working at Nightingale Design Research, I've done a lot of work on large government projects, building digital services that need to be accessible to everyone who lives in the UK. Working with the various NHS bodies, the Home Office and the Department for Education, I've found that research and design in situations like these provides a unique and interesting set of challenges.

Everyone never really means everyone

Personally, I've never seen a product or service aimed at literally every living human being, so the first stage of these projects is to identify who you're not designing for. Every group you can identify that you're not serving lets you focus more on those you are. For example, national government services tend to be targeted at those over the age of 16 and legal residents of the country. So already we've cut it down from 7 billion potential users to just tens of millions. On top of that there are always some assumptions that need to be made to realistically be able to deliver a service. Some common examples for web services are that people will:

- Be fluent speakers of one of a small number of languages
- Have access to the internet
- Have a minimum reading age

While some of these are unavoidable, the government service standard emphasises the importance of providing a joined-up service across all channels, which includes support or alternative services for those unable to access the web service.

Once we've identified who we're actually designing for, we're still left with a massive range of users with huge variation, which presents us with a number of challenges to the traditional approaches to human factors research.

How much testing is enough?

Whether it's a physical prototype of the latest bus seat or a smartphone app to help store-workers organise a warehouse, how much testing to carry out is a key consideration. As always, when developing services for 'everyone', the key is the balance between the cost, in terms of money and time, versus the risk of missing potential opportunities to improve a design. The difference is that with such a wide range of potential users, you're never going to cover all your bases; the range of users is so broad that you'll never identify, recruit and test with all possible combinations of individual differences and contexts of use. Instead, you need to adopt a four-pronged approach to testing:

1 **General testing:** convenience sampling to get the basics covered and find any major issues that would affect most users.

2 **Focused testing:** looking at user groups that are likely to struggle with the service or find it particularly difficult to use. Examples could include those with specific disabilities or with low confidence with technology.

3 **High risk testing:** if there are any user groups that failure or mistake with the service would disproportionately affect, it's important to test specifically with them.

4 **Mitigating failure:** because you're never going to get to test with everyone, when a service goes live it's very likely that some users will have problems with it, so it's vital that systems are in place to help users deal with errors and failure. There also needs to be a process for identifying these issues and iterating the service in response.

As always, when working in a team it's important to make sure that everyone, especially key decision makers understand what testing you have and haven't done, as well as the risks involved in relying on the evidence you provide.

Using personas

I'm ambivalent about personas at the best of times; they are perhaps one of the most often misused human factors tools but also one of the most valuable ones. Designing for 'everyone' only makes things more complicated as personas become both more important, to give the development team concrete concepts of user needs and contexts, but also more risky, as they will only ever represent a tiny fraction of the users that will be engaging with your service.

It's vital that anyone who uses the personas understands that they are simply exemplars and represent neither single actual users nor the full range of possible users. With this in mind, I prefer to keep personas light weight/low fidelity, as the ambiguity this provides allows for discussions that go beyond the user types captured in the personas.

Best practice and when to ignore it

One of the best things about working on services for 'everyone' is that you're not the first one to face a lot of the research and design challenges that you'll come across, and many of those working in this domain, often charities and government agencies, are happy to share what they've learned. In the UK, we're lucky to have the Government Digital Service who collect, curate and share resources to help people designing services for the general public. They provide a massive range of tools, processes, patterns and even code examples that have been developed, used and refined across UK government services. While these provide a great starting point, they aren't going to have all the answers, so it's important to also reach out to organisations and individuals working on similar projects so you can share learning and avoid reinventing the wheel.

The flip side of this coin is that you also need to know when best practice isn't the best for your project. Often, the way to do this is with trial and error but with experience you can see when it's important to go in your own direction.

It's important to focus on getting the basics right rather than setting yourself up to fail by starting with an overly ambitious goal

Being realistic

Perhaps the most important factor when working with a service with a wide range of users is to be realistic about what can be done. The amount of information you can communicate and complexity of service you can deliver is hugely restricted when you have a broad user base, so it's important to focus on getting the basics right rather than setting yourself up to fail by starting with an overly ambitious goal. With this in mind, it's worth identifying your minimum criteria for success early in the project, as well as additional things to aim for once those basic goals have been met. Your aim should be to help as many people as possible complete the most important actions.

Many of the points here are generally good practice for the development of all types of products and services but when you're designing for a wide range of users the focus shifts further towards accessibility and error reduction over functionality. With all this in mind, it's clear that while these projects can be intimidating there are plenty of ways to make things easier for yourself and start researching and designing for everyone.

Michael Brown is a specialist design researcher and Chartered Ergonomist and Human Factors Specialist. He is Chief Research Officer and co-owner of Nightingale Design Research (formerly Fowlam) and has 16 years' experience working in user research, human factors and human computer interaction with government, universities, the NHS and the private sector. For more information, see www.nightingaledesignresearch.com.

Further reading

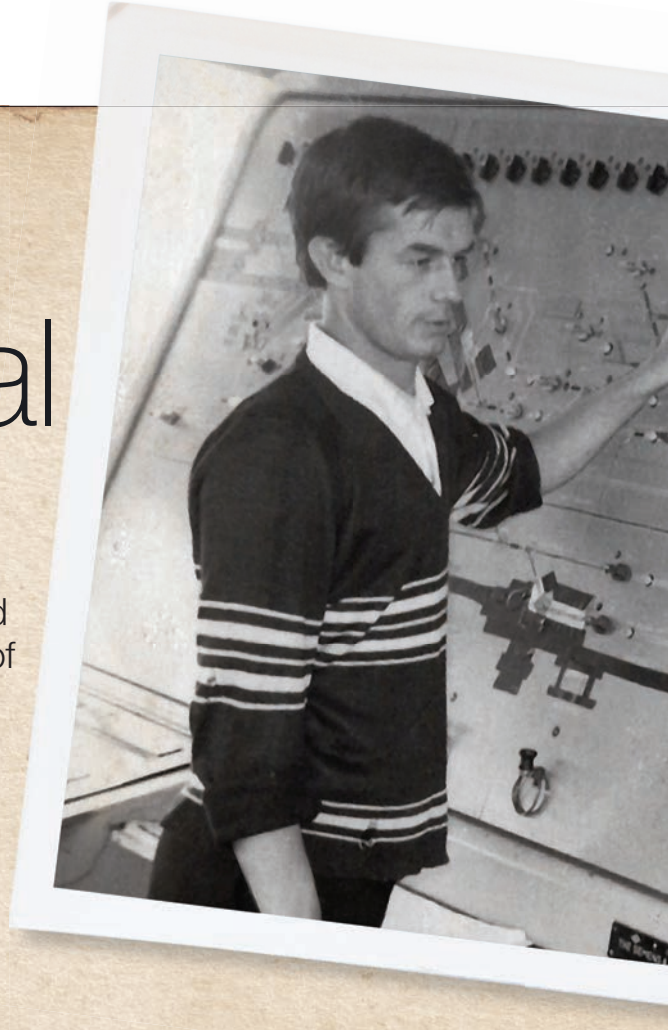
Government Digital Service: www.gov.uk/government/organisations/government-digital-service

IMAGE: GETTY

Obituary

The accidental ergonomist

Bob Muffett left school in 1958 - he was 15 and had no qualifications. Fifty-seven years later, at the age of 71, he became an award winner for his ergonomics work. **Richard Bye** looks back at his life



Born Robert James Muffett in Walthamstow, north-east London, Bob followed his dad, Bill, and elder brothers, Larry and John, into a career on the railway. His first job was as a box boy at Silvertown signal box on the North Woolwich line, doing everything from cleaning, to conveying Morse code telegraph messages, and climbing up the box's semaphore signal posts to replenish the lamp oil.

With his love of the railway cemented, Bob qualified as a signaller and spent the next three decades progressing through the signalling grades at various locations across east London. In 1989, Bob moved to the new Liverpool Street Integrated Electronic Control Centre (IECC), or the "Starship Enterprise" as he liked to call it, filled as it was with banks of screens and the latest digital technology.

New horizons

Having spent over 30 years operating mechanical levers, block bells, and push-button entry/exit (NX) panels, Liverpool Street–at the time, one of the most advanced control centres in the world–provided Bob with new and exciting challenges. Challenges that required him to draw upon his deep understanding of railway people and processes, and which led to him instinctively, albeit unknowingly, applying ergonomics principles to help manage the ironies of automation, balance workload, and build resilience, in his work to optimise the IECC's signalling displays and route setting algorithms. "He loved technology, but never lost sight of the fact that, in times of major events or failures, you need human insight - at those critical moments a machine is not a lot of use," said Professor Andrew McNaughton, then Production Manager, EA Zone, Railtrack.

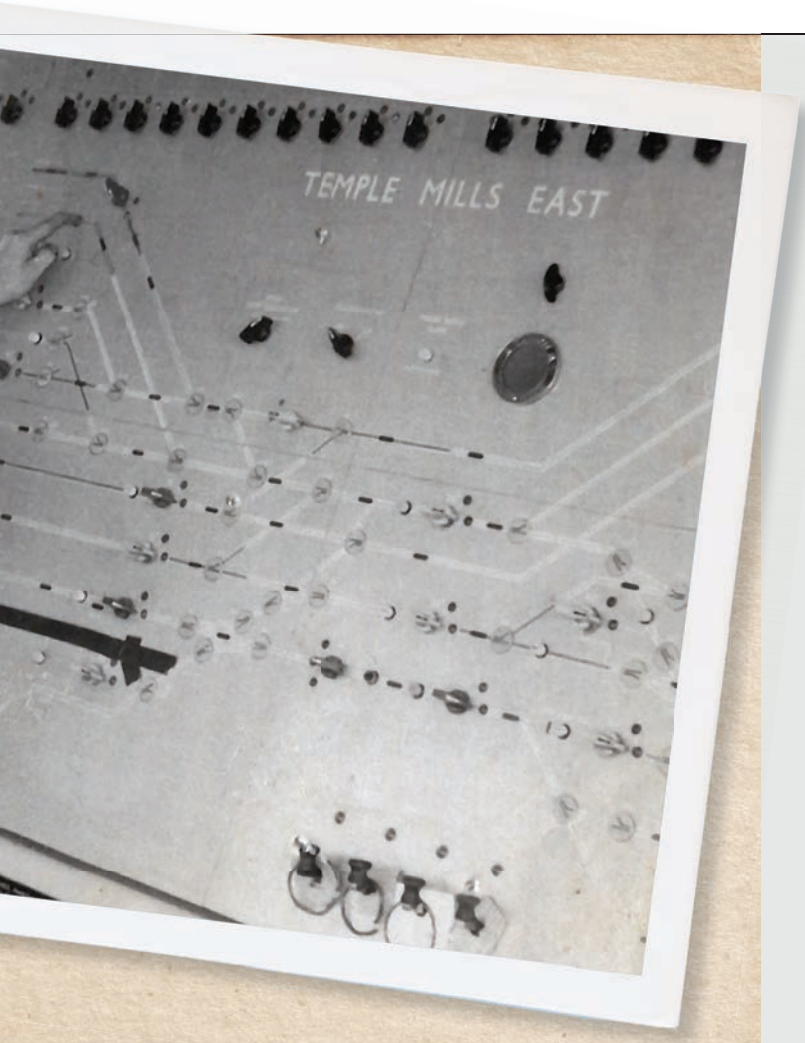
After helping to improve the effectiveness of operations at Liverpool Street, Bob went on to work on the next-generation design concepts for the West Coast Route Modernisation (WCRM) project. And it was from here, in 2002, that he entered the last phase of his career.

Bob knew Theresa Clarke, Lead Ergonomist on the WCRM project, who was in the process of setting up the first incarnation of Network Rail's Ergonomics team: "The team needed significant operations expertise but there was no model for this - I didn't know how, or even if, it would work," she recalls. "I recruited Bob, and another Operations Specialist, John Robinson, and as it turned out we were very lucky to have them."

Along with John, Bob became an integral part of the new team, helping to shape its ethos and approach. He supported numerous projects, teaching ergonomists about rail technology, rail operations and about the railway people at the heart of the system, and in doing so, about how to get the best out of all three.

Bob structured a comprehensive evaluation of the musculoskeletal risks of lever frame signalling operations

The development of a toolkit to assess signaller workload was a key early focus. Bob played a central role in this activity, helping PhD student Laura Pickup (now a Chartered Fellow of CIEHF), to identify factors impacting signaller decision making and performance. Laura's research generated checklists, rating scales, observational protocols and questionnaires that make up a six-method



workload toolkit that is still used by rail human factors professionals today.

Just as Bob taught the team and its affiliated students about the ways of the railway, he ended up gaining an education and a qualification himself. Following some arm-twisting from Professor John Wilson (who worked with Network Rail), Bob successfully completed a Postgraduate Certificate in Applied Ergonomics at the University of Nottingham. Although Bob was somewhat of a reluctant academic, the course provided him with a new language for the "common sense" that he'd been applying for years, and as John Robinson remembers: "It introduced the two of us to a whole new way of thinking."

Levers for change

Bob's time at Nottingham helped him to structure a comprehensive evaluation of the musculoskeletal risks of lever frame signalling operations. During a routine visit to a mechanical signal box, he had discovered that signallers were struggling with the physical operation of the levers used to operate signals and points. This discovery marked the beginning of a multi-year project to identify the safe limits for lever weights, the characteristics of good lever pulling technique, and the need for national risk management controls.

Bob worked with signallers, mechanical engineers and locking fitters on a range of initiatives to manage the →

Bob, age 26, in 1969 at Temple Mills East signal box

BOB MUFFETT

1943-2020

A life of influence and impact

Laura Pickup, consultant at LP Human Factors

As we walked into the first signal box, Bob drew a sharp intake of breath. "Ooh, that's a tricky panel," he said. And so my PhD began, slowly unpicking the complexities of infrastructure layout, engineering design, timetabling, automation and all the other demands that contribute to signaller workload.

Bob was able to explain what made signalling difficult and why. This was fundamental to the development of a conceptual framework that could explain mental workload in signalling, prioritise areas of research focus, and provide useful approaches and tools for the rail industry.

Working with Bob helped to reveal the decision making strategies adopted by expert signallers to maintain situation awareness, balance real time trade-offs, and to understand conflicts and interactions. What came naturally to these SMEs could then be translated into factors used to measure cognitive demand and operator effort, helping to support current performance whilst also informing the design of future railway systems."

Fiona Kenvyn, Manager Human Factors Integration & Change, Metro Trains, Melbourne

Many of us have Bob to thank for our continuing careers in rail - his passion was contagious and he knew before we did that we were going to be far more effective in our jobs, in understanding human factors in a rail setting, if we actually understood the mechanics of rail operations. I think he loved that he could give that to us. →

Banbury North, one of the lever frame signal boxes that Bob visited

personal safety risks associated with what became known as 'heavy pulls'. At the time, there was no mechanism to model the activity, no tools to measure the forces, and no process to identify the risks. Using his passion and ingenuity, Bob ensured that everybody knew what the problems were, understood their underlying complexities, and recognised how important they were to fix.

Bob identified the 'swing', 'drag' and 'shuffle' techniques used by signallers, developed a bespoke measuring device, and undertook a programme of assessments at over 160 locations. This combination of field observations and biomechanical modelling, alongside the evaluation of sickness data, resulted in a national programme, still in place today, to help signallers manage risk.

Bob's innovative lever pulling work led to a paper, published in *Applied Ergonomics*, and to him being awarded the International Ergonomics Association/Liberty Mutual Medal for "outstanding original research leading to the reduction or mitigation of work-related injuries."

During his 11 years with the team, Bob was a coach, mentor, analyst, subject matter expert and interpreter of all things rail. I joined Network Rail in 2007 and must have looked as overwhelmed and out of place as I felt. Perceptive as ever, Bob spotted this, took me aside and said: "Don't worry, I landed here by accident too - you'll find your feet." And he was right - as he was about most things. Bob had a way of instilling a quiet confidence in those fortunate enough to benefit from his wisdom. He was, in the words of ex-team member, Kate Moncrieff, a "father figure" to a whole generation of rail human factors professionals.

Sadly, Bob died in April this year. As former PhD student, Nastaran Dadashi, said: "He'll be missed by all who knew and worked with him, and by those who didn't get the chance to."

Bob Muffett was born on the 31st August 1943, the fifth of eight children, to Margaret and Bill Muffett. Married to Val for 56 years, Bob was a devoted family man. Val and Bob had one son, Gary, a granddaughter, Jess, and a great-grandson, Theo. Bob retired in 2013 after 55 years' service to British Railways, Railtrack and Network Rail. During his later years, Bob was diagnosed with Parkinson's disease and dementia.
He died, aged 76, on 27 April 2020. ●

Richard Bye is a Principal Ergonomics Specialist at Network Rail.
With thanks to the Muffett family, Steve Gwinnett and John Robinson.

Professor Andrew McNaughton Chairman of Network Rail (High Speed) Ltd

Bob wasn't afraid to say: "that's a stupid idea", but would then take the time to explain why he'd said that, and try and help us address the issue at hand by making informed, positive and practical suggestions. He respected expertise and ideas, not egos or job titles, and he wanted to explore every opportunity to make the railway work better. He wanted to make a difference.

Nora Balfe, Human Factors Specialist, Iarnród Éireann Irish Rail

I started my rail career with a series of signal box visits with Bob, and even now I get a little tremor of trepidation when I have to go to one without him. I've been lucky enough to visit signalling centres all over the world but it's Bob's patient explanations from my first days on the railway that have made those visits worthwhile. I owe him an enormous debt.

Anthony Coplestone, Head of Ergonomics, HS2 Ltd

Bob has had a great influence on my work. I met him when I started at Network Rail in 2005 and quickly realised the importance of working with an operational subject matter expert. As HF professionals we learn to apply our skills in many industries, but we can sometimes, in the haste to get things done, underestimate the value of working with other SMEs.

Laura Sutton, HM Principal Inspector of Railways - Human Factors, ORR

The deep understanding of railway operations that Bob was able to impart was, and continues to be, crucial to the delivery of informed, practical and effective solutions to the challenges faced by rail human factors professionals every day.

Mike Carey, Head of Ergonomics, Network Rail

When we were focusing heavily on cognitive operational tasks, Bob would frequently remind me of the physical and other psychological challenges we also needed to address. This has stayed with me, along with the memory of that smile, and wondering, as he walked towards me, what I was about to learn!

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The Future Human including robotics/cobotics; wearable technology; AI; online learning

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Q&A

MEMBER PROFILE

Tina Worthy talks to human factors advisor, **Angela McLean**, about her career in the energy sector

What's your background?

I've worked in the oil and gas industry for almost 30 years starting out as a legal secretary with an oil major and progressing through various jobs and companies. My roles have primarily been in support functions rather than operations-focused positions. Following the birth of my son, I did a communications degree at university as a mature student, then returned to the oil and gas industry in health and safety roles supporting the maintenance of safety cases and Control of Major Accident Hazards (COMAH) reports.

What does your current job involve?

In my current role, I'm responsible for co-ordinating and delivering Chrysaor's Human Factors Programme. This involves liaising with key stakeholders and collaborating with consultants to ensure this is delivered in accordance with company strategy.

How did you find out about human factors?

In my time within the industry, I've come across the term 'human factors' many times, but each time it was fleeting and poorly understood. In my previous role as Technical Author, the term was often mentioned as a compliance requirement. There was a lot of debate and discussion about it but no clear or consistent understanding, no encouragement or enforcement and the discussions petered out.

How is your organisation using human factors?

When I joined Chrysaor, it was refreshing to discover the approach was to integrate human factors into everything we do as a key part of our major accident prevention strategy. We've taken time to understand industry guidance and from this developed a comprehensive plan to improve human factors across the business with full leadership support and endorsement.

It sounds simple but I've realised this really is a marathon and not a sprint. I've witnessed the 'bunny in the headlights' look when human factors is mentioned and it's fair to say I was one of those bunnies! Having gone through that myself, I realise it's important to explain it in as simple terms as possible and to try to make this relevant to the work being carried out. The aim is to demystify it and address some of the preconceptions or misconceptions that exist.

At Chrysaor, we looked at the human factors topics from the Health & Safety Executive and mapped their relevance to individual functions. We then carried out short awareness courses with our teams. Since the discipline is so diverse and complex, it makes sense to give a broad overview of aims and then focus on the elements that we're dealing with at any given time. Fortunately, we have a good regulatory structure and guidance from which to develop our internal framework.

What particular projects have you been involved in?

When I inherited a key deliverable to update our safety-critical process operating procedures, I had a baptism of fire into the discipline! I had to do a lot of quick learning and after a few stops and starts this culminated in a robust process for conducting task analysis. We carry out awareness sessions with personnel to explain why we should consistently use safety-critical procedures that minimise the risk of working beyond operational parameters and ensure the task is performed consistently.

Our crews are fully involved in the development

and review of our safety-critical procedures and some operational integrity issues have been addressed as a result of their feedback. This ensures the safety of our people and plant and reduces the potential for a major accident. It also highlights where engineering controls need to be considered to reduce human intervention. Tantamount to this is continued collaboration with frontline personnel to ensure the procedures are accurate, fit-for-purpose and allow more efficient and safe execution of safety-critical tasks.

What has the organisation learnt from this project?

This particular project is challenging, and subject to great debate across the industry, which I think is fantastic. This demonstrates there's an appetite to understand and implement human factors that wasn't there before. There was some scepticism at the start of the process and a little pushback, which is understandable. Why are we changing things that have seemingly worked for years? Once the teams participate and contribute in workshops, the change in their thinking is striking and there's a real desire for them to take more ownership of their procedures. This is a great endorsement of the process, and the knowledge and experience of our human factors team. If there's any criticism, it's that we're struggling to respond to their needs as quickly as they would like us to.

We've taken time to understand industry guidance and from this developed a comprehensive plan to improve human factors across the business

What plans does your organisation have for increasing its human factors capability?

I've seen an increase in the desire to understand and participate in human factors in the last few years and we're in danger of not being able to keep up with this demand. To that end, we're looking to improve our internal competency to ensure we can capably support our colleagues and bring them along on our human factors journey.

How are you developing your own human factors competence?

Personally, I have just completed a Postgraduate Certificate in Ergonomics and Human Factors with the University of Derby and I'm now focusing on completing the Learning Pathway offered by the CIEHF and their training partners, i-CAB. This is a vocational course that I can do at my own pace and use practical

examples from work while applying the foundational principles to real world scenarios. This will help to embed my understanding of the discipline. I'm very fortunate to have access to some great human factors experts who have amassed a broad range of experience, which I can use to engage with our workforce.

How do you see human factors capability increasing in your sector?

It will take time for human factors to become firmly embedded within the oil and gas industry and I believe it will need monitoring and enforcement by our Regulator. But if we can demonstrate its benefit in terms of improved operational efficiency and a reduced number of incidents due to better equipment design and processes, it should be an easier journey.

Some of my colleagues have said that that the consistent factor in our operated assets is our people, therefore, we need the systematic approach of human factors to support them in safely carrying out their work. Especially when we know what the consequences of failure can be.

I'd like to see human factors well established in the projects and management of change areas. This would prevent operators having to work around less than optimal plant or equipment. A real success though would be the recognition that human factors as a discipline is equal to engineering or other technical professions.

What advice would you give someone considering a career in human factors?

The best advice I could give would be to find a practitioner and make them your mentor! There's a lot of fascinating research and academic material but my biggest struggle was understanding the real-world application for most of it. It's a diverse and complex discipline and there are many routes into the field. Figure out which aspect best matches your skill set or your ambition. Is it the behavioural (psychology) part? Or is it user-centred design that intrigues you? Maybe it's the broader application and you want to be a generalist? Whatever your preference, there are experienced people who can guide and support you and it's important that all knowledge is shared.

It's all go!

Thinking about resilience, a word that has popped up a lot recently, the CIEHF community seems to be doing well, busier than ever and going from strength to strength. With the help of our members we have so far already held more events than in previous years (albeit not in-person events), published two White Papers and produced an array of useful and well received guidance documents in very challenging times. The 'Creating a safe workplace' guide alone has been downloaded more than 2600 times. This helped us to connect to individuals and organisations and demonstrate what we are about, how we can help and why our discipline is so important. We managed to capture the interest of large organisations who are looking to implement human factors training in their staff development plans and embed a human factors culture.

Members tell us more sectors now expect human factors knowledge in their teams and often job descriptions include the requirement to be a member of the CIEHF. This may be one of the reasons why we are receiving a higher than usual number of enquiries for membership at the moment. CIEHF membership allows people not only to get the recognition they deserve but also provides an opportunity to improve their professional prospects and make their careers more resilient.

Your membership means strength in numbers and the support of the community you belong to. This may be through the help of a mentor, connecting with other members via one of our Sector Groups, or just having a friendly conversation. Look out for our upcoming 'Tea time chats' which we'll be introducing soon.

I look forward to meeting more of you. If you'd like to have a one-to-one talk, please just give me a ring or contact me by email.

Iris Mynott
i.mynott@ergonomics.org.uk
07702 542166

A framework for learning

Our Learning Pathways are becoming more popular. These are structured programmes of education based around a framework that incorporates knowledge resources, activities to put theory into practice and question sets to test comprehension. There are three levels to complete which each go into increasing depth and those successfully reaching the end of the programme are eligible to apply for Technical Membership of CIEHF.

With the release of the second level material for our Energy Learning Pathway, we're seeing growing numbers of oil & gas companies signing up their workers to the two-year programme. We're also seeing increasing interest from other sectors. Currently, development is nearly complete of a Pathway in healthcare which could see a large uptake with support already being given by some of the major organisations in the sector.

Interest in starting to develop Pathways has also come from the defence and the construction sectors, and work is now underway to ensure that such development starts from common core content and is fully supported through a structured approach. Watch this space!

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
Ergonomics & Human Factors Careers Day	Thu, 25 February, online	This well-established and popular event will give you a real insight into a career in ergonomics and human factors, whether you're just starting out or are looking for a change of direction.
Ergonomics & Human Factors 2021	Mon-Thu, 19-22 April 2021, online and London	A showcase for human factors success stories, challenges and research that celebrates, explores and advances our fantastic discipline.
IEA2021	Sun-Fri, 13-18 June 2021, Vancouver	Learning and networking opportunities for the human factors and ergonomics community around the world. Visit www.iea2021.org for details.

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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