No. 581 | Jan-Feb 2021

THE ERGONOMIST

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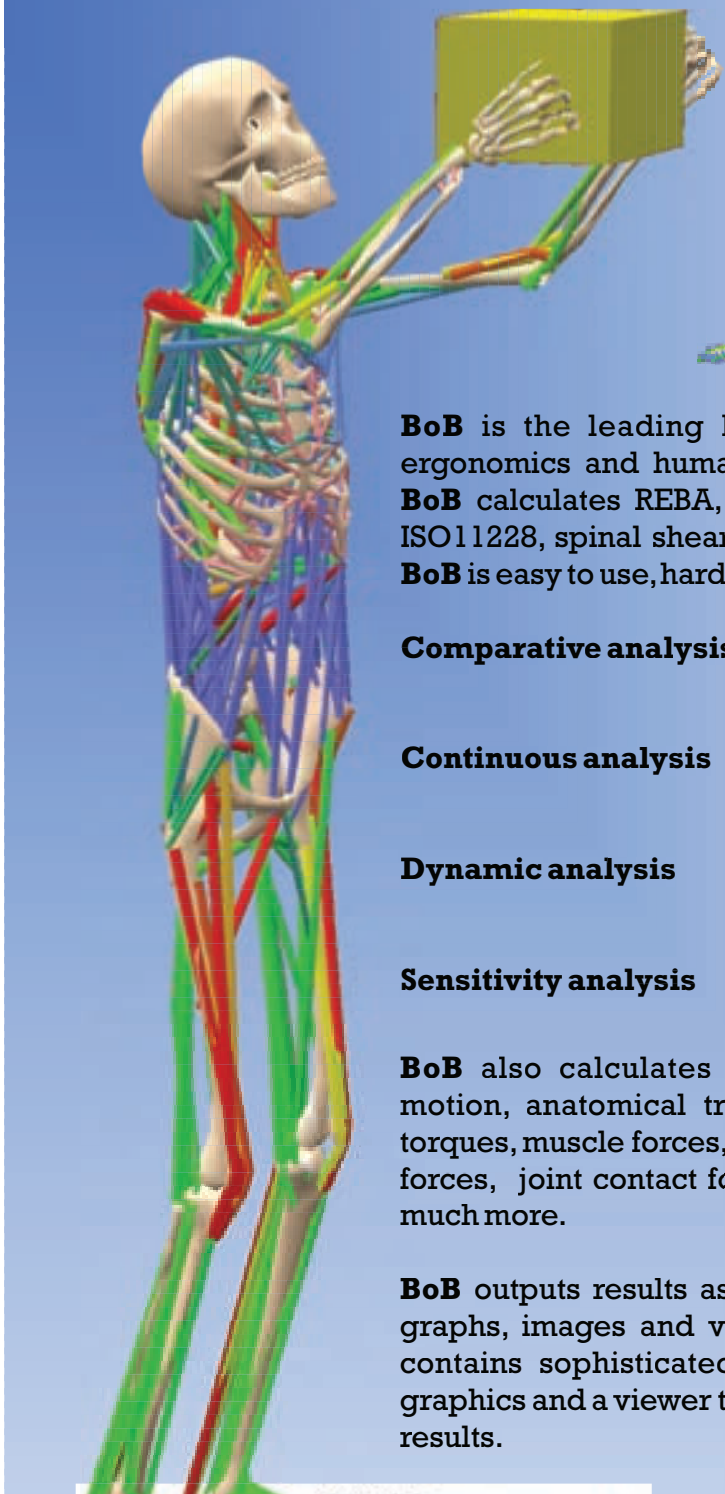
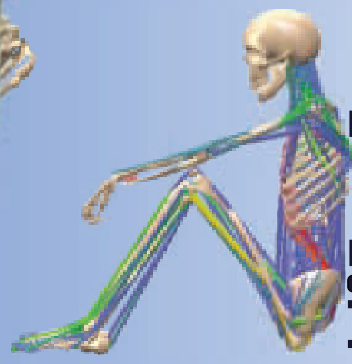
THE TROUBLE WITH TRAVEL

How training can help you beat the debilitating effects of motion sickness





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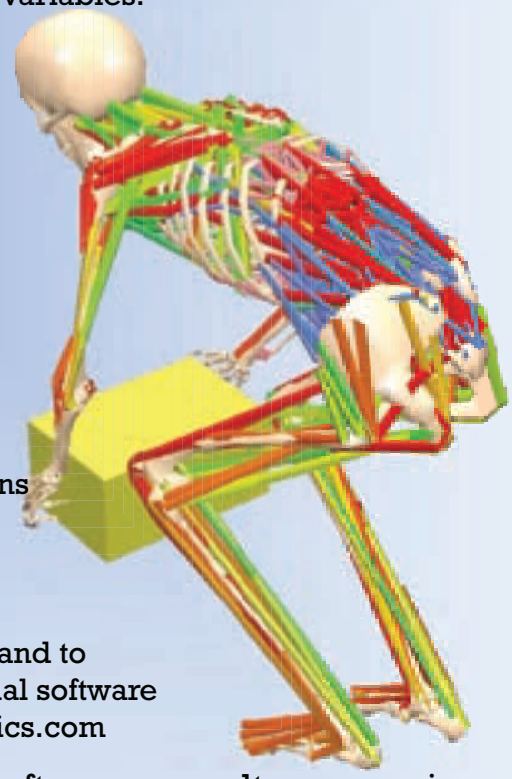

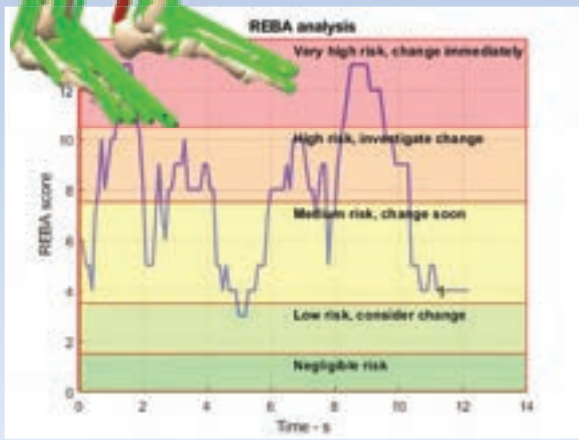

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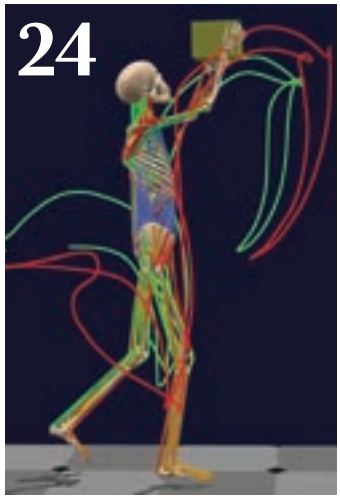

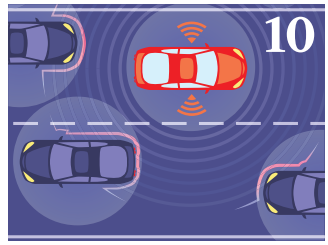

COVER IMAGE: ALAMY

RESEARCH MATTERS

CIEHF NEWS

Chartered Institute of Ergonomics & Human Factors

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- The review of subsystem verification evidence from the supply chain.
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Wearables

Deadline:
1 February 2021

Ready to submit?

Find more details at
comfort.ergonomics.org.uk

This event is being organised in partnership with the Chartered Institute of Ergonomics & Human Factors and with the support of ComfDemo.

FROM THE PRESIDENT

Engagement on all fronts

Amanda Widdowson
CIEHF President

president@ergonomics.org.uk

As the CIEHF community, we can be proud of the way in which we pulled together in the face of adversity in 2020. Perhaps the first notable success was our conference, EHF2020. The organising team and presenters did an amazing job of transforming a face-to-face event into a virtual one. The webinar platform has been put to good use since then and the incorporated chat function has proved to be particularly popular. The success of this format shaped future events such as EHF2021. Keep an eye on the events website to ensure you don't miss out.

Multiple Covid-19 related guides were produced by member volunteers and with partner organisations. Topics included ventilator usability and workspace design in, and outside, the home. White papers on *Learning from Adverse Events* and the future of aviation were released. Several of these publications were downloaded thousands of times each.

The *Design for Everybody* project was launched to gather more diverse, up-to-date anthropometric data. As data collection was hampered by social distancing restrictions, we don't yet have enough to produce a guide but we'll reactivate our plan when restrictions are lifted. In the meantime, our online collection of data continues and the reliability of self-measurement has been tested. A sample of people recorded ten measurements every day for five days and statistical analysis found that the online self-measurement technique is reliable.

I attended the International Ergonomics Association (IEA) council meeting in October. A survey found that the triennial conference (the next one is in 2021) and publication/dissemination of papers were among the top priorities of the voting countries. In the same week, CIEHF Past President, Bob Bridger and CEO, Noorzaman Rashid, attended a meeting with the US Human Factors and Ergonomics Society. We're keen to collaborate more with international organisations such as these in sharing news, events and publications.

Whatever 2021 brings, the CIEHF will be here, continuing to champion the importance of human factors and supporting our growing membership.

We pulled together in the face of adversity in 2020

FROM THE EDITOR

Good news to end the year

Our cover article features a topic that no-one wants to experience - motion sickness. But Joe Smyth reveals that a reduction or even an end might be in sight for sufferers. This may be good news for more of us than we think, if autonomous cars become the norm and the driver finds themselves with time on their hands to read, as Filip Florek explains.

But Clara Greed notes that if you need a comfort stop, you might be searching a while as closures have meant that public toilets are few and far between, and often aren't as inclusive as they could be.

We reveal good news too for students, who've won awards for their projects and have received recognition for their part in a successful industrial placement scheme at a large pharma company.

We learn about ambulance interiors, the layout of a Nightingale hospital and a tool for analysing posture and movement. We also find out about an innovative electrical network simulator, developments in IT and a new journal in neuroergonomics.

Finally, I'd like to thank all those who have contributed to the content, editing and production of *The Ergonomist* this year. We've covered a huge number of topics (as this issue demonstrates!) that serve to illustrate just how versatile and all-encompassing our amazing discipline is!

Wishing you the very best for 2021.

Tina Worthy
editor@ergonomics.org.uk
@ciehf

2020 the year in numbers

It's been a year of moving goalposts and constantly evolving plans, so we take a quick look back at some of the highlights.

We'd like to sincerely thank all our many contributing members and partners, both individuals and organisations, who have worked with us and enabled us to, collectively, achieve so much.

318
New members

1864
Members

21
New partnerships and collaborations

40
Online events

667
Posts in Communities discussion forums

102
New volunteers for CIEHF activities

439
Participants at EHF2020 online

35
Publications and pieces of thought leadership

4.4k
CPD records submitted for 2019

5.2k
Registrations for online events

961
Replays of online events watched

26.9k
Downloads, views or opens of published material

Take part in this unique project!

A measured approach

As you may know, Amanda Widdowson has chosen to collect body measurement data for her CIEHF President's Project to highlight the importance of taking anthropometric diversity into account in people-centred design. It's a great idea and one that getting a lot of support from people, including from Caroline Criado Perez, best-selling author of *Invisible Women*, and from many different organisations.

Despite our initial plans for hands-on measuring sessions having to be postponed due to social distancing restrictions, we've carried on with publicising the project. People have been very keen to be involved and to add their measurements to the data set - and we're very much hoping you will be just as keen to join in too. You just need to take ten measurements and enter them into an online form. We've got illustrated guidance for you and even a short video (see https://bit.ly/Take10CIEHF).

We've made it as easy as we can for you to take part in this unique 'citizen science' campaign, by including with this issue of *The Ergonomist*, the guidance sheet and form for your measurements. Not only that, if you live in the UK, we've also included a tape measure for you to use (and keep)!

We're sorry that postal restrictions mean that those outside the UK don't get the tape measure but we've included the guidance and data form for you, so you can take part too.

The more data we can collect the better, so please join in, and if you can persuade your family, friends or colleagues to measure themselves too, you can print more copies of the data form or email them a copy from here: https://bit.ly/DesignForEverybodyForm

Thank you – this is a ground-breaking project for the CIEHF and your participation will help make it a great success! ●

Chartered Institute of Ergonomics & Human Factors

19-21 April 2021 – ONLINE

Ergonomics & Human Factors 2021

Invitation to take part in this international conference showcasing success, challenges, research and application.

Format

A three day online event with engaging and informative live sessions, together with a large range of on-demand recorded content. Social networking time includes interactive chat and an online quiz.

Themes

We'll be exploring and discussing the contribution of ergonomics and human factors across four contemporary themes of global importance. Here's a flavour of what we'll be showcasing:

Have you booked your place?

Perspectives on the Pandemic: shaping the way ahead

There's no doubt that the effects of the pandemic will be felt for years to come. We look at how the provision of products, services and training has rapidly changed and how organisations have adapted and developed their work and management practices.

Attitudes & Behaviour: understanding people's influences and motivations

We look at why the format and language we use in communication is so important in achieving a successful outcome. We find out why instilling a sense of empathy is vital for effective design and we uncover the best approach for understanding safety culture.

Human Performance: resilience and reliability in teams and individuals

We explore task complexity and variability in everyday work to understand more about what's needed for reliable operations. We look at tools and training that enable good decision making and communication. And we find out how to manage fatigue.

Technology & Automation: living and working smarter and better

We explore the often uneasy alliance between people and technology. We look at automated aids for detecting threats, strategic planning and decision making. And we find out about technology benefits for children, home workers and older adults.

For details on the programme and how to book your place, go to

conference.ergonomics.org.uk

Learn | Meet | Discuss | Be inspired

#ehf2021

NHS Nightingale: First temporary coronavirus hospital opened in London's ExCel Centre

Lessons from the frontline

The Nightingale hospitals, which were set up after the outbreak of coronavirus, pushed everyone working on them into uncharted waters. The speed of their creation and the uncertainty over how the pandemic would develop presented a complex network of problems to be solved.

Just ten days after its creation was announced, the Nightingale Hospital London officially opened its doors. Laura Pickup, National Investigator for the Healthcare Safety Investigation Branch (HSIB), was one of the human factors specialists invited in by Professor Bryn Baxendale to support the unprecedented project as London's ExCel centre was transformed into a vast intensive care ward.

Laura admits that driving through the capital's deserted streets to reach the new hospital was an incredibly surreal experience. The city was at the height of lockdown and the usual traffic noise had been replaced by silence and surprising sights, including a Chinook helicopter touching down outside the centre.

Laura said: "You walked through the door and it was like entering another world. But the atmosphere inside was one of real positivity with so many people from so many places being brought together."

The Nightingale operation raised plenty of challenges which had to be considered. Some staff involved in the project had no background in healthcare and the time pressures meant training had to move at a much quicker pace than normal. The layout of medical kit was not the same around every bed, potentially increasing the cognitive load for workers coming on shift. The speed of setting up the site also meant a lot of plans were already in place when Laura arrived with her colleague Neil Alexander from HSIB.

Laura worked closely with the clinical engineering team in particular, to find solutions for the unusual environment. She said: "They play a critical role in a hospital and that becomes even more critical when you're setting up an emergency service like this. They brought in the ventilators and we worked together to see how we could ensure that everyone turning up on the day knew what they were going to use. Although there was a lot of different types of equipment and different ventilators, they tried to standardise what kit there was in each area."

Another area where human factors could offer advice during the planning stage was the space set aside for workers to change in and out of their PPE. The team drew on previous work carried out by colleague Tracey Herlihey on infection control during the Ebola virus outbreak to give guidance on how to make sure staff minimised the risk of spreading Covid.

Design and layout can support people rather than asking them to read posters or remember training

They suggested laying out protective equipment in the order it should be put on to help ensure workers follow the correct sequence – a more effective method than asking staff to read instructions on a poster. A mirror was also recommended so employees could visually check they were doing everything correctly.

Taking off PPE can pose even more of a risk of spreading infection. Following Tracey's research, individual stations were recommended with different sized bins to remind workers of the correct order to remove their PPE safely. Tape markings on the floor to show red, amber and green zones, depending on the level of risk, could also help protect staff.

"When we looked at the donning and doffing room it was a blank canvas, so we mapped out a potential design," said Laura. "Tracey worked with us remotely and we used the evidence from her research. It's a critical stage which is often forgotten. We showed how design and layout could support people rather than just requiring them to read posters or remember their training."

During the project, Neil also worked with the fire and estate teams to influence the layout and design of critical infrastructure and marry up education and training with their emergency protocols.

The experience from the Nightingale Hospital and subsequent work completed with the CIEHF to support the design of bedside aids for tracheostomies and ventilators highlighted the many benefits human factors can bring to areas of healthcare where it might not always be considered.

Laura added: "You'll find human factors influencing operating theatres and surgery but you probably won't find it in outpatients for example, or at the front door. If the work that's been done could be built on and become part of the fabric of healthcare system, that would be fabulous."

IMAGE: REUTERS

Look, no hands!

How much human input does a car need to drive itself on a motorway at 40 mph? That's the question asked by the UK government in August in its preparations for the introduction of vehicle automation onto UK roads, but there's no simple answer, as **Filip Florek** explains.

Drivers currently are required constantly to maintain awareness of any changes on the road, trying to anticipate what other road users and pedestrians might do next but accidents of course, still happen. There is a tremendous effort across the UK to reduce road fatalities and one way to do this is to introduce technology to vehicles that gives them the potential to increase road safety. An example of such technology is the Automated Lane Keeping System or ALKS.

ALKS, when activated, will keep a vehicle within its lane, controlling its movements for extended periods of time without the driver needing to do anything. The driver would, though, be expected to be ready and able to resume driving control when prompted by the vehicle. And herein lies the problem.

How can the driver maintain full situational awareness at all times, when the idea behind the technology is to allow the driver to do something else with their time, something 'productive'? Such non-driving-related tasks could include reading text messages, browsing the internet or even watching a film. If the vehicle is in complete control of the dynamic driving task, a 'secondary driving task' may effectively become a driver's primary task, both cognitively and physically.

Existing industry standards consider these tasks as a distraction and recommend them being 'locked out' during driving. The proposed introduction of ALKS will have a significant impact on driver distraction standards and acceptance testing in the automotive industry, especially when the permissible use of the infotainment system fails to address the relationship with the existing laws prohibiting the use of electronic devices like laptops, tablets or smartphones while driving. For ALKS to meet safety objectives, legislation will need to confirm that ALKS-equipped vehicles are legal to use by all occupants when ALKS is activated.

Maintaining situational awareness

Maintaining situational awareness when an operator is no longer controlling the equipment has been the focus of research, analysis and recommendations for decades. ALKS should encourage the driver to maintain some degree of situational awareness, together with an understanding of the performance and operational status of ALKS itself. For this, we need to understand how driver behaviour might change due to the presence and use of the new technology and what happens when control of the vehicle needs to shift back to the driver.

A driver would be expected to take over the controls in case of a vehicle systems failure or downgraded performance, for example caused by the weather, and resume previously interrupted manual driving. What does the driver need to know about the vehicle in order for them to spot a fault early, before the operational envelope of ALKS is exceeded and a failure occurs?

The Centre for Connected and Autonomous Vehicles (CCAV) is the UK government's representative in this arena. CCAV defines the driver's residual responsibility to respond to the handover request and calls it the 'transition demand'. Communication of the vehicle's state and its understanding of surroundings is an

The CIEHF's response to CCAV's call for evidence

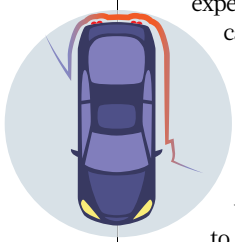
important aspect in developing trust between human driver and the automated vehicle. Existing driver interfaces don't communicate this kind of information effectively however, especially when the transition demand occurs, with the result that the driver may not be able to react in time.

A great deal of attention should be given to specifying guidelines for the driver interface so the design is completely intuitive and communication with the driver can occur rapidly and fluidly at all times, whether or not they are actively monitoring ALKS. Understanding the term 'monitoring' is key to specifying the split of responsibilities between the driver and vehicle. Specifically, ensuring appropriate detection and response to a handover request implies, to a certain degree, 'monitoring'.

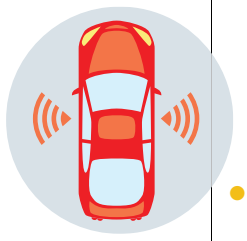
Call for evidence

In 2016, CCAV consulted the public on the regulatory requirements of so-called 'motorway pilots', committing to consult further when these systems were ready for commercial deployment. Building on the responses, the new 2020 call for evidence process follows other EU countries in the adaptation of UN Regulation on ALKS for passenger cars. According to the UN Regulation, ALKS is classified as a Society of Automotive Engineers (SAE) Level 3 conditional driving automation system (where no driving automation is at Level 0, and full driving automation is at Level 5). This states that ALKS, once activated, may completely take control of the driving task.

However, the CCAV call for evidence asks whether vehicles using this technology should be legally defined as an automated vehicle in line with the Automated and Electric Vehicles Act 2018 (AEVA) which would mean car makers would be responsible for the safety of the vehicle when the automated system is engaged, rather than the driver.



By adopting non-standardised definition of the automated vehicle, there is a potential for incoherence and ambiguity. In SAE Level 3, the driver remains the 'fallback-ready' user, and so must remain responsive to vehicle requests to perform a driving task. On the other hand, AEVA says the driver is not required to monitor or control the vehicle in specific conditions.



Additionally, there is no specific information on what constitutes controlling and monitoring a vehicle by the driver under vehicle operating modes. In contrast, the term 'automated' is an important aspect of the SAE's definitions and is used precisely to reflect the capabilities of the vehicle, separating capabilities from 'driver assistance' to 'automated', a vitally important aspect, both for governance and usability.

The call for evidence caused much discussion in the CIEHF community, notably about the perception of risk within our society, road safety culture, driver requirements to maintain sufficient situational awareness, and alignment between technology and societal needs. By responding to the call in the way it has through a comprehensive response document and lobbying on these very relevant issues, CIEHF, as a professional body, could influence decisions on the implementation of ALKS affecting all road users in the UK. The CIEHF experts engaged in this response came from relevant transport domains including automotive, aerospace and rail.

ALKS will have a significant impact on driver distraction standards and acceptance testing in the automotive industry

What next?

Technological progress alone will not be enough for ALKS to achieve its potential. The next steps should focus on:

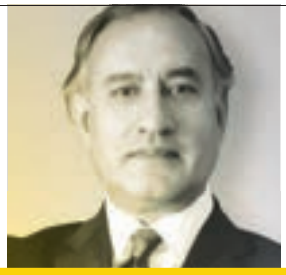
- Initiating dialogue between all key parties: the public, the car makers, the governing bodies, law enforcement and road safety agencies in the UK.
- Informing the public about the potential benefits to them and what they can and cannot do in ALKS-equipped vehicles. Public understanding of the changes in the driver's role in future vehicles is essential.
- Informing the public about in-car occupants monitoring, detailing what data will be collected and why. Integration of ethical principles for data collection and management will be essential to align this emerging technology with the society.
- Future research in collaboration with key parties. Professional organisations like CIEHF should encourage the public to get involved in trials and be part of the innovation process.

CIEHF's response to the government's call for evidence identified and explored several other assertions by CCAV that did not have full consideration of human factors nor sufficient evidence. This included response to handover requests, dual-function allocation to primary driving controls, reliability of the driver monitoring system and conditions where driver inputs may be suppressed by ALKS. Also included were conditions related to driver attentiveness, the environment and infrastructure but without consideration of availability, serviceability and safety.

Vehicle technology roll-out should not be restricted but guided, where regulations ensure safety of all road users but also sustain innovation. This initiative should be considered as a positive step towards technological adaptation and public acceptance of automated vehicle technology and to enable new and emerging technologies.

The full version of CIEHF's response to the CCAV call is available to download at **https://bit.ly/CIEHFALKSResponse**

Filip Florek is a Human Factors Specialist in the automotive industry.



A small selection of the many publications we've produced this year.

CHIEF EXECUTIVE'S PERSPECTIVE

Looking forward to a very positive 2021

Twenty twenty was my first full 12-month period as CEO of the CIEHF and what a year it's been. We agreed at the beginning a new five-year strategy with four key themes and a very full programme of in-person events including a Human Factors Roadshow across several regions and a target to recruit 200 new members. But the pandemic meant a radical change to our plans.

When the first lockdown was announced we were just five weeks away from our annual Ergonomics & Human Factors Conference, EHF2020, that was to run in parallel with Organisational Design and Management (ODAM). We regrouped and set about moving all content online, and thanks to the efforts of the CIEHF team and all the presenters, it was so successful that we almost doubled the usual attendee numbers. Thanks to Tina Worthy and Sally Hawkes in particular, with assistance from Rebecca Charles and Dave Golightly, chairs of the Programme Committee.

We quickly responded to Covid-19 by setting up a team to respond immediately to requests for help. Chaired by myself, with support from Professor Paul Bowie (NHS Education for Scotland, NES), Professor Sue Hignett (Loughborough University), Dr Mark Sujan (Human Factors Everywhere) and Professor Paul McCulloch (University of Oxford), we met each week.

Over a dozen key guides have been produced in collaboration with many allied professional bodies including BOHS, the Chartered Institute of Personnel and Development, the Confederation of British Industry and the Royal Academy of Engineering. Deploying our UX expertise, we designed interactive infographics to help push out messages and engage audiences rapidly, perhaps the most impactful being our infographic on usability testing for the rapid manufacture of ventilators. This infographic and a report written by Mark Sujan and myself, with over 20 contributions from others, on "Human factors in the design and operation of ventilators for Covid-19" was produced in 48 hours and distributed internationally by Innovate UK and the government to all manufacturers of ventilators. Best of all, we influenced a change in government policy to ensure the integrity of future designs. For all material, visit https://covid19.ergonomics.org.uk.

For 2021 we've set ourselves some more challenging targets whilst continuing to build a world class membership body

In seeking to make our discipline more impactful and visible, our input to the Patient Safety Syllabus (part of the NHS Patient Safety Strategy) and the subsequent development of a Healthcare Learning Pathway is a significant step that will influence the take up of human factors within the healthcare sector.

I'm very proud of the way we've engaged over 100 new volunteers this year, including members in under-represented groups from the BAME community. Our Sector Groups are very productive, two news groups being Workplace led by Kirsty Angerer and Ed Milnes and Defence led by Laird Evans and Steve Harmer. Special Interest Groups have also emerged including AI and Digital Health. These groups and the Regional Networks are meeting frequently, contributing to CIEHF becoming one of the most vibrant networks for human factors and ergonomics professionals.

Our social media visibility has increased significantly too. This, combined with 40 online events and 35 publications, has seen membership grow by over 300 this year at a time when other similar organisations report losses. I'd like to thank Iris Mynott, our Membership Manager, for her sterling efforts in membership engagement.

For 2021 we've set ourselves some more challenging targets whilst continuing to build a world class membership body. Here are just a few, described under our four strategic themes:

1. Creating a world class organisation: Growing and consolidating the financial and member resources that secure and support our long-term future in order to build our reputation as the pre-eminent professional body for our discipline.

We will be rolling out a new website and Learning Management System to ensure that all our resources are easily accessible. We'll also be putting in place a new membership database to help us engage more effectively with members.

2. Supporting our members: Identifying and providing ways to support our members in becoming more effective and influential, so enhancing the reputation of our members, the discipline and the Institute.

We'll be developing a stronger programme of Masterclasses and personal development activity for members. We'll support members to create more thought leadership pieces that we can publish to influence our discipline and practice.

3. 'The Future Human': Identifying, organising and supporting innovative and disruptive thinking that can make a significant contribution to life, well-being and performance.

We'll identify and engage with at least four new areas of research through collaboration to help promote CIEHF as the most vibrant network for human factors professionals in the world. We'll be facilitating Sector Groups and SIG activities to further impact human factors specialist areas including areas such as neuroergonomics and the future workplace.

4. The Partner of Choice: Collaborating and working with professional and occupational institutes, trade bodies, research entities, government departments and agencies and others to influence how integrated design can improve life, well-being and performance. We'll continue to explore and exploit collaborative work with others to build our visibility and promote our discipline and profession. We'll look for more opportunities to influence government policies and collaborate with at least two other ergonomics societies. We'll also identify ways in which CIEHF can accredit more courses to extend our influence.

Thank you in particular to Past President Bob Bridger, President Amanda Widdowson, President Elect Chris Ramsden and our Treasurer Jon Berman, for their support.

Noorzaman Rashid
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noorzaman rashid

Let's celebrate

We're looking forward to emerging into a new year, and one of the first things we're very pleased to announce is the launch of our awards to recognise excellence in the discipline. This year, we've moved the nomination window forward so we can celebrate the winners in a live event next summer.

Quality postgraduate work by students is recognised through nomination by course leaders for the Best Student Project Award. Following graduation, excellent work by an early career human factors professional is celebrated with our New Ergonomist of the Year Award.

Outstanding research and development or the application of knowledge by a group is recognised by our President's Award, whilst our Innovation Award is given for any project or programme of work that's made a significant, impactful and innovative contribution to the discipline.

Two Lifetime Achievement Awards are given: one for outstanding scientific research, development and application of knowledge; the second for outstanding practical application of human factors.

A special Outstanding Communications Award is given for an effective and impactful one-off communication of information through digital or print media. Finally, we recognise the contribution to our work of our amazing members through our Volunteer of the Year Award.

Let's celebrate together the impact our discipline makes and its success in all aspects of life by recognising the people behind it.

Nominations open 1 February 2021 and close 1 May 2021. The awards ceremony will take place at the end of June. For all details, see awards.ergonomics.org.uk

Ambulance design revisited

After recent research highlighted how human factors could help improve ambulance design in Canada, we explore the progress that has been made in the UK and the challenges that still lie ahead.

Lives often depend on ambulances as a vital resource. As they may often travel at speed, they present some unique challenges in respect of vehicle occupant safety including the crew, the patient and any escort in the treatment saloon. There are many issues involved, including safe restraint of the patient and crew, practical and sensibly placed storage of essential equipment and lifting stretcher trolleys in and out of the vehicle. In some circumstances, these potential difficulties can compromise health. Human factors has an important and unique role to play in addressing these hazards and risks.

A new study conducted by Canadian experts carried out a detailed examination of ambulance design and human factors across 13 of the country's provinces, looking at a broad range of metrics including seats, cots, workspace layouts, ingress and egress. It concluded that existing design standards included few performance-based human factors requirements and as a result, principles in this area continued to be considered reactively through retrofit rather than proactively via upstream design.

The study said: "A lack of awareness and knowledge of human factors principles limits the viability of procurement administrators to adequately prescribe performance-based human factors requirements to supplement existing standards. Based on these findings, we propose that performance-based human factors requirements be integrated directly into ambulance design standards."

Worryingly, the paper also said that the human factors barriers found within the Canadian system were not unique. "In fact, these barriers are commonly faced within the human factors community and other industries. Leveraging standards as a means for the knowledge translation of human factors may also address similar barriers to developing safer and more efficient products in other countries or industries."

But what about the situation in the UK? Do the same problems and lack of priority given to human factors exist here? There are currently ten ambulance services trusts in England, each specifying their own design requirements. Scotland has its own single body, the Scottish Ambulance Service, as does Wales with the Welsh Ambulance Services

NHS Trust, and Northern Ireland with its Ambulance Service Health and Social Care Trust.

Sue Hignett, Professor of Healthcare Ergonomics and Patient Safety at Loughborough University and a CIEHF Fellow, has experience in human factors in ambulance design. She helped set up an ambulance risk management system for East Midlands Ambulance Service 20 years ago. She took some of the issues arising from this forward as research, going on to assist in developing the standard emergency ambulance and in researching an increase in clinical capacity in the vehicle and away from emergency departments.

"A lot of the research design concepts have appeared in future design for ambulances," Sue explains. "There is now potential for human factors to be included depending on the local specification. Initially our research was based on musculoskeletal assessment relating to how to get people in and out of ambulances. For instance, there are now state-of-the-art ambulance trolley cots that can climb which are designed to reduce manual handling. A lot of our research was to quantify how much of a risk manual handling was for the staff, not just for loading but also moving patients. Both ambulance vehicles and trolley cots have improved, and you can see much more innovative design."

An ergonomist colleague at Loughborough University, Dr Mike Fray, looked at modularisation for staff working in the patient compartment of ambulances and how the equipment is laid out.

"It's about creating a safe and efficient workspace," Sue says. "It's not just about moving people but also how you provide care and treatment for them. The result of this work was a significant improvement in design and in consideration of human factors", she says. "One of the things we did was to look at military ambulances and field hospitals and how they have modularised their ambulances."

Despite the advances led by the National Patient Safety Agency (NPSA) in 2007, the NHS Trusts in England still have to implement a lot of the improvements suggested by the research. "Unfortunately," Sue says, "the procurement process now seems to have become fairly deregulated. The tendering process is still quite regulated but the specification and the need to use an evidence base, not so much. In 2007, we worked with the National Ambulance Fleet Managers Group using the research from the NPSA to recommend a single design. But now we seem to be back to a situation where every NHS Trust can specify its own ambulance design. There's a lot of variation and we've returned to where we were in the early 2000s."

Another CIEHF member, Graham Forman, is an ergonomics adviser with the Scottish Ambulance Trust and an authority on the implementation of human factors in vehicle design. Like Sue Hignett, he thinks that the UK is ahead of Canada in terms of standards and instead shares common ground with other countries and regions such as The Netherlands, Ireland and Australasia. He believes that there may at times be merit in having some flexibility in ambulance design. "If you're seeking sign-off by a dozen agencies or so, that makes for a very slow and entropic system. However, if you allow a degree of variance, things move on and it allows innovation. For instance, the East of England Ambulance Service is currently doing some bold things and others are really interested to see if they've taken the right approach. Giving trusts the ability to do that allows us to have a debate."

"There can be issues around Type Approval for ambulance design", Graham adds, "where operational requirements can sometimes be felt to clash with vehicle safety. Staff can sometimes feel that the regulations are working against them."

One example is the location of the information screen or cab-based terminal on the dashboard. Crew generally like the unit to be able to freely pivot to make it easier to see, particularly if there's a lot of glare, and for key information to always be available. Safety standards are pushing towards screens being recessed in the dashboard and set at a fixed angle, with certain fields blanking once a vehicle is travelling at a set speed.

We ensure staff and patient groups are involved throughout the design process

Graham concedes that the Scottish Ambulance Service has an advantage in that the lines of communication are shorter than in England. As a single national service, they can engage directly with the Scottish Government. As far as human factors and ambulance design is concerned, Graham says, everything is about compromise. The vehicles are only so big, so moving or adding a piece of equipment will require other items to be relocated "People will tweak here and there, always seeking the magic solution. As far as human factors in Scotland is concerned, we've made significant progress but there's always room for improvement. Like other trusts, we ensure staff and patient groups are involved throughout the design process. Sometimes we think we're there, but then there are game changers such as what base vehicles are available on which to build a new generation of ambulances. But we're always able to evaluate what others are doing, and that's a good thing." ●

Further reading

Design for patient safety: future ambulances and Designing future ambulance transport for patient safety: research undertaken, National Patient Safety Agency (both 2007, National Patient Safety Agency/Helen Hamlyn Trust)
Du B, et al (2020) Exploring the need for and application of human factors and ergonomics in ambulance design: overcoming the barriers with technical standards, *Applied Ergonomics* 88, 103144

IMAGES: ISTOCK / SHUTTERSTOCK

Finding a toilet has become quite a problem, particularly in areas of the country where cafes, pubs and restaurants have been temporarily shut down because of the pandemic. But even when you do find them, public facilities can be difficult to use for many, so how can we make them more inclusive?

Public inconveniences

For a whole range of people, from delivery drivers to people with continence issues and pregnant women, the difficulty of finding a toilet can be a real problem. Even before Covid-19, the number of public toilets had been decreasing as local authorities cut back on spending but Professor Clara Greed, emerita professor of inclusive urban planning at UWE Bristol, believes this is a false economy. The ability to spend a penny is very much linked to improving the local economy of an area and increasing its attraction as both a place to live and visit.

Self-confessed 'toilet obsessed' Professor Greed first became interested in the subject when she was researching the social aspects of planning. She asked members of the public what the main problems with cities were and what they wanted from town planners. Professor Greed explained: "Many people, especially women, said they were concerned about the lack of public toilets as it affected their chances of travelling and accessing the city 'comfortably', especially for those accompanied by small children. In fact, public toilet provision is not a statutory duty on town planning departments in the UK. As a town planner and urban designer, I've been researching and campaigning on 'women and planning' issues for many years and toilet provision is part of that passion."

The sensationalist "mountains of rubbish and human waste" newspaper headlines, after crowds flocked to Britain's seaside resorts this summer, highlighted the issue of the lack of public conveniences. Professor Greed said: "With so many people away from work and unable to travel abroad for holidays because of Covid-19, there is an even greater need for toilets. The 17 million people who usually go abroad are holidaying in the UK but so many of the toilets that used to cater for large crowds of holidaymakers have long since closed."

Professor Greed is not convinced the closure of many of the UK's public toilets for health reasons is the right approach, as she explained: "It can be argued that Covid-19 is not transmitted more strongly in toilets, as it can be found on any surface, especially door handles and rails, in any location. The UK Government keeps on telling us to wash our hands during the Covid-19 crisis but there are very few public places where you can do that."

In addition to campaigning for more toilets, Professor Greed is concerned with the trend towards 'unisex' or gender neutral toilets as a panacea for poor public toilet provision. Local authorities, architects and developers argue that gender neutral

Studies show that gender-neutral toilets exclude people as much as include them

Professor Clara Greed, above, town planner and urban designer

toilets make these facilities more accessible and will help reduce queues for women's toilets but Professor Greed and others say that studies show that they do as much to exclude people as include them.

She explained: "Sticking a gender neutral sign on an existing public convenience does not solve the problem. Just because you're asking both males and females to share the same toilet does not increase the number of toilets, just the number of people using that particular toilet. We need to factor in the importance of gender. In order to create 'toilet equality', it's not enough just to provide equal provision but rather to provide more facilities for women who take longer to use the toilet for a variety of biological reasons including menstruation, pregnancy, incontinence and also having to get into the cubicle and remove some of their clothing.

Professor Greed said: "Another issue with gender neutral toilets is the issue of people feeling uncomfortable mixing in this environment particularly women when they have their periods, both sexes when queueing together, and 'bladder shyness' especially for men caused by anxiety. A women's toilet is also still seen as a separate and safe space for women."

This anxiety is also acerbated by poor design: cubicles too narrow that do not allow people to bring in pushchairs or large shopping bags; very large toilet roll dispensers that impede movement; large sanitary bins that can further reduce room; and doors that open inwards restricting space. And then there is the issue of design and placement of locks, levers, door handles and flushing devices. Professor Greed said: "The less touching of fixtures and fittings and the more automation, the better, provided the mechanisms are serviced and rapidly repaired when they malfunction."

To try to ensure some of these issues are not forgotten, she's a member of British Standards committees, notably BS6465 and BS8300, which address sanitary provision and accessibility of public buildings.

Another fellow campaigner is Jo-Anne Bichard, Director of the Public Toilets Research Unit at the Royal College of Art's Helen Hamlyn Centre for Design, and co-author of *Publicly Accessible Toilets – an Inclusive Design Guide*. She agrees with Professor Greed's concern around gender neutral toilets. She said: "It's not a question of just changing the sign on the door, they actually do require their own specific design."

Jo-Anne's research looks at the issues of an ageing society and the fact that the poor provision of public toilets creates a serious barrier to their wider participation in public life. She said: "Government health messages encourage people to go outside to be active but, in many cases, people find it difficult to go on even short journeys if they know there is no toilet available. With more toilets closed because of Covid-19, this situation has been exacerbated."

Poor provision of public toilets can create a serious barrier to participation in public life

The Publicly Accessible Toilets study looked at the best practice in provision of a range of public toilets including community toilet schemes organised by local authorities, automatic toilets or 'superloos', and accessible toilets. The research team also developed The Great British Public Toilet Map app which provides the locations of nearby public toilets (see www.toiletmap.org.uk).

When you ask Professor Greed what the ideal toilet should look like she puts on her planner's hat and says that it's actually way down on her list of priorities; the first issue is where toilets should be located. She explained: "At a district level, you want them where there is the most footfall, so in city centres, transport interchanges like bus and railway stations, and shopping centres. Then look at a neighbourhood level so there's at least one decent public block of toilets, particularly where there are attractions such as at a local park or beachfront.

"Then look at the location of the toilets and consider accessibility, lighting and visibility. For safety reasons, you ideally want them in the middle of a town and not hidden behind bushes or next to bins. And good signage needs to let people know the direction and walking distance to the toilet. Only then do you look at the design of the actual toilet block and ask if it's good for the user and makes the situation better. Let's start by thinking about what people actually need."

Further reading

Publicly Accessible Toilets – an Inclusive Design Guide by Gail Knight and Jo-Anne Bichard

IMAGES: ISTOCK / GETTY

The trouble with travel

The misery of motion sickness affects millions of people across the world but new research has revealed that training your brain could hold the key to beating the condition, as **Joseph Smyth** explains.

When travelling, a conflict can arise between what your eyes see and the motion detected by the tiny organs in your inner ear. This throws the brain out of balance and can lead to motion sickness. Symptoms can include nausea, dizziness, vomiting and general discomfort.

Motion sickness happens in cars, on planes and boats, in 'virtual reality', and even in space. While encountering it, any sort of productivity becomes impossible and the only thing most sufferers can think about is how to make it go away. However, there could soon be a breakthrough thanks to a new study and a remarkable discovery.

I'm a Research Fellow at the Warwick Manufacturing Group, an academic department at the University of Warwick, and previously led a group of ergonomists that have found that the brain can potentially be trained out of the condition through a series of cognitive exercises involving visuospatial tasks. The breakthrough could change the way people live and work.

We started the work in 2017; we thought it was worth doing because no one had looked at it before. We'd identified from our previous studies that there could be a causal link between natural visuospatial skill and motion sickness susceptibility. But we wanted to know if this skill could be trained – after all, there's limited benefit if you can't do anything about it – and what effect that training would have on motion sickness.

We recruited more than 40 participants to research the utility

of our method in both a driving simulator and in real-world on-road trials. Participants were assigned to either the '3xD driving simulator' at the University of Warwick (a Range Rover Evoque sat within a 360 degree cinema screen) or to an on-road test.

First, we measured everyone's 'baseline' test performance and susceptibility to motion sickness before any intervention was made. This started by working out the participants' visuospatial ability through a standardised mental rotation test.

Then, depending on which group they had been allocated, they drove in a simulator for 30 minutes along a pre-determined route, or sat as a rear-seat passenger as a trained driver took them on a 30 minute drive along a pre-determined on-road route. We then measured the motion sickness they experienced using questionnaires based on pre-validated and widely accepted measures both throughout and directly after the journeys.

Then we devised a training pack based on 14 visuospatial skills involving random 3D rotated shapes and asked each participant to take part for 15 minutes a day over 14 days. That 14 day timescale was important because we know that people become habituated to motion sickness. For instance, if you frequently travel on a boat, you'll get less seasick over time, and we didn't want to re-test participants if they were benefiting from any habituation from their baseline exposures.

After the 14 days, the participants' visuospatial ability was measured again with another randomised mental rotation test. The results were impressive. At the end of the two-week period, the visuospatial skills of the participants improved by an average of 40%.

At this point, the participants were asked to drive around again in the simulator or on-road, depending on their allocated group, with everyone completing exactly the same task as before. When we measured motion sickness again, we found that the first group reported a 51% decrease in motion sickness and a larger improvement of 58% for the second group who took part in the real-world road trials.

The results showed the training had turned out to be very effective. We had fair reason to believe this would be true for the driving simulator trials but were surprised to see the strength of the effect for the real-world on-road trials.

So what happens now? In terms of development and a move towards marketisation, the project is currently between the research and production stages in terms of technology readiness. We plan to go back and delve further into the fundamental underpinnings, conducting research to discover which mechanisms of visuospatial skills are most effective and evaluate the best training regime, including the most efficient time to complete the tasks, how long the effect lasts for, and so on.

The practical real-world application of this ground-breaking research and training also needs to be assessed. We know that it reduces motion sickness in both cars and simulators. So what if we can do it for airline pilots in simulator training and for military personnel? And what about navy crew who suffer motion sickness? If we can reduce it, we can improve their job performance. It could also improve inclusivity; if people currently can't get jobs in these domains because they are susceptible to this condition, then training could change that.

Our team is now looking to carry the project forward by finding partners and new funding. We're hoping to find an organisation that uses simulator-based training that's interested in working with us to develop a tool for their specific application, whether it be physical simulators, or virtual reality based training. Then as the technology develops and we understand it more, it will hopefully filter down to the consumer level and will be available more widely.

One particularly exciting future use is in the rapidly developing area of autonomous vehicles. Drivers of existing manually controlled vehicles tend not to suffer motion sickness as their concentration on the road in front of them means their brains don't become spatially conflicted. In an autonomous vehicle you might effectively become a passenger and be reading a book or be on your phone instead of driving, and few people can do that without suffering motion sickness. But if someone has to take back control of the car because it finds itself in an unusual situation and the person is suffering from even slight sickness, is it safe for them to do that? We have previously evidenced the negative effect motion sickness has on human performance and by definition of this scenario, they'll suddenly be facing a complex situation – if it was simple, the car would have handled it.

This breakthrough could change the way people live and work

Of course, not everyone suffers from motion sickness and some can work productively while travelling as a passenger. But there's a large potential application here; if we can train ourselves to be less susceptible to motion sickness, we really will gain the benefits. The prize of such a breakthrough could be huge as the value of the productivity benefits would be enormous. It's estimated that the annual economic benefit could be greater than $500 billion, which is roughly equivalent to the GDP of Belgium. These are outstanding numbers.

Everyone is familiar with this issue and can understand it. Motion sickness really hasn't seen much research in the past so this is very exciting work.

Dr Joseph Smyth is a Research Fellow at WMG at the University of Warwick. He has a background in human factors research including working for Jaguar Land Rover, who sponsored this motion sickness research.

Further reading

A journal article on the study has been published in *Applied Ergonomics* and is available to download for free for the rest of 2020 at https://doi.org/10.1016/j.apergo.2020.103264

CIEHF will be running events on this topic early next year, given the interest and relevance. The issue will also be discussed within the CIEHF's new Automotive Sector Group led by Joseph Smyth.

IMAGE: ISTOCK

Encouraging early talent

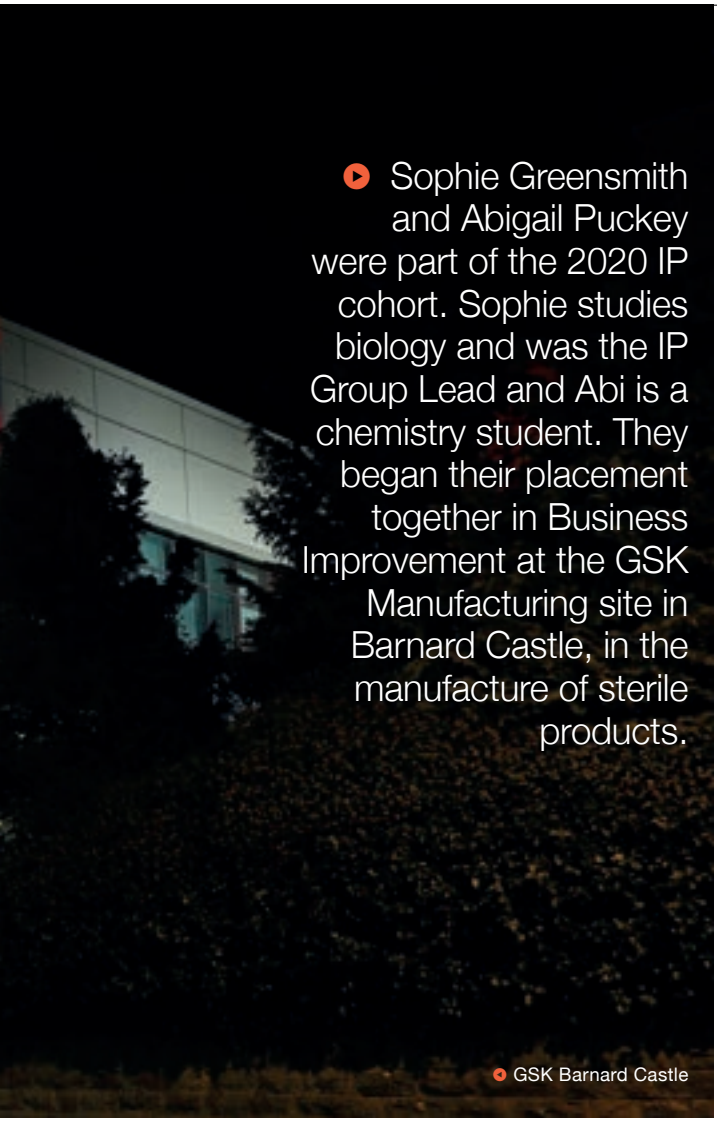
In the UK, over 200 students join the science-led, global healthcare company, GlaxoSmithKline 'early talent' programme each year, with several of them taking up future graduate roles. Inclusion of human factors in the Industrial Placement students' training at the Barnard Castle site has been a revelation, as **Julie Avery** explains.

GSK has three global businesses that research, develop and manufacture innovative pharmaceutical medicines, vaccines and consumer healthcare products. Every day, we help improve the health of millions of people around the world. Our Pharmaceuticals business has a broad portfolio of innovative and established medicines including respiratory, HIV, immuno-inflammation and oncology. The business recognises the value of talented people (see www.GSK.com).

As human factors lead, I coach students that we are all change agents from the moment we arrive in a supportive organisation at whatever level. Trusting we can make a difference brings confidence to our human factors work and helps us deliver performance. We focus on three areas:

- **Reactive:** Problem solving.
- **Preventive:** Mitigating risk.
- **Proactive:** Setting people up for success.

We work to integrate human factors into existing systems to enhance organisational resilience.



Sophie Greensmith and Abigail Puckey were part of the 2020 IP cohort. Sophie studies biology and was the IP Group Lead and Abi is a chemistry student. They began their placement together in Business Improvement at the GSK Manufacturing site in Barnard Castle, in the manufacture of sterile products.

GSK Barnard Castle

Translating human factors tools and language into operational 'speak' is part of our strategic approach. At Barnard Castle we use practical, relevant examples to bring human factors to life and help with everyday challenges and opportunities. We coach people to wear 'human factors glasses' and develop a growth mindset to help see things differently. We integrate human factors into our lean thinking and the GSK Production System.

Our industrial placement students, or 'IPs', join us for a year. We offer insight and technical experience in many aspects of the pharmaceutical industry. We help our students add value in the workplace to make an impact and develop career opportunities.

Students come from a variety of universities and backgrounds and although most study STEM-related subjects (Science, Technology, Engineering and Maths), there are many other opportunities such as business improvement roles. Students bring curious minds, they question and challenge, and their fresh ideas and different ways of thinking can really support our business objectives.

We give our IPs real roles and responsibilities with projects to complete that will have a significant impact →

SOPHIE'S STORY
2020 IP COHORT

Near the beginning of our placement, we joined an introductory session on human factors with Julie Avery. The intention was to widen our interests and explore an area that many of us had not heard of before that we could apply to support site goals. I found this an interesting opportunity to expand my skills and capability and subsequently took the lead in developing a human factors programme for the IP students. The programme grew organically based on feedback from the IPs to align with their interest, curiosity and activities.

We quickly realised human factors enabled many of us to become change agents across the site. A key focus for myself and Abigail was how to increase the pace of digitalisation in process performance management. The cycle of application of human factors and resulting benefit increased interest in the IP human factors programme at our site including by the Site Leadership Team who asked us to help digitise their process performance system. Being able to step out of our placement year shoes and be seen as change agents helped us gain confidence and be respected as peers by colleagues.

The students that took part in this programme had diverse roles in the manufacturing site including engineering, microbiology and supply chain logistics. This strengthened the viewpoint about how universal human factors and growth mindset principles are and how they can be applied. Within the programme, we saw a harmonious link between our learning from the NeuroLeadership Institute (NLI) and human factors. Combining these skills helped us to have better conversations and implement change more effectively.

With some people working from home due to Covid-19, my IP colleagues and I were able to expand our reach with a wider online audience for our human factors and change agent work. I hosted a mini series of webinars on growth mindset and human factors which enabled a greater appreciation and awareness of these disciplines.

Human factors became a familiar part of conversations, and, more importantly, people sought us out to learn more. We found there was legacy thinking that human factors meant human error, but of course, understanding how something happened rather than who made the mistake is the fundamental starting place for any human factors work. We set up focus sessions with manufacturing teams and problem solved how to set teams up for success. Leaders recognised my work in establishing the human factors programme which was very encouraging.

Human factors still plays a key part for me day to day, from conversations with my family about achieving a growth mindset to applying human factors to scenarios at university. I particularly recognised the wider application of this discipline when I attended the CIEHF's Ergonomics & Human Factors 2020 virtual conference, where I could see that human factors is very identifiable and transferable across sectors. My placement year would not have been as rewarding if I hadn't been introduced to human factors. It opened new doors, allowed me to network and most importantly, achieve and exceed my goals and those of the business.

New Aseptic Facility at Barnard Castle

on the business, focusing on Safety, Quality and Efficiency improvements. A supportive manager is key to an IP student's success. At Barnard Castle we have a strong reputation for supporting and developing early talent; the competition to join us is strong and the partnership forged over the year is challenging and productive.

In addition to their technical development, the IPs focus on human factors and change management skills. They ask more effective questions and develop their understanding of human performance behaviours to gain insight into work as done. Sharing their insight with the business helps develop user-centric improvements. The students are now able to describe their new skills in their CVs with examples of using human factors with demonstrable improvements in the business being shared at their end of year graduation.

Students bring curious minds, they question and challenge, and their fresh ideas and different ways of thinking can really support our business objectives

The 2020 group were an engaging and enthusiastic group who soon took the lead in sharing their practical knowledge of human factors to engage others. The IPs achieved much and brought energy, pace and optimism everywhere they went. The 2021 group are now up and running, inspiring all stakeholders with their newfound passion for human factors.

The learning gained from human factors as individuals and as an organisation has helped us improve and set people up for success beyond our original expectations. It also helps us deliver our GSK mission to our patients and consumers: Do More, Feel Better, Live Longer. In these challenging times this mission has never been more relevant.

Julie Avery is Director Human Factors at GSK, BioPharm Supply Chain. With thanks to Helen Smith, Learning & Development Lead – Early Talent at GSK Barnard Castle for her input into this article.

ABI'S STORY
2020 IP COHORT

One part of the human factors sessions that fascinated me was learning about personality types. Recognising that any change needs to start with us, we looked at various personality profile models and used a psychometric questionnaire to highlight personality preferences and behaviours for individuals and teams.

Learning about NeuroLeadership as described by NLI really resonated with my scientific mindset as a chemistry student. It helped me understand the science behind decision making and the link to human factors, for example, how mistakes can occur due to habits created.

Sophie and I initially collaborated on the digitisation of the Tiered Accountability Boards for performance management in Steriles manufacturing. For some time, the morning meetings were completed using a sticky notes system with varying success. Working with the meeting participants, Sophie and I slowly but surely encouraged people to change. The result was a streamlined and effective meeting, that was later used as a standard template for the site.

Julie noticed our ability to act as change agents and challenged us to tackle bigger things by changing the rest of the site's Tiered Accountability Process and Boards, including for the Site Leadership Team. We helped the Leadership Team to develop their skills and nurtured their confidence in the new technology and innovative process. Old habits were exchanged for new.
At the same time, our own confidence grew to implement change. In the IP programme, we learned about change management tools and techniques as shared by Chip and Dan Heath in *Switch Change Management*, which guides people in a cycle of engagement for improvement.

During lockdown some key processes, such as completing a Root Cause Analysis, became more difficult to conduct effectively online and I started to develop a new way of working. I thought if Barnard Castle site had this issue perhaps other sites would find it challenging too, so I contacted GSK sites across the world, building a wide network and found that if you just reach out, people are willing to engage.

I designed material for online engagement and education sessions including a video, which helped me effectively communicate the benefits that human factors and change management could bring. Using our internal communications network and platform allowed us to easily share knowledge globally and get real time feedback.

Exploring the next frontier

The brain contains so many mysteries that discovering its operational principles and internal mechanisms are a significant opportunity to advance human civilisation. At the moment, we're far from that but a new academic journal aims to pave a way forward, as the editors explain.

It's clear that we have a lot to learn about the brain and how it operates. The first step is observing its activity, not only in a limited artificial way but also in an unrestricted, direct way, during everyday life. But what do we stand to gain from a better understanding of the brain?

Well, we could imagine a future where neurological and psychiatric conditions can be treated with ease, and even abnormalities could be predicted before symptoms start. A deeper understanding of the brain can also improve human-technology coupling in diverse sectors such as healthcare, education, transportation, manufacturing, entertainment, communication and everyday life at large. And, eventually, it can enhance natural intelligence and help to develop artificial ones.

Recent advances in neuroscience and engineering have allowed increasingly accessible, mobile and wearable neurotechnologies, providing the flexibility to assess or alter cerebral and body functioning of healthy and impaired subjects in naturalistic settings and bringing neuroscience into everyday life.

Following significant conceptual and methodological improvements within the last two decades, portable neuroimaging sensors, electroencephalography and near-infrared spectroscopy are now widely adopted to study the neural mechanisms underlying human perceptual, cognitive and motor functioning with a focus on real-world contexts. Despite the progress, there are still significant shortcomings that plague their full utilisation, including low spatiotemporal resolution and signal-to-noise ratio. Nevertheless, portable neurotechnologies demonstrate exceptional potential and are poised to transform all aspects of our daily lives.

Accurate measurement and precise modulation of brain activity in a diverse array of everyday tasks is an urgent and needed capability. As an interdisciplinary new field, neuroergonomics aims to fill this gap, understanding the brain out in the wild, its activity during unrestricted real-world tasks in everyday life contexts and its relationship to action, behaviour, body and environment.

This discipline has been summarised by its pioneer, the late Professor Raja Parasuraman, as "the scientific study of the brain mechanisms and psychological and physical functions of humans in relation to technology, work and environments".

A deeper understanding of the brain can enhance natural intelligence and help to develop AI

Our motivation in establishing this new journal, *Frontiers in Neuroergonomics*, was that no single leading publishing platform was integrating all the sub-fields of neuroergonomics. Launched in October 2020 amid much excitement and interest, the aim of the journal is to help develop this new field by providing a forum for cataloguing the research community's achievements.

It was particularly at the first International Neuroergonomics Conference in 2016 in Paris, France, that the community's dire need for a journal was voiced. Later, at the second Neuroergonomics Conference in 2018 in Philadelphia, USA, that need was more emphasised and underlined. But it was after the 2019 Applied Human Factors and Ergonomics Conference in Washington DC, USA, that we, as the trio of Field Chief Editors, came together to tackle this issue and developed a proposal for this new journal that will serve the neuroergonomics community worldwide.

We've already published books and multiple journal special issues with record submissions on neuroergonomics. With the support of leading scientific experts, teaming up as Specialty Chief Editors and Associate Editors, the journal (family) with seven sections was formed.

We look forward to receiving your original papers addressing research innovation and applications of human-centred design, human-technology convergence, human performance, cognitive engineering, experimental psychology and neuroscience. We also welcome articles on neurotechnology design, development, neuroengineering and applications, both wearable and traditional, and real-world task development, virtual and real environments, and other scenarios. We hope that the ergonomics community will benefit from this new interdisciplinary domain and the open-access journal.

For all further details, see the website at **www.frontiersin.org/journals/neuroergonomics**.



Hasan Ayaz, **Frederic Dehais** and **Waldemar Karwowski** are Field Chief Editors of Frontiers in Neuroergonomics

Further reading

Dehais, F, & Karwowski, W and Ayaz, H (2020). Brain at Work and in Everyday Life as the Next Frontier: Grand Field Challenges for Neuroergonomics. *Frontiers in Neuroergonomics,* 1, 1. www.frontiersin.org/article/10.3389/fnrgo.2020.583733

A revolution in 3-dimensional movement capture hardware and biomechanical analysis software offers ergonomists new insights into the workings, and injury mechanisms, of the human body. **Barbara May** and **James Shippen** discuss just how valuable this can be.

Motion capture

Biomechanical analysis is the application of engineering theory to a mechanism, which happens to be a person, in order to calculate the movement of the body (kinematics) and loads occurring within the body (kinetics). This approach is well over 100 years old and has been developing more sophisticated instrumentation and analysis methods throughout. However, much of this work has been undertaken in clinical environments or research laboratories with little leaking into the workplace. But in the last five years the technology has advanced so much it's enabled biomechanics to robustly enter the working industrial environment.

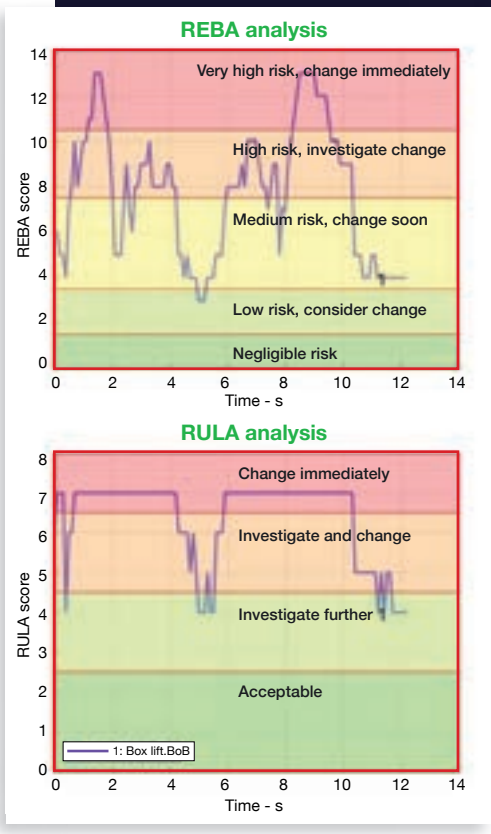
Traditionally protractors have been used to measure posture of the joints but this is limited to 2-dimensional angles and can only be done statically. However, in the last few years sensors have been developed which can measure the 3-dimensional movement of people and objects, in real time and in real places. This is complemented by new analysis software containing biomechanical models of the human skeleton and musculature which can represent individuals or ethnic populations.

In addition, the musculoskeletal system can be animated using the captured motion data and the external forces acting on the person can be measured or calculated. Software can then calculate the torques occurring at the joints, the forces in the muscles, the range of motion of the joints, the trajectories of points on the body and many more biomechanical characteristics.

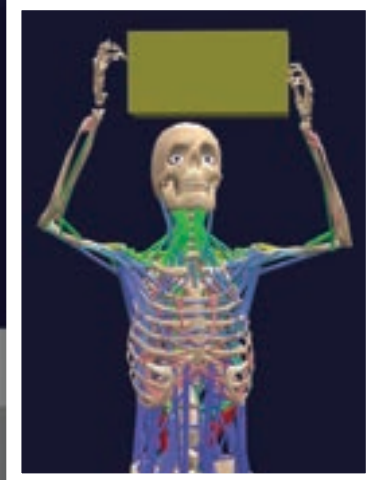
Measuring motion

The biomechanical analysis is typically a two-stage process. The first stage is a measurement of the motion of the subject and of the forces acting on the subject. This objective measurement will be accurate to within a degree. The motion can be directly compared to another individual to investigate and understand the difference between their kinematics or against a sample of a larger population.

Motion capture can be undertaken using a range of techniques which vary in price, accuracy and practicality. Most modern systems use Inertia Measurement Units (IMU) which are low priced, high in accuracy and high in practicality. A full body system typically consists of 17 sensors; within each of these sensors are three linear accelerometers, three rate gyroscopes and three magnetometers (some sensors contain additional functionality). These sensors are attached to the body using elasticated straps or sewn into an elasticated suit. The sensors communicate with a computer via WiFi to reconstruct the motion of the subject.



The trajectories of the hands during a box lift. The skeletal figure synchronises with the RULA and REBA plots for easy identification of good and bad postures.



Analysing biomechanics

Following data collection, the data is loaded into a biomechanical analysis package, such as BoB (see BoB-Biomechanics.com), containing a musculoskeletal model of the human. The biomechanical model can calculate the forces occurring within the body, which can be many times larger than both body weight and the external loads. The biomechanical analysis can also calculate:

- Trajectories of any point on the body
- The velocity vector of any point on the body
- The distance between any two points on the body
- The angle between any three points on the body
- Joint angles
- Joint contact forces
- Ground reaction forces
- Joint torques
- Muscle forces, length, contraction rate, energy, power
- The trajectory of the centre of mass

Extensive graphics may also be available for displaying the musculoskeletal model, the above biomechanical metrics, tabulated data, graphical information, images and videos.

Calculating force

The torques at the joints are generated by the muscles which cross those joints. The human muscular system is massively redundant consisting of over 600 locomotor muscle units to generate 90 torques at the major joints and therefore there is not a unique solution to the muscle force distribution within the body. To calculate the forces in each of the muscles, an assumption is used that the body tries to turn off the muscles as much as possible while still generating the required torques to lift a weight, push an object or just move. This reduces fatigue in the body; a strategy with good evolutionary survival value.

This single, simple assumption enables the calculation of the muscle force distribution across the body and if the forces in the muscles which cross the joint are known, the total contact force at the joint can also be calculated. Knowing the total joint force can be important in assessing the potential for chronic or traumatic joint damage which results from work tasks. Additionally, the maximum force generation potential of every locomotor muscle in the body is known and if the tasks demand a greater force than the muscle can supply, a tear, strain or chronic injury is probable.

Using the data

On completion of the measurement and analysis steps, quantitative data is available on all the movement, forces and torques of the body. This information can be used to undertake an automated ergonomics assessment of the task. But it's more than just a quicker way of performing traditional manual calculations as it offers the following additional benefits:

1 **Dynamic analysis:** the biomechanical model includes the dynamic characteristics of the body, the forces and torques resulting from linear and angular accelerations and the changing moments of inertia of the body and equipment throughout the duration of any movement.

2 **Continuous analysis:** a traditional assessment of a task may be performed by considering a single static posture which is assumed to characterise the whole task whereas a biomechanical assessment can be completed many times every second throughout a task ensuring that potential for harm or injury is not missed.

3 **Sensitivity analysis:** a quantitative approach can provide information on how sensitive the scoring of the task is to each of the design variables. For example, a change in the horizontal reach might affect the score more than a change in vertical reach. Knowing the degree to which each independent variable affects the task helps to identify an efficient route to optimising the task, equipment design and workplace layout.

4 **Comparative analysis:** provides the ability to quantitively compare multiple tasks undertaken by multiple people.

In summary, biomechanical modelling can provide the ergonomist with objective, quantified information on movement and loads within the body. It also enables the calculation of widely recognised ergonomics metrics, including REBA/RULA, NIOSH, ISO11228-1, to conform to industrial standards and legislative requirements.

James Shippen is a Director of BoB Biomechanics Ltd and has a PhD in biomechanics. He's a chartered mechanical engineer specialising in mathematical modelling, simulation and writing analysis code.

Barbara May is a Director of BoB Biomechanics Ltd, has a PhD in biomechanics and specialises in injury mechanics associated with muscle physiology in the workplace.

Further reading

Search YouTube for "BoB Biomechanics" for animations. BoB currently dynamically calculates Marras risk classification, REBA/RULA, the NIOSH revised lifting equation and ISO11228-1 for all times throughout the task.

Performing under

Stressful situations can lead to mistakes being made by even the most skilled and knowledgeable people. In the oil and gas sector, a high-fidelity electrical network simulator provides a safe way for individuals and teams to improve the way they react when the pressure is on.

After hearing about the 'Bad Day in the Office' scenario planned for their final day, most of the delegates undergoing the week-long high-pressured training in the People Factor Consultants' (PFC) power distribution simulator are dreading the upcoming exercise. And, unsurprisingly, for most it does not end well.

Based in Aberdeen, PFC provides a wide range of electrical and human factors training, particularly for electrical personnel in the offshore oil and gas industry. Its high-fidelity Electrical Generation & Distribution Simulator allows the trainers to pile on the pressure to make scenarios as challenging as possible but within a safe environment.

PFC provides courses to enhance an operator's technical knowledge in areas such as high-voltage power systems operations and protection relays. They also give technical grounding in Electricity at Work Regulations or becoming an industry-recognised Responsible Electrical Person but the company has an equal focus on developing non-technical skills.

Scott Moffat is PFC's Human Factors Director and, together with Managing Director Brian Crichton, puts the delegates through their paces: Brian coaches on technical aspects while Scott highlights non-technical skills, particularly when the pressure mounts.

Scott explained: "Brian is a leading expert in the control and management of electrical systems in oil and gas facilities. He developed the simulator with his late wife, Dr Margaret Crichton, who was a specialist in applying human factors in high hazard industries. They recognised the importance of both technical and non-technical skills, which combined can help improve safe and effective performance."

The simulator is the only virtual switch-gear in Europe and gives candidates as close to an offshore experience as possible. They experience scenarios on high and low voltage circuit breakers, main high voltage generators and emergency generation, as well as monitoring and reacting to information from a generator control panel.

"The simulator recreates a realistic working environment, allowing us to assess every aspect of technical and non-technical skills. It enables individuals and teams to train and practise operating the equipment in an interactive, realistic but safe environment."

Scott said that delegates' technical competence is not usually the issue; it's about assessing how they apply their knowledge to an unfamiliar environment and under pressure.

A typical five-day course will involve a relatively relaxed first day as delegates get used to operating the electrical power distribution simulator to manage a virtual network. The non-technical skills are also introduced, together with how the brain normally interprets information and how this changes under different conditions.

pressure

Scott said: "When we introduce the non-technical skills, we ask delegates which one they think they will have no problem with and, without exception, everyone is very confident about their communication skills. They soon find out that this is not the case."

This is evident on the second day when Brian throws in an unexpected time limit on an exercise. Scott added: "The technical problems we set are not particularly difficult. However, by introducing pressure and stress, through imposed time limits, asking them for information and questioning their decisions during the exercise, their non-technical skills become compromised and they make mistakes.

"Communication is often the first skill to suffer under stress; people shut down and typically stop listening to each other and start using their own experiences and assessments that can lead them down to a dark place. Good communication needs verification; information has not only got to be received but also understood.

"Under pressure, the brain cannot take in great amounts of information and process it, so the best way to mitigate this is by reducing the information to bite-sized pieces and using effective communications to verify ideas and proposed courses of action. That's why it's important to ask open questions so the other person has to process the information and give a considered response."

Situational awareness is one of the main skills which gets derailed under pressure. This, in turn, affects decision making as stress creates a barrier between the working memory and the long-term memory, as Scott explained: "The brain is phenomenal but it can also be extremely lazy. If the working memory experiences a problem, the brain may refer back to its long-term memory for a similar incident and solution. If this link is compromised by stress there's a possibility that the brain will identify and attach an incorrect or unrelated past experience, therefore creating a 'false world syndrome'. This is why communication between people is so important to verify the proposed information or the actions required."

Brian Crichton (main photo) at a PFC power distribution simulator

The delegates learn about other 'brain freeze' fixation errors, where people are unable to identify the real issue. 'This and only this' is a classic case of not being able to see the wood for the trees, as Scott explained: "Above one of the switchboards is a large real-time electrical single line diagram which has been purposely designed to be the most salient piece of equipment in the simulator. Once the system trip is initiated, everyone flocks to this screen to attempt to determine the cause of the issue, however the answer is often staring them in the face upon the switchboard itself, for example, a small red light.

Another fixation error under stress is the 'Everything but this' scenario where people overthink the problem and need to step back to assess the big picture. More alarming is the 'Everything is ok' attitude where, just because something catastrophic has not happened, the situation is deemed to be fine, as Brian encountered on a trip to an oil rig many years ago. Scott said: "Brian visited the high voltage switch room and was alarmed to see water pouring down the side of the equipment into a bucket. He called for someone to explain and was told that it had been happening for three days. When Brian challenged the operator, he said everything was okay because they had plenty of buckets!"

Communication is often the first skill to suffer under stress; people shut down and typically stop listening to each other

Scott Moffat, above, PFC's Human Factors Director

Another problem with the erosion of non-technical skills is 'confirmation bias', where people just expect to see what they see. This is highlighted on the second day when an unexpected problem is introduced to the delegates, and very few people spot the error as they do not expect it to be there.

Scott said: "In order to keep confirmation bias in check, operators should make use of procedural aids, such as a simple checklist. The brain can only take in so much information so you need to simplify things. Checklists are a way of slowing down the decision making process and allowing the brain time to take in the information."

As the course goes on the pressure builds and Scott suggests that by day three he can really start to determine someone's true non-technical behaviours. He said: "If they can still hide them by day three then they deserve an Oscar!"

By the end of the course the delegates have been put through their paces and the dreaded 'Bad Day at the Office' is just that but they come away with a much better understanding of how they react under pressure and how to mitigate these reactions.

Scott added: "Experience has shown that bad things can happen to the most technically competent individuals or teams. Ensuring that both technical and non-technical skills are viewed as equally important can reduce the chance of errors and increase safe and effective performance in any high hazard industry."

The CIEHF has long recognised student project work; its Ulf Åberg award for best postgraduate project was first awarded in 1977. Over the years, students have shown creativity and come up with innovative ideas and fresh thinking, and this year was no exception.

The award for Best Student Project went to Ali Cooper for his work on safety management systems and frontline performance in rail. He started studying for his Master's degree at Loughborough University after spending more than 15 years working as a clinical psychologist and was delighted to discover he had been awarded this year's top prize.

Ali said: "I was shocked when my supervisor said he was going to put my project forward for the CIEHF award and I was over the moon when I heard that I'd won – it was a big surprise. I'm really humbled by it and I couldn't have done it without all the support I got from my family."

Runners-up for the award were Chloe Ng, Elena Fratini and Eirik Engelsen. Here, Ali, Elena and Chloe explain what inspired their projects and what they learnt from them ●

ALI COOPER,
SENIOR PSYCHOLOGIST AT THE TRANSPORT

My background is clinical psychology and there's a big overlap with human factors so it wasn't too hard to make the leap. I've always been interested in systems and how individuals and their actions get influenced by the context that they're in. I'm also really interested in accident causality and accident analysis that doesn't seek to blame an individual. All the different components influence an individual on the frontline and it's very rare that someone would be behaving in a way that is counter to safety just because they wanted to. There are many different factors that contribute to accidents rather than an individual just making an error.

The project investigated the impact of safety management systems (SMS) on the railways, particularly looking at how SMS impact on frontline performance of staff. It was quite a broad initial brief which came from an inspector at the Rail Accident Investigation Branch. They had investigated a number of incidents where human performance on the frontline called into question the SMS of an organisation. The inspector was interested in how

RESEARCH LABORATORY

SMS could be conceptualised into a simple diagrammatical representation.

I used a combination of methods in the research and came up with a diagram that looked a bit like a spinning top, which gave a useful analogy to understand safety management systems. The energy of safety has to come from the top but there has to be constant energy through the whole system to make the dynamic process come alive. For example, an important component of a SMS is whether staff are enabled to talk about near misses and safety incidents. If there's a good reporting system and the culture rewards good reporting, then the SMS can learn and adapt. But if you take the pressure off, it starts to slow down. If something is not going wrong people may assume the system is alright. Whereas in fact it might be that people are working around weaknesses in the system or the system hasn't been tested in a certain aspect and when it is, that's when things go wrong. This little spinning top analogy became a good way of conceptualising it.

The railway is a really interesting industry. Thousands of people work on the railway and human factors plays a big part in improving safety, so I thought that this was quite a valuable project. My interest in transport has continued and I now work at the Transport Research Laboratory where we conduct many different research projects, from automation of cars and electric vehicles, to evaluating the driver speed awareness course, to looking at the impact of the pandemic on people's public transport choices.

ELENA FRATINI,
PHD STUDENT AT LOUGHBOROUGH UNIVERSITY

As shopping habits shift from in-store to online, the focus of my project was to use smart mirrors, that is, mirrors with embedded technology, to improve the in-store experience in clothes shops through a user-centred design process.

With the help of the technology and a simple interface, shoppers could see what they might look like in their chosen clothes without actually trying them on. Photos of the users were taken prior to testing and then edited together with the clothing so it looked like they could actually see themselves wearing a garment.

A research method that I found particularly useful for this was the 'Wizard-of-Oz' technique: you control the interface 'behind the scenes' in real time, so it looks like users are actually interacting with a button on a full length 'mirror' in front of them, while in reality they were simply touching a projected image. This made the testing as realistic as possible within a limited budget. This approach could be useful for future projects since it can apply to different types and stages of research within the same project.

The inspiration came from the technology itself and its potential. This type of augmented reality technology can offer much in terms of user experience and when it comes to shopping, it can take away some frustration and speed things up, whilst also making it more accessible and inclusive.

One of the main challenges I encountered was probably learning how to be a good listener during the interviews. Listening well enables you to grasp hints and nuances that can help uncover meaningful and sometimes unexpected answers.

My plan for the future is to work creatively with new and existing technologies to produce a positive impact on people's lives through design. There's an ambitious vision embodied in my current PhD research of exploring the interaction between self-driving cars and pedestrians, through external human-machine interfaces.

CHLOE NG,
MASTERS RESEARCHER AT UCL

In my study, I explored alternative interaction techniques for mobile devices. I was interested in how people would interact with devices in social groups, and how they might enhance social interaction. Eventually, I took inspiration from the gesture elicitation methodology to look into cross-device interaction between two players in a game setting.

I recruited paired participants who already knew each other so that they were more comfortable giving their opinions, with the added bonus that it was also good fun. One of the interesting findings was that participants preferred the more collaborative gestures, those that allowed more interaction with their 'opponents', for example, bumping their devices to transfer virtual objects, the same way you might tap drinks glasses together.

From the project, I've learned important skills in design research, such as effective data visualisation and artefact presentation, so as to disseminate findings in a digestible way for a wide variety of audiences. Now, I'm working in user research for mobile and web applications, as well as doing social data science research. I'm very keen to apply what I've learned from human-computer interaction to my upcoming projects.

Q&A

MEMBER PROFILE

Tina Worthy talks to **Paul Wilson** about his long career in information technology

How did you get into ergonomics & human factors?

My work wasn't as an ergonomist – I had a career in computing but I've been a member of the CIEHF since 1972 when I got my ergonomics degree from Loughborough. I've applied ergonomics opportunistically since then. After graduating, I joined Kodak as a Distribution Division Trainee, and became acquainted with the company's stock control computer systems. After two years, I became a Needs Analyst, acting as the interface between users and the systems department, and heard about the 1974 MICA report on *Man-Computer Interaction in Commercial Applications* authored by Ken Eason, Leela Damodaran and Tom Stewart working within HUSAT at Loughborough. I got a copy and drew upon it heavily over the next five years. I moved to CPC, a corn processing factory in Manchester in 1976, where, among other things, I contributed to the design of an order processing system by writing papers on workplace ergonomics and on job design. I also designed a swivelling workstation to enable one VDU (visual dis0play unit, then very expensive) to be shared by two people.

How did your work in computing develop?

In 1978 I joined the National Computing Centre (NCC) where my job was to seek out best practice and feed it back to industry via books, talks etc. My first topic was 'Human Factors for Systems Designers' and the NCC had already been talking to Loughborough's HUSAT group. Over the next two years, I visited user and supplier organisations and worked with Leela and Alison Simpson at HUSAT to produce the book *Designing Systems for People*. During that period VDU health & safety was becoming a national issue, and the Ergonomics Society (as the CIEHF was then) arranged a one-day meeting on 'Eyestrain and VDUs' which I attended along with over 300 others.

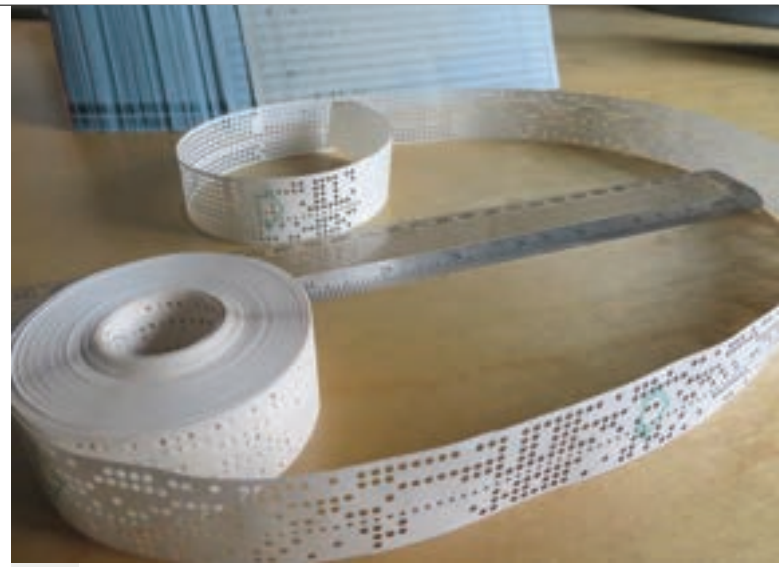
I subsequently orchestrated NCC Management Guideline No 44 Working with VDUs. I was also involved in another Ergonomics Society initiative: its collaboration with the National Electronics Council to produce a report on Human factors and Information Technology in 1983 under the chairmanship of former Society President Ivan Brown and edited by Denis O'Brien.

What other IT systems were coming along?

In 1980, I had moved into NCC's Office Systems Division to research the embryonic electronic office. There I had my first encounter with social media systems (called computer conferencing back then) when NCC joined the British Library experiment to produce a scientific journal electronically (BLEND). The project was run by Brian Shackel, Professor at Loughborough's Department of Human Sciences and former Society President. I was an enthusiast, rushing into work early to log on to the remote system using a teletype printer terminal and dial-up modem.

After a couple of years I joined some of my fellow networkers, including Nigel Heaton, to write a paper online about *Group Working on Mailbox Systems* – an endeavour informed by my conversion to the notion of 'mailbox structures' (adding functionality to simple messaging systems, such as adding a 'like' button). This group subsequently pursued funding for a project to design a Configurable

In 1980 I had my first encounter with social media systems



Punched paper tape and cards

Structured Message System (COSMOS), within the UK government's Alvey Programme. I took my participation in this proposal with me in 1984 when I joined Computer Sciences Corporation (CSC) as a Consultant. The three-year COSMOS project was given the green light in 1986 and was a collaboration between Queen Mary College, the universities of Manchester and Nottingham, British Telecom and CSC.

What was the Ergonomics Society doing in this area?

Also in 1986, the Ergonomics Society established an IT Special Interest Group which created a working party to provide email for the group. We made contact with DEC through one of our members, John Brooke, and in 1987 DEC gave the Society a grant of £70,000 to purchase a DEC VAX computer and the DEC VAX Notes Computer Conferencing software. The system was hosted by Loughborough's LUTCHI Department and we called it HICOM; it went live in December 1987. The Ergonomics Society established an independent body to manage this free-to-use communication facility for all HCI professionals. So, I became the manager of the HICOM Executive in which, for the following eight years, 40+ volunteers (listed in *The Ergonomist*, July 1989), did sterling work running the service. The recently established CIEHF Communities Open Forum Digest is a poignant reminder of those days. However, in the 1990s the hardware and software needed renewing, HICOM had no money, and the Internet with a myriad of competing facilities, was rising. In the end, we bowed to the inevitable and closed the service in 1996.

What other major IT initiatives were you involved in?

Going back to 1986, I had attended the first conference on Computer Supported Cooperative Work (CSCW) on behalf of the COSMOS project. That led to my involvement in organising the first European CSCW conference in 1989, and to an 18-month consultancy assignment helping the UK government's CCTA Computer Agency to research CSCW. In 1991, my CSC management sent me for interview with the Inland Revenue (IR) IT Office in Telford where I was assigned a position within the Systems Architecture Unit.

By 1993 I had created an *HCI Architecture* document and an accompanying style guide which were adopted for use in the design of IR systems.

Then the IR asked me to investigate the potential of usability engineering and I was given an in-depth practical education in the subject by Nigel Bevan and his team at the National Physical Laboratory, prior to making recommendations for the IR to apply the techniques. I subsequently managed the usability testing of taxpayer forms for the introduction of Self Assessment. We conducted the tests using some 50 randomly selected taxpayers in Leicester and Telford.

After leaving my IR assignment in 1995, I spent four years in various CSC architecture projects for large organisations. CSC had recently implemented the Lotus Notes messaging and conferencing system, so I used it to share my IR HCI experiences with CSC's global HCI community by running an 11-month online workshop in 27 parts.

In 2001 I moved into CSC's bidding operation, where I managed bids and documented and improved the bid process. The bids were large; the biggest I worked on and won was worth $2.9 billion. The work was intensive and hours were long and I took the opportunity to retire as early as I could in 2012.

What are you doing now?

I'd decided to use my retirement to explore personal computing applications that I hadn't had time to investigate while working and to record what I was doing in a website at www.pwofc.com. It's proved an effective way to move activities forward, to present a credible image to potential collaborators and to provide a written record which I'll continue to add to.

I've also included these and other experiences in a book called *Sorties into the IT Hurricane*. The contents are accessible online by using the PREVIEW button at www.blurb.co.uk/b/10337345-sorties-into-the-it-hurricane

IMAGES: ALAMY / GETTY

Any last thoughts?

The 'IT hurricane' has transformed the way we live and presented huge challenges for ergonomists and human factors specialists. However, what's coming is probably going to be even more extraordinary and our profession's contribution will become even more important.

What will I find?

Get a real insight into a career in ergonomics and human factors through talks by those who've taken the journey into sectors such as healthcare, defence, transport, energy and design. Find out exactly what an ergonomist does and discover the challenges and opportunities that are out there for you.

What's included?

The day features a series of talks and a lively Jobs Fair. You'll receive:

- ✓ A digital copy of our Careers Guide.
- ✓ A digital delegate pack from our Jobs Fair exhibitors.
- ✓ The chance to listen to and talk to our presenters about what it's like to work as a professional in the discipline.
- ✓ The opportunity to find out about jobs, schemes and openings direct from employers and course providers.
- ✓ Direct access to CIEHF to talk about career pathways and membership options.

What you'll get from this day could change your life!

Looking for someone?

If you're seeking someone to enrol on your MSc course, join your graduate scheme, or to add skills to your team, book a stand at the Careers Day Jobs Fair. Your exhibitor package, which costs £250+VAT, includes:

Before the event

- Publicity for your organisation via logos, links and social media campaigns.
- Your own virtual booth for you to advertise who you are and what you do.
- Material in the delegate pack to inform and attract people to your stand.

On the day

- Playback of your own promotional video letting all delegates know more about you.
- Time to contribute to chat online about work in your sector.
- Your own dedicated break out room to meet with delegates, in a group or 1:1.

For all details about how to book your place, go to

events.ergonomics.org.uk

Chartered Institute of Ergonomics & Human Factors

Notice of Annual General Meeting

The CIEHF's AGM will take place at 17:15 on Monday 19 April 2021 by webinar for the following purposes:

- To receive the minutes of the 2020 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
- Council Members (trustees)
- Professional Affairs Board Members

Nominations are sought from Associate Members for the following position:

- Associate Member Representative on Council (trustee)

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 5 March 2021.

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 19 February 2021.

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

Sad loss

We're sad to announce the passing of Professor Nigel Corlett at the age of 97. He was a long-standing supporter of the CIEHF and will be remembered for his significant contribution to the discipline and as an influential colleague and mentor to many. We'll be celebrating his life in an obituary in the next issue of '*The Ergonomist*'.

Become a leading light

If you're a Registered Member, Fellow or Associate Member of the CIEHF, and you'd like to understand how a professional membership body is organised and run, please consider standing for Council. You'll become a trustee of the organisation and will be able to contribute to and influence the strategic direction we take over the next few years, enabling us to fulfil our mission of becoming the pre-eminent professional home and voice for human factors.

Alternatively, if your interest lies in standards of professional practice and you're a Registered Member or Fellow, please consider standing for a place on our Professional Affairs Board. You'll be setting requirements for individual accreditation, ensuring our career pathways enable people from all backgrounds to join us and get the support and recognition they deserve. You'll also influence our course accreditation criteria, improving the scope and quality of education and training in ergonomics and human factors.

If you'd prefer to take a more prominent role, spearheading projects and representing the Institute, please consider standing for the position of President. In your first year, as President Elect, you'll join our Executive Committee, bringing with you, your reputation and expertise in the discipline. Your second year will bring your thought-leadership to the fore as President, and your experience in the role will lead you into a guiding position in your third year, as Past President.

For all positions, you'll meet and work with other members at the heart of our community in a rewarding voluntary role over your three year term. You'll make an important contribution in helping us to become a world-class organisation and ensuring our discipline stays firmly on the map.

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 community spirit

A year coming to an end is often a time for reflection and making plans or New Year resolutions. For me it's also a time to think about my first year as Membership Manager of the CIEHF. In brief so as not to bore you with details – I'm loving it!

While I didn't know anything about human factors before I started, I'm fascinated when I hear or read about what all of you are doing. Everyone's aim is to help others and make the world a better place – clearly not an easy feat but you are tirelessly doing just that. I get a glimpse of which challenges can be overcome and how you and your work make a difference.

Not surprising then that I found so many members to be very kind and helpful, and willing to invest their time and expertise to help other members, the Institute and the discipline. I'd like to share a telling example from a recent Regional Network meet-up on Zoom. In a small break-out group, a member was asking about experience with writing papers as it was her first time doing so. Within seconds, another member encouraged her to give it a go and yet another volunteered to assist her in getting started. It was amazing to watch!

This spirit of helpfulness, the willingness to assist each other and share findings, also shows in our Communities forum, which has become the resource of support, information and discussion we'd hoped for. Some of you may think it's just part of what you do but I think it's also something that makes the human factors community special.

Finally, the end of the year is also a time to say thank you. So many of you volunteer to help and without you the Institute could neither function nor make a difference. We know very well that your time is scarce and there are lots of other priorities, which makes us even more grateful for your continued support. Thank you!

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.

Registered Membership

- Ian Hartwell
- Julie Goddard
- Rebecca Cooke
- Teodora Stefanova
- Sarah Johnson
- Aiza Ahmad
- Colleen Butler
- John Philip
- Peter John Pisula
- Matthew Godbold
- Robert Pringle
- Katie Parnell

Technical Membership

- Natalie Meehan
- Robert Gilbert
- Susan Nicklin
- Katie Potter

Fellowship

- Robert Cummings
- Paul Chesham

CIEHF events at a glance

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 2021, online	A well-established and popular event giving real insights into a career in ergonomics and human factors, for students, new graduates and all those looking for a change of direction.
Ergonomics & Human Factors 2021	Mon-Wed, 19-21 April 2021, online	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.
Comfort Congress 2021	Thu-Fri, 2-3 September 2021, Nottingham	A CIEHF-supported, cross-sector event exploring comfort in transport systems seats and interiors, beds, noise, vibration, temperature and wearables.

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

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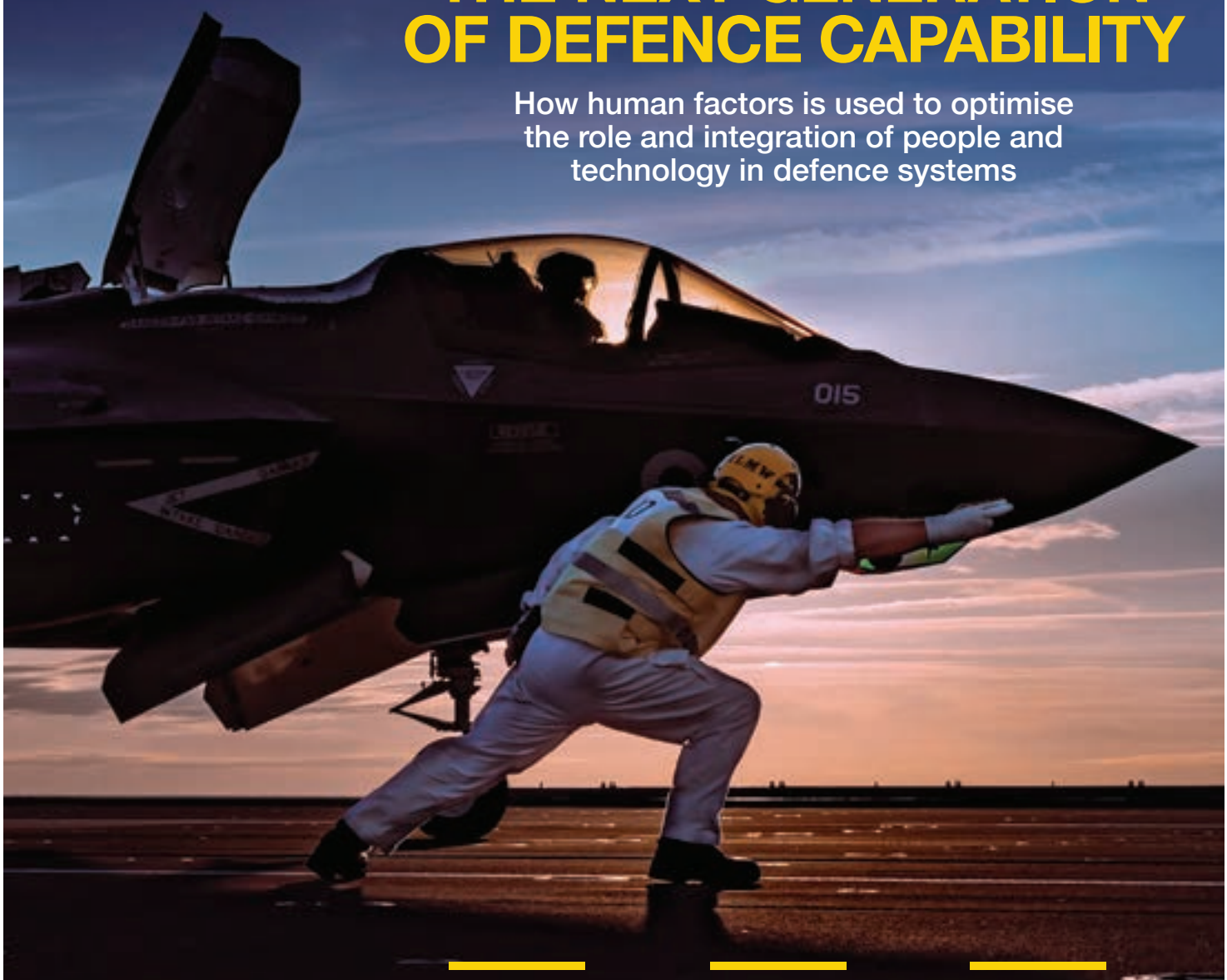

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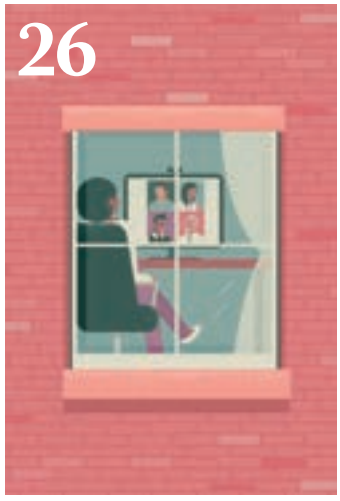

RESEARCH MATTERS

CIEHF NEWS

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FROM THE PRESIDENT

Moving on

Amanda Widdowson
CIEHF President

president@ergonomics.org.uk

Preparations for our annual conference, EHF2021, taking place in April, are well underway. We decided to make the whole event virtual again this year in the light of restrictions associated with the pandemic. I hope you can join us. Of course, this means I will have spent the whole of my Presidential year without a face-to-face event. I am naturally disappointed not to have been able to talk to you in person but it was necessary given the circumstances. I'm hoping to be able to see some of you at a CIEHF awards event in the summer, restrictions allowing. By that time, I will have transitioned to the role of Past President and Chair of the Honours Committee.

I'm looking forward to welcoming a new President Elect and Council members at our AGM in April, where I'll also hand over the Presidency to Chris Ramsden. Standing for President is a three-year commitment, serving on the Executive Committee. The first year is spent as President Elect, the second as President and Chair of the board of trustees (Council), and the third as Past President. If you would like the opportunity to shape CIEHF strategy in this position, please contact myself or our Chief Executive, Noorzaman Rashid.

The CIEHF five-year strategy was created under the leadership of my predecessor, Bob Bridger and former CEO, Steve Barraclough. At the last Council meeting, we discussed focus areas for 2021 proposed by Noorzaman and presented in the last issue of *The Ergonomist*. Highlights include a new learning management system to enhance access to resources and continuous professional development activities. We will also progress development of a UX Learning Pathway, consider the feasibility of specialist Chartership grades and continue to raise the profile of human factors. I will retain the 'Design for Everybody' diverse anthropometry project so if you haven't had a chance to using the tape measure and guide sent with the previous issue yet, you're not too late! I'll give an update on the project at EHF2021. Thank you for your support.

You have an opportunity to help shape CIEHF's strategy

FROM THE EDITOR

Reaching far and wide

Whilst the pandemic still dominates, there's much human factors work on a variety of other fronts. Our cover article highlights the many projects being undertaken to ensure human capability is maximised across our defence services. Laird Evans and Steve Harmer introduce the CIEHF's Defence Sector Group and a set of case studies illustrates the range and impact of human factors integration in the sector.

A thought-provoking piece by John Lovegrove discusses the requirements for a move from a linear to a circular economy and how our discipline can play its part. We learn about the extent of ergonomics education and practice in Iran, and Ron McLeod introduces work on a new CIEHF White Paper on human factors in automation. The potential advantages of technology in healthcare, specifically the use of AI, is the topic of a piece by Mark Sujan.

Of course, there is still plenty to report on the Covid-19 situation. We gain insight into Scotland's pandemic response from Professor Jason Leitch, the country's National Clinical Director. Peter Buckle shares his experiences of collaborative work in Covid testing, and Helen Vosper discusses the background to a new guide on clinical decision making. Research into the cognitive effects of home working for the masses and all it entails, is reported by Rob Houghton.

For those that can venture out, one form of exercise that's proving increasingly popular is cycling, although not many would venture as far as Alex Stedmon, who explains, in his article, the attraction of long-distance rides.

Tina Worthy
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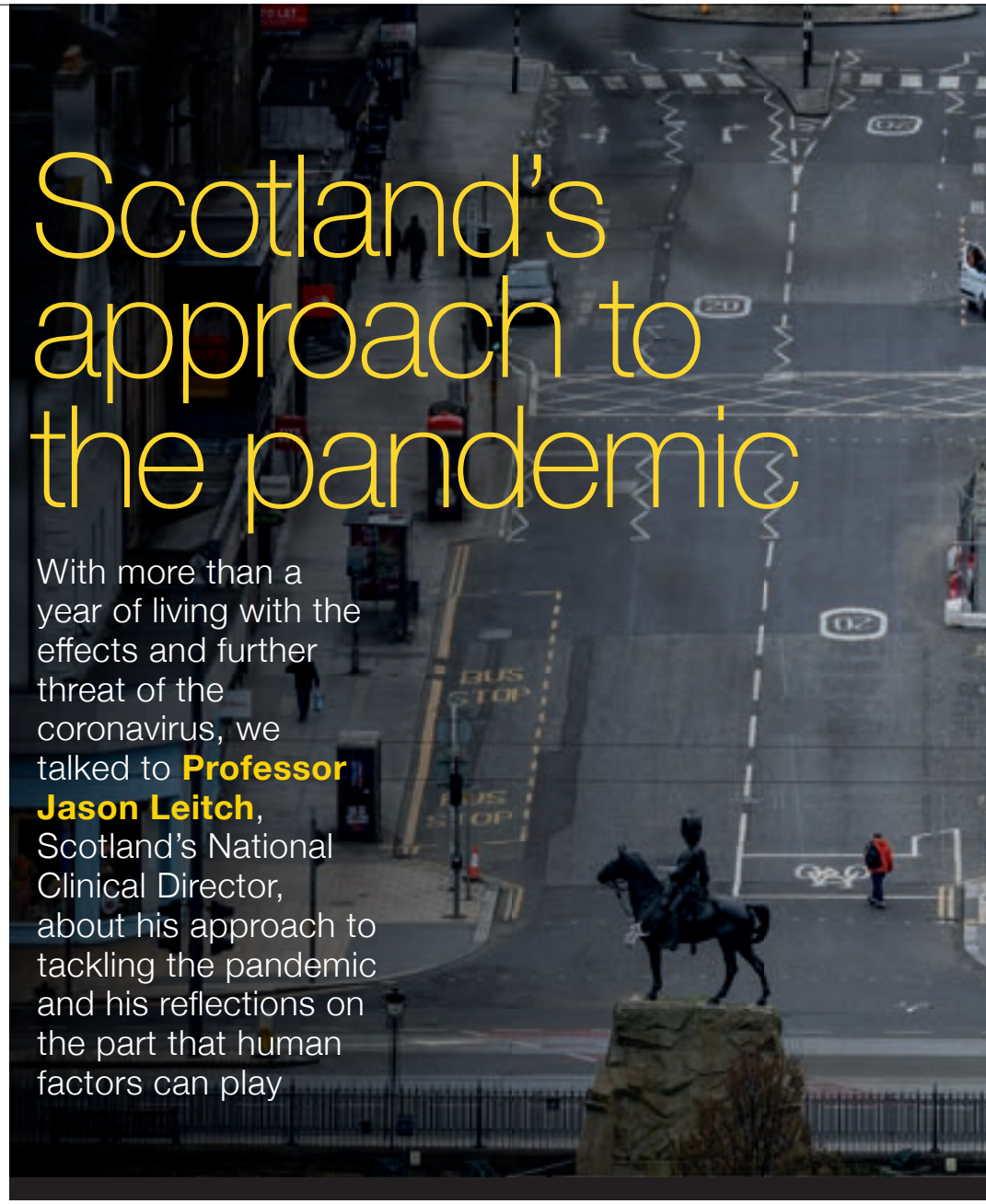
@ciehf



Scotland's approach to the pandemic

With more than a year of living with the effects and further threat of the coronavirus, we talked to **Professor Jason Leitch**, Scotland's National Clinical Director, about his approach to tackling the pandemic and his reflections on the part that human factors can play

It seems like a long time ago. Not Monday 23 March 2020, when we entered the first lockdown, but Tuesday 26 May. That was the day when the number of daily cases of Covid-19 in the UK had fallen from a peak of more than 5000 to fewer than 2000, and deaths from more than 1000 to fewer than 200. In Scotland, the equivalent figures were down from 776 to 66, and from 63 to 16 respectively.

On that Tuesday in May, Scotland's National Clinical Director and the public face of the country's response to coronavirus, Professor Jason Leitch, took part in a webinar, 'The new normal: sustainable leadership lessons from lockdown', organised by the Royal College of Physicians and Surgeons of Glasgow. It was a moment for reflection on the most challenging health crisis to face the world since the 1918 flu pandemic. It was also – at the time – an opportunity to look ahead with a degree of optimism; the Scottish Government had published its 'route map out of lockdown' and, on 29 May, restrictions in Scotland began to be eased.

"I feel both hopeful and nervous," said Professor Leitch in an interview via email. "Hopeful, because it's the first day of the lockdown release. But I'm also nervous, because there are still 800 people in hospital and I worry about the future of this viral pandemic."

Professor Leitch qualified as a dentist in 1991 and was a consultant oral surgeon in Glasgow before becoming a Quality Improvement Fellow at the Institute for Healthcare Improvement in Boston. He joined the Scottish Government in 2007 and in 2020, he became the public face of Scotland's efforts to combat Covid-19. While First Minister Nicola Surgeon is preeminent, Professor Leitch has been the person that the Scottish public regards as the voice of authority.

In his webinar presentation last May, Professor Leitch put up a slide showing a 'driver diagram' which he and his team used as the basis for its advice to the Scottish Government on shaping and managing the response to the pandemic; in part, a human factors-based approach to influencing people's behaviour. It asked:

- What is the mission? To reduce deaths from coronavirus, to reduce non-virus harms to the population, and to keep health and care staff safe and supported.
- How? Through clear, accountable leadership.
- Using? Open and transparent communication, by creating a safe culture, and through reflective practice and support.

In the webinar, Professor Leitch described his approach to team-working: "I surrounded myself with a group of people who I trusted, who I thought would be helpful. Not all exactly the same as me; a lot of different individuals with different skills who would also hold me accountable." He also spoke of the importance of tapping into networks in Europe and around the world for support and insight, his admiration of Alaska's Nuka system of care, and the part played by family and friends in maintaining personal resilience.

The note of caution he sounded in that interview last spring proved justified; as winter set in, the nations

Frederick Street in Edinburgh, one of the main city centre thoroughfares, during the coronavirus pandemic

IMAGE: GETTY

of the UK endured varying levels of renewed strictures. Worse was to come, but, six months on from the webinar, we wanted to find out from Professor Leitch what role he thought human factors had played in how Scotland had managed the pandemic, and could this science be used more effectively as we looked ahead to 2021 and beyond.

When we spoke to him towards the end of November 2020, there was a repeat of his optimism tempered by wariness. "Well, the news around vaccines is good," he said. "But the virus is still here." A month later, the UK was bracing itself for a return to full lockdown. What role did human factors play in his job? "My recent career has taken me down a lane of quality and systems improvement. Within that, there's an awareness that human factors has to be incorporated into changes you want to make, whether it's theatre checklists or [the design of] door handles," said Professor Leitch.

"We've been teaching quality improvement techniques, including human factors and design, throughout the Covid response. I wouldn't say it has been 'front and centre' but it's part of the scientific jigsaw of how we respond."

Could the way in which human factors is applied in complex systems such as healthcare, aviation and the energy sector be extended to the system that is society? "I think that's a big stretch," he said. "I think what we've used is, in its broadest sense, behavioural science. As well as SAGE [the Scientific Advisory Group for Emergencies], there are advisory committees within that ecosystem, such as the Scientific Pandemic Influenza Group on Modelling and the Independent Scientific Pandemic Insights Group on Behaviours. So, as well as understanding how viruses work, we can understand how people work.

We've been teaching quality improvement techniques, including human factors and design, throughout the Covid response

Professor Jason Leitch is Scotland's National Clinical Director and an Honorary Professor at the University of Dundee

"The scientific advisory group in Scotland also has behavioural scientists on it, so they can tell us how people will respond if you put in place travel restrictions or if you close hospitality but allow people to meet in homes. Inside the decision making is an understanding of behaviours which – if you look through a slightly squinted eye – you might end up in human factors because, for example, you want testing available where people are, and you want vaccinations to be easy to get."

What has been learnt since March last year, through those initial periods of optimism and back again to where we are today, and how will that shape thinking going forward? "I think the virus is nasty," said Professor Leitch. "It's been nasty since February 2020. So, the science, the policy and the human behaviour elements evolve; you learn much more about transmission, about the use of face coverings, what works what doesn't work. You learn also about how cultures, politicians and systems around the world respond. The virus is the same everywhere but the healthcare system design, the demographics, the way people live is all different."

The way in which governments and systems around the world have responded to the pandemic has, unsurprisingly, become the focus of academic study and the public's opinions of their government's response varies widely from country to country.

"On a human level, I think we've done well," said Professor Leitch. "We've learnt a great deal. We have, with good motive, done our best. Whether the system has done well in the longer term that will be a matter for public inquiries and for historians to write about. The fundamental behavioural science lesson is, don't blame people for catching the virus; bring them with you, in a positive way, to help solve this crisis." ●

Further reading

Covid-19 in the UK: https://coronavirus.data.gov.uk/cases

Webinar, The new normal: sustainable leadership lessons from lockdown: https://rcpsg.ac.uk/college/covid-19/digital-education/the-new-normal-sustainable-leadership-lessons-from-lockdown

Alaska's Nuka system of care: www.kingsfund.org.uk/publications/population-health-systems/nuka-system-care-alaska

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Prof Sarah Sharples
University of Nottingham

Prof Peter Buckle
Imperial College London

Prof Paul Bowie
NHS Education for Scotland

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Prof Hasan Ayaz
Drexel University, PA

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Dr Kritina Holden
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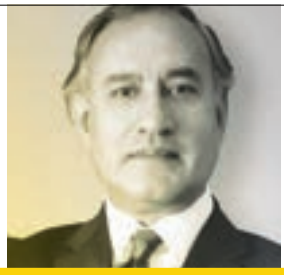


A healthcare worker prepares a coronavirus vaccine dose at a medical centre in Edinburgh

CHIEF EXECUTIVE'S PERSPECTIVE

A busy and exciting start to the year

Now that we are well into 2021 it's clear that the impact of the pandemic continues to make deep scars on how we live, work and perform, now and in the future. The Institute is continuing to play a proactive role by responding to emerging issues with much help from our members, using our discipline and all that it has to offer. We are proud to have over 100 volunteers registered to support us in these endeavours.

CIEHF has joined forces with NHS Education Scotland to support the safe design of mass Covid-19 vaccination centres. The initiative is led by Professor Paul Bowie and key contributors include Janette Edmonds, Courtney Grant, Mark Sujan, Helen Vosper, Sue Hignett and Chris Ramsden. We have support from ISQua (International Society For Quality In Health Care), Patient Safety Learning and the International Ergonomics Association. Research and information is being collected internationally to help ensure our guidance will have relevance across the world. Guidance will be produced for healthcare leaders later this month followed by further guidance for those responsible for establishing vaccination programmes. If you'd like to contribute to this project, please email me or volunteer here: **https://covid19.ergonomics.org.uk**.

Working in partnership with Loughborough University, the Royal College of Nursing RCN, Health Education England and others, we will launch our Healthcare Learning Pathway in the Spring in response to the Patient Safety Agenda arising from the NHS. We hope that this will lead to more qualified human factors professionals working across NHS Trusts in the UK.

The issue of working from home and the future blended, dispersed work landscape is evolving. Here we're collaborating with others including Leesman, a world-leading independent authority on employee experience at work and at home, who use business intelligence tools to analyse work experience (www.leesmanindex.com). Digiworkz is our other partner in this space (www.digiworkz.com). Here we're exploring how organisations can build a culture that supports successful collaboration whilst working remotely. Our own guide on safe working at home was referenced in a recent BBC article, so well done Kirsty Angerer and Ed Milnes, our Workplace Sector Group Leads, who wrote the guidance!

We're emerging as a world-leading network for professionals

The next guide on *Human Factors in Architecture and Design* is being led by Lillian Antonio of our Workplace Sector Group. This will look at how our discipline should be influencing the design of the built environment.

During 2021 we'll build on our exciting online programme and we'll create more publications. This will be further reinforced by our membership groups. John Lovegrove and Christian Wilhelm co-lead the Nuclear Sector Group and are planning three events. Joseph Smyth and Filip Florek co-lead the new Automotive Sector Group. They have four events planned for 2021 and have already published two documents. All our online events are available on-demand from here: **https://events.ergonomics.org.uk**.

Our Ergonomics & Human Factors Conference, EHF2021, will follow last year's successful online event but this time over three days. We have more presenters from global organisations this year including NASA, Airbus, BAE Systems and more. At this year's conference we'll also be launching two more new Special Interest Groups, one on neuroergonomics and another on cybersecurity. We aim to make this the most enjoyable and interactive online event of its type! Find out more at **https://conference.ergonomics.org.uk**.

In particular, I'm looking forward to the contribution from Richard Browning, inventor and entrepreneur, on how he has overcome some of the ergonomics issues in the design of a jet suit. Dr Kritina Holden from NASA will also be discussing her work on astronauts' interaction with computers.

I'm also delighted to report that in 2020 we recruited 330 new members against our target of 200. This is further evidence that CIEHF is emerging as a world-leading network for ergonomics and human factors professionals. Whilst CIEHF has several LinkedIn groups, I would encourage members to visit our *Communities* discussion forum to join conversations, post research news and ask for advice from other professionals; it's fast becoming one of the most effective ways to get assistance from other members.

I'd like to give a 'shout out' to some of our Corporate Sponsors for EHF2021: Cardinus, Digiworkz, Osmond Ergonomics, Elsevier and Greenstreet Berman. Rebus Medical and K Sharp are theme sponsors. Do contact me directly if you'd like to discuss sponsorship opportunities.

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

noorzaman rashid

Perspectives from Iran

Home to one of the world's oldest civilisations and largest historical empires, Iran has a colourful history and a important place in the Middle East. **Payam Khanlari** explains more about the country and its efforts to increase ergonomics knowledge and practice

Iran is a diverse country, with a population spanning many ethnic and linguistic groups. Its civilisation dates from the fourth millennium BC and reached its territorial height in the sixth century BC, when Cyrus the Great founded the Achaemenid Empire. It stretched from Eastern Europe to the Indus River, making it one of the largest empires in history.

Iran is still a vast country, one of the world's most mountainous. It's the second largest by land mass in the Middle East after Saudi Arabia, and the second most populous after Egypt.

Iran experiences 11 of the world's 13 types of climate, ranging from arid and semi-arid, to subtropical. Its highest point is the 5610m Mt Damavand and its lowest is 28m below sea level on the shores of the Caspian Sea in the north.

Iran's labour force in 2017 was 30.5 million people and of these 16.3% were employed in agriculture, 35.1% in industry and 48.6% in services. Iran has leading manufacturing industries in vehicle manufacture, transportation, construction materials, home appliances, food and agricultural goods, armaments, pharmaceuticals, IT and petrochemicals. According to the 2012 data from the Food and Agriculture Organisation, Iran has been among the world's top five producers of many fruit and nuts including apricots, dates, aubergines, figs and pistachios.

Iran's carpet-weaving industry dates from the Bronze Age, and Iran is now the world's largest producer and exporter of handmade carpets, producing three-quarters of the world's total output.

From 1970 to 2000, ergonomics was introduced to Iranian academics through university courses and workshops by professors including Dr Houshang Shahnavaz and Dr Nader Kavoussi. An ergonomics workshop for a group of Iranian university lecturers was run in May 2000 at Tarbiat Modarres University in Tehran and a group was assigned to prepare the ground for the establishment of the Iranian Ergonomics Society (IES).

After a year of hard work by the group, the IES was accepted by the Commission for Scientific Societies of the Iranian Ministry of Health in February 2001. The first election of board members was conducted in May 2001 and the IES was formally accepted as a Federated Society of the International Ergonomics Association (IEA) in 2003. Currently, the IES has 670 members.

Published in Persian, the society's journal was launched in 2013 with English abstracts and is indexed nationally and internationally. The society has organised a biennial conference in Iran since 2014 and the next conference will be held in March 2021 in Shiraz.

Ergonomics was adopted as an academic discipline in Iran in 2007 at Master's level and is currently taught in 12 universities, including Tehran, Hamadan, Shiraz and Tabriz. In 2014 it was adopted at PhD level as a highly specialised discipline in four universities where there are good laboratory facilities and infrastructure.

Given that ergonomics in Iran was initially separated from the field of

IMAGES: GETTY

occupational health, most students and professionals in ergonomics have an occupational health background. However in recent years, students with degrees in industrial design, biomechanics, mechanical engineering, occupational therapy, etc. have been attracted to the discipline. In general, occupational ergonomics is the most advanced branch of ergonomics in Iran.

In the last decade as ergonomics graduates have started working in industry, the field has become relatively well known, considering the small numbers of graduates, both among engineering and social science professionals and among industry executives. It could be said that ergonomics skills in Iran are the highest in the region and in some neighbouring countries, there is no academic field of ergonomics at all, so Iranian professionals often take the opportunity to share their knowledge with their neighbours.

Many research papers have been published focusing on workers in the main industries. A 1976 paper by Nader Kavoussi called 'Ergonomics in traditional Iranian industries' published in the *Journal of Human Ergology* reported excessive fatigue in carpet weavers and a proposal for a design of a metal loom to improve musculoskeletal health.

A 2020 paper published in the journal *Work*, called 'Assessment of occupational safety, health, and ergonomics issues in agriculture in some cities of Iran' carried out a study involving 430 villages with the help of rural health centres. Many further studies have been published including in areas such as television assembly, academic laboratories, dentistry and concrete manufacture.

Iranian workers in Eshtehard Industrial Town producing masks for the pandemic

Ergonomics was adopted as an academic discipline in Iran in 2007

Iranian workers work at Kachiran Sewing Machine industrial factory, in Qazvin

Although Iran is one of only 50 countries that have an ergonomics association and a university degree, there is still a lack of skilled ergonomists in the various industries, agriculture and the large service sector. So there is a need to expand existing knowledge of the discipline but the necessary infrastructure for ergonomics in the country must be provided first.
The transfer of knowledge and technology requires more world-renowned professors or students gaining places at major universities to acquire knowledge.

In recent years, a number of companies producing ergonomic products have been established in Iran, They focus more on the production of chairs and ergonomic equipment related to computers, although ergonomic industry-related projects have also grown well.

I and several ergonomics students founded the Ergonomics Student Magazine (ESM) in 2018 and it has grown well since then and enables wider understanding of ergonomics for its readers. The goal of the ESM is to contribute to the dissemination of ergonomics information not only among students but also to create ergonomics awareness among as many people as possible. Introducing ergonomics to industries in Iran and training employees and management in ergonomics know-how and practice is another main focus of the ESM.

Given that ergonomics is related to people's health and this issue is more important in developing countries such as Iran, the need for ergonomics development is felt more than ever. I urge all ergonomics enthusiasts to do their utmost to advance this field. We in Iran and at the Ergonomics Student Magazine welcome any help and collaboration to improve ergonomics knowledge. I wish good health and happiness to all ergonomists around the world. ●

Payam Khanlari is the chair of the Ergonomics Student Magazine and a Master of Ergonomics at the Hamedan University of Medical Sciences, Iran. He can be contacted at p.khanlari@edu.umsha.ac.ir

Further reading

Iranian Ergonomics Society website: http://www.iehfs.ir

Taking a more rounded approach

We're currently experiencing the perfect storm of events which are rapidly changing how we live and work. **John Lovegrove** explores the changes, the drivers influencing change and the behaviours required to adapt. How can the human factors community support these developments and smooth the transition to a different way of living?

The concept of a circular economy, that is living closer to nature, only using what is absolutely necessary, is as old as our ancestors, when survival would rely on the skills required to catch, preserve, repair, reuse and recycle when resources were scarce. We have managed it before and can manage it again.

The TV series *The Good Life* followed the ups and downs of trying to escape modern commercial life by being totally self-sufficient, what in recent times has become known as living 'off-grid'. There are currently 75,000 people living in around 25,000 off-grid homes across the UK. The homes range from caravans, cabins, cob houses and modern eco homes. Living off-grid is not easy but schemes like the Welsh government's One World: One Planet project help the few that are resilient enough and patient enough to build that life.

The current UK population is almost 68 million people so in order for us to make a meaningful difference in the fight to save the planet, we must embed the principles of off-grid living into modern life for all. It's generally acknowledged that the model of self-sufficiency and living off-grid is not realistic or achievable for an entire nation to achieve, so instead we have to look at creating an infrastructure based on those principles: small footprint, reduction in landfill waste and more energy conservation.

The circular economy

In a circular economy, growth is decoupled from the consumption of scarce resources. Products and materials are kept within productive use for as long as possible and when they reach end of use, they are effectively cycled back into the system. Arriving at true circularity means rethinking and transforming full value chains to create a system in which waste is designed out entirely and the goal is net positivity (adding instead of extracting resources) through restorative models.

Writing in his book, *Forget Mars: The Circular Economy, The Next Big Opportunity*, Stephen J Wright identifies six processes to help businesses to transition to a circular model and profit as a consequence. They are:

- **Loop:** Feed back waste products into the production system. This could be your waste or you could sell the waste to another organisation who use it as a raw material.
- **Exchange:** Encourage and develop a culture of exchange amongst your consumers (i.e. offer part exchange).
- **Virtualise:** Create the virtual office, this reduces overheads associated with running an office and reduces unnecessary commutes.
- **Share:** Your business should also build a culture of sharing and borrowing. Consider renting equipment and sharing with other companies instead of owning everything.

IMAGE: GETTY

- **Optimise:** Every single resource available to your business should be optimised. For example, look at retreating wastewater for reuse to reduce the demand for fresh water.
- **Regenerate:** It may not be possible to refurbish and convert all old products into new ones but there may be some components or parts that you can use as raw materials in making new products.

But how is any of this relevant to the human factors community? Are we able to support businesses as they transition from the linear to circular economies, and can we define our role?

Supporting the circular economy movement

Reflect on your own job role. How many of your current skill sets are transferrable and relevant for supporting the human to innovate and implement new systems of work and living? In my opinion, we should consider the general principles of our discipline:

- Systemic analysis i.e. breadth and then depth.
- Inter-disciplinary approach i.e. an inclusive approach that encompasses the findings of all interfacing disciplines.
- Goal-orientated task analysis.
- Stakeholder identification and engagement.
- Target population identification and characterisation.
- Products, systems and services designed for all.
- Physically and mentally healthy experiences available for all, whether at work or at home.

The list above is not exhaustive. I haven't explicitly called out safety or quality principles because they're measurable consequences of good or bad human factors. If we fail to apply the general principles of human factors then there will be consequences that usually manifest as safety, quality and productivity problems.

We are ready to support but how do we get discovered by the circular economic movement?

Moving from one model to another

In the last couple of years, the CIEHF has taken great strides to increase the visibility of our discipline. A notable yet under-publicised step is the publication of BS EN ISO 27500:2016 and BS EN ISO 27501, *The Human Centred Organisation.* These standards provide the building blocks for transitioning an organisation from the linear economic model to the circular model from the human perspective. Building a framework that encourages innovation and collaboration within an organisation and between organisations. Not being frightened of the unknown but embracing it. Enabling your workforce to feel free to roam and explore without constraint.

During the lockdown, I received my first enquiry from a business dedicated to the regeneration of waste, The Orthios Eco Park in Holyhead. The company is building a world first, the Tech 5 Pyrolysis Plant, which regenerates waste plastic and produces hydrocarbons that can be reused, such as oil and bitumen.

We're ready to support but how do we get discovered by the circular economic movement?

Their request was simple: please can you help to design the control room. Expertly designed human machine interfaces are still required, more so because as industries explore novel ways of working, and the risks will emerge with progress.

In summary, we can support the circular economy industries by providing the following services:

- Human-centred organisation audit and transformation activities.
- Expert evaluation of the HMIs and HCIs (keeping the human in the loop).
- Workload evaluation (physical and mental).
- Incident investigation (human-centred).
- Website and app design to support the circular economy's principles and increase engagement with all stakeholders.

This is the first step in exploring how the human factors community could support the circular economy. I know that some members have been closely involved with the development of advanced manufacturing processes at research centres such as the AMRC in Sheffield. This is an open invite for interest in forming a CIEHF group dedicated to supporting the transition from linear economic models to circular economic models. Contact john@canarydesigns.co.uk.

John Lovegrove is the founder of Canary Designs Ltd and has more than 18 years of experience as a practising ergonomist across multiple industries. He studied ergonomics at Loughborough University and is a Chartered Ergonomist & Human Factors Specialist and registered European Ergonomist. John uses world leading digital solutions to independently assess designs from the perspective of the entire target population, to optimise inclusivity and to challenge dehumanising designs and initiatives at source.

Further reading

P Lacy, J Long, W Spindler, 2020, *The Circular Economy Handbook – Realizing the Circular Advantage*, ISBN 978-1-349-95967-9

S Wright, 2019, *Forget Mars, Circular Economy, the next big opportunity – Business Opportunities and how to position your company to profit from the circular economy*, ISBN 978-3-9525126-0-9

Testing times

Near the end of March last year, and ten days before the first national lockdown, with the incidence of Covid-19 increasing rapidly, I took the decision that we should send the Imperial in-vitro diagnostics team home for a while to do some 'remote' working. I thought I'd tell the boss later as he was busy in the operating theatre. Many months later and I've still not seen any of my team, other than online. But that's just the start of the Covid-19 story as it unfolded within one small part of the massive, Imperial College Covid-19 research engine. Perhaps I'd better re-wind a little.

I've led the human factors 'real world' section of the team developing new diagnostics at Imperial for seven years. The team are partly funded by the National Institute for Health Research (NIHR) and are based at St Mary's Hospital campus. Being embedded within the clinician and patient environment has been essential for our human factors research as we're superbly placed to understand 'work as done' versus 'work as imagined'. Our research covers diagnostic innovation across a wide range of health conditions including cancer, infectious diseases and metabolic conditions. The team is directed by Professor George Hanna, Head of the Division of Surgery and Cancer at Imperial.

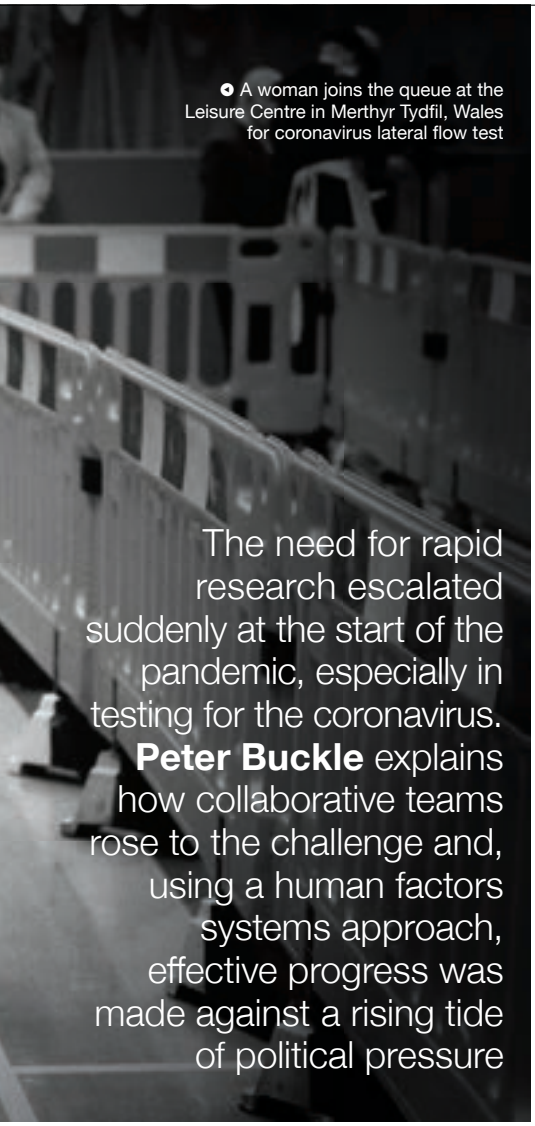
In April last year, we were suddenly told by the NIHR to pause research on many of our other initiatives and focus, not surprisingly, on Covid testing. The human factors challenges quickly emerged, as did the extended knowledge base needed to understand the disease and its detection. Having taught epidemiology for 25 years at a postgraduate level, I at least felt comfortable with most of the concepts required. Incidentally, I wonder how many of my students still remember the lectures on zoonoses, sensitivity/specificity analyses, risk evaluation and critical interpretation of epidemiological data? I hope, if any are reading this, that you did and that you used this knowledge to illuminate the discussions you no doubt had during the unfolding pandemic.

On the human factors side, I felt we might need to harness skills worldwide. A hastily set up 'hfcovid19' LinkedIn group recruited over 300 people in a week, testimony to the desire of the global human factors community to help. A national network for evaluation of Covid tests 'CONDOR' soon followed and suddenly we were plunged into the most extraordinary rollercoaster of a research ride. New candidate tests for an entirely novel disease sprung up everywhere. Many tests were purchased by governments before data on their validity were available. Evaluation and procurement emergency committees screamed out for evidence. SAGE groups were modelling the course of the pandemic without hard data. 'Test and trace' initiatives without adequate testing of the population was a non-starter and everything the scientists did was "too slow".

Whilst conventional validity testing was predominantly a clinical laboratory exercise, the real world evaluation of point of care tests (POCTs) for Covid was fast becoming an essential parallel exercise which, to a large extent, we were leading. Yet, still everything the scientists did was "too slow".

The political pressure was, and still is, intense. In 40 years of research, I've never seen the interface between science and politics so clearly. The trade-off between research integrity and the speed to deliver results being pushed to its limits.

Our human factors team soon learned that streamlining our methods and running remote studies



A woman joins the queue at the Leisure Centre in Merthyr Tydfil, Wales for coronavirus lateral flow test

The need for rapid research escalated suddenly at the start of the pandemic, especially in testing for the coronavirus. **Peter Buckle** explains how collaborative teams rose to the challenge and, using a human factors systems approach, effective progress was made against a rising tide of political pressure

was imperative. Ensuring they were 'valid' became a major challenge. Expert review panels, patient public engagement and clinical stakeholder evaluation studies were launched, papers and reports to the decision making committees in the Department of Health and Social Care (DHSC) and in government were prepared at weekends and still everything the scientists did was "too slow". Research time scales went from years to months, then to weeks and finally days. Interest in our work spread outside of health and social care as the need for rapid Covid testing in the events industry, in transport, in schools and in colleges ramped up. All in all, an overwhelming task with limited resources. Nevertheless, our human factors systems approach stood up well to these pressures and our work was

IMAGES: GETTY

In 40 years of research, I've never seen the interface between science and politics so clearly

a key element in research reports and was regularly submitted for peer review publication and made available through our websites to enable others to do their own evaluations.

Throughout this period, the CONDOR national diagnostic testing network enabled us to focus on POCTs for Covid in acute/secondary settings, primary care and in care homes. It brought together the very best of diagnostic researchers, clinicians and patient and public representatives across five prestigious universities and others beyond. Between us the traditional inter-university 'competition' rapidly fell away, enabling true collegiate, scientific collaboration to shine through. Integrity and resilience became the underlying principles. As a result of this national network, we can now call out 'poor tests' without fear of reprisals from manufacturers (who, incidentally, can make fortunes if a test is approved) or from others who may have invested heavily and procured tests prior to their evaluation.

Panic buying at the start of the pandemic

As I write this, I'm aware that 2021 will require even greater efforts. The need for testing will remain, perhaps for ever, as the disease becomes endemic and sits alongside so many other infectious respiratory diseases. New virus strains will require us to innovate and refine our methods. In addition, the long-term efficacy of vaccines has yet to be shown, some groups will not be suitable for vaccination and, in our unequal world, many countries may never have adequate vaccination schemes. All of these scenarios, and many more, will ensure that we rely on valid and usable Covid testing for the foreseeable future. Whatever happens though, I'm certain that our human factors system-based approach and practice must be an integral part of both the innovation pathway and the evaluation of all such tests.

Professor Peter Buckle is Principal Research Fellow at the Department of Medicine, Imperial College, London and CIEHF Chartered Fellow and a past President. Contact him at p.buckle@imperial.ac.uk

Acknowledgements

Thanks to the whole CONDOR team and all my colleagues at Imperial College, especially those within the in-vitro diagnostics team. Note: All views are my own and not those of the organisations to which I belong.

Further reading

CONDOR platform human factors analysis: www.condor-platform.org/condor_workstreams/human-factors-analysis

CONDOR activity report: www.condor-platform.org/condor-activity-report

NIHR Human Factors approach to COVID-19 testing process: https://london.ivd.nihr.ac.uk/our-covid-19-research

POCTs in care homes: www.medrxiv.org/content/10.1101/2020.11.30.20240010v1

POCTs in patients with suspected Covid-19: https://www.medrxiv.org/content/10.1101/2020.10.15.20213108v1

Unmet clinical needs for COVID-19 tests: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0242125

Cycling promotes a sense of wellbeing which is invaluable during the lockdowns. It keeps you in shape, makes you feel fitter and helps you sleep better. Applying human factors to the sport also helps you to learn more about your own, sometimes surprising, capabilities as cycling enthusiast, **Alex Stedmon** explains

The loneliness of the long-distance cyclist

Dave Moore and I have been friends since his keynote at one of the Institute's annual conferences. We share a passion for all things two wheeled (a wheel at each end, rather than a wheel at each corner). We were doing some research in New Zealand, where Dave is based, trialling a new approach for motorcycle safety and enhancing the rider experience. As we chatted about research and motorbikes, our conversation turned to bicycles (still keeping with the 'wheel at each end' theme). I'd not long started cycling and had an ambitious idea of touring around New Zealand. "If you do it, I'll give you a lift up to the top and buy you a beer at the end!" Dave said.

I took up cycling about four years ago. I tried running but it's a bit slow and you don't go very far. I swim but there's the hassle of going to a pool, getting wet and then getting dry. Cycling gets me out in the fresh air and every ride is different. It's low-impact exercise, which is kinder on your joints, it works your core muscles and it's a good mix of static and dynamic work.

Cycling as a system

Cycling is where 'tech meets geek'. At the top end it has advanced composite frames, wheels and tyres that cost more than those you'd put on your car, cycle computers with live-streaming data, lights with radar capabilities, and even programmable electronic gears for the best ratio switchovers as you power along.

In human factors, we're familiar with concepts such as the user, equipment, task, environment and systems thinking. When I started cycling, I tackled it at a macro level looking at the whole ride as a single system, which was overwhelming in its complexity. Cycling may be better understood as a system of systems; rather than fixating on the whole ride, consider the sum of the parts. Its rather like Csíkszentmihályi's concept of 'flow'. You're in the moment, focusing on the hill in front of you. Only it's not a single hill, it's a series of gradients, and some will be steeper than others as you make it to the top.

To ride 100 miles (the 'century') in a day is a great achievement and milestone for many cyclists. At a micro level it's a series of shorter rides after which you recover and then tackle the next section. Think of it as 'ride, recover, repeat' until you get to the end. Then, after 100 miles, something magical happens - you sometimes find that you can keep going! I reckon the next 50 miles after that 100 mile marker are easier that the 50 miles that went before.

People spend a lot of money shaving grams off the weight of their bicycle to increase their performance but the human is

still the limiting factor. I've heard that you can only improve your performance so much, and with continued training, its more about how quickly your body recovers during an activity that gives you the edge.

Bigger targets

In my second year of cycling I attempted the Rapha Manchester to London ride. You cover 220 miles in a single day, starting at the Manchester Velodrome, heading through the Peak District, down the centre of England and into London, with over 13,000 feet of hills between start and finish. I trained for it with short intensity rides in the week and longer endurance rides at weekends. I dressed up as Elvis for charity and Sir Bradley Wiggins signed my outfit. I completed it in 14 hours and promptly vowed never to do it again. It had been so tough... but then your mind plays tricks on you and you start thinking "it wasn't that bad, you could do it again, you might even do better!"

So I stepped up my training by riding from Nottingham to Aberystwyth. It's a route I knew well by car and motorbike but cycling would be a whole new experience. I travelled light with a puncture kit, a waterproof jacket and some 'road fuel'. It's important to keep fed and watered, especially on longer rides. If you feel hungry or thirsty it's too late and you're in danger of hitting the 'wall' (or 'bonking' in cycling terms).

I'd analysed wind direction for a perfect window of opportunity, as headwinds really sap your energy. I prepared directions like rally driving notes ("> T-junction, R, L post box, hill, > next town") taking backroads through Stafford, Telford, Shrewsbury, Welshpool, Machynlleth and then on to Aberystwyth. I covered 166 miles in 10.3 hours, averaging 16mph and over 6000 feet of ascent. On longer rides, you might expect to go through a couple of 'rinse cycles' with the weather, and in true Welsh form, as I tackled the Cambrian mountains and darkness descended, the last 40 miles were very hilly, very windy and very rainy.

But there's something special about doing such a long ride with only yourself to rely on. Digging deep, it builds self-reliance and confidence. It can be lonely and hard work without other riders to coax you along and you sometimes hear a voice whispering in your ear that you really need a rest. But understanding the ups and downs of exertion and recovery on a long ride make it possible to keep going. In many ways, the hardest part of any long ride is not the physical endurance but the mental preparedness before you set off. It's easy to overlook that aspect of human performance.

The loneliness of a long-distance ride gives you time to yourself, for yourself, away from the usual routines. It's an opportunity to just be 'in the moment'.

It's easy to overlook the mental preparedness aspect of human performance

The next day, at the train station, I was told, "Sorry, you have to book your bicycle on the train 24 hours in advance". So much for connected journeys! With no alternative, I cycled the 166 miles back home. But it was good preparation for my second Manchester to London ride as I finished 11th for 'Team North' and 18th overall.

What I learned

Through cycling, I've developed a greater awareness of cyclists as vulnerable road users, which ties in well to my work, helping clients procure specialist road safety solutions. I've also learned more about biomechanics, physiology and comfort. There's the physical work the body does depending on gear ratios for the terrain; what resources the body requires to maintain performance over long distances; and physical and thermal comfort when you're spending 10 to 15 hours in the saddle.

A lot of attention is also given to 'fitting the bike to the rider'. As Sandy Robertson said about motorcycle design, you're sitting at a constrained workstation with limited options for your bottom, feet and hands, and it's the same with cycling. Aspects of human factors and workplace design have helped me understand my cycling needs, requirements and limitations.

So what's next? Last year I planned to do the Deloitte 'Ride Across Britain' event (1000 miles from Lands End to John O'Groats) and hope that will take place this September. If I raise enough sponsorship money, I'll wear my Elvis outfit on the ride. I'm thinking that it'll be good training for New Zealand, maybe in January 2022 or 2023 ... I'll just remind Dave about the lift to the top and the beer at the end! ●

Professor Alex Stedmon is founder of Open Road Simulation Ltd and Science Witness Ltd. He helps international clients procure specialist road safety solutions and provides expert witness services to the court. He is a Fellow of the CIEHF. If you'd like to sponsor Alex on his Lands End to John O'Groats ride for Macmillan Cancer Support, visit https://uk.virginmoneygiving.com/Stedders.

Further reading

For more details about the Manchester to London ride, see https://www.rapha.cc/gb/en/stories/manchester-to-london-report. Look out for a photo of Alex in his Elvis costume.

IMAGE: GETTY

The next generation of defence capability

While drone swarms, self-driving 'tanks' and other semi-autonomous weapon systems will no doubt be the future of warfare, the role of humans will always be crucial in their design, deployment, maintenance and, of course, control. Here we look at how human factors can help maximise capability.

People will remain a critical component of military capability and while their position may change from being an active participant in conflict to taking a more supervisory role, the new systems will have to be designed to get the most effective performance out of the human operator. The process to achieve this currently in the UK defence sector is termed 'Human Factors Integration' (HFI) and is currently mandated in the MOD's Joint Service Publication (JSP) 912, entitled *Human Factors Integration for Defence Systems*.

Every item of equipment procured by the MOD's Defence Equipment and Support (DE&S) organisation, from a pair of soldier's boots to a multi-billion pound aircraft carrier, has to undergo HFI to identify, track and address people-related considerations. This applies throughout the equipment's lifecycle, from delivery, training of personnel, maintenance, use and disposal.

For the past 30 years, human factors specialists from the MOD and industry have worked together through the MOD-Industry HFI Working Group to promote HFI and best practice within the defence sector. This group has now joined the CIEHF as the organisation's Defence Sector Group. Laird Evans, Chair of the MOD-Industry HFI Steering Group, was delighted with the move. He said: "The aim is to share ideas, learn about best practice and distribute these as widely as possible throughout the defence sector. It makes sense to align with the CIEHF as our work closely matches its aims and we can learn from the excellent work being done in other sectors."

Steve Harmer, current Defence Sector Group MOD Co-Chair, agreed: "It gives us access to a wider community of human factors practitioners and this is important for us to share an understanding of approaches to human-centred design being developed and applied in other sectors."

Laird added: "Human-Machine Teaming is emerging as an important topic for the defence HFI community. There's a lot of overlap with the CIEHF's Healthcare Sector Group, where we can learn from their experience of complex decision making, the increased use of semi-autonomous systems, as well as the use of augmented and virtual reality to support training and operations."

The CIEHF Defence Sector Group consists of a Steering Group, chaired by Laird, which discusses HFI policy and processes, and a Liaison Group, co-chaired by Steve and Gareth Shaw (of BAE Systems) which serves as a forum for those working within MOD and industry. It's already attracted interest from the wider human factors community with 80 people tuning in to its first virtual meeting in September and 154 attendees at its webinar on the history of HFI in UK defence in November. The webinar was presented by Chris Kelly, a long-term Defence Sector Group member and Steering Group Industry representative.

While HFI is mandated in all procurement projects through JSP 912, it's not always explicitly defined in detail in all tenders, as Chris explained: "The extent that HFI is addressed in a project is very much dependent on how the particular MOD project team expresses it in their original requirements documents. This often determines how industry responds to the tender, and why the uptake of HFI is a bit patchy across defence projects. It's improved in recent years but there is some confusion with engineers over the terms human factors and HFI. HFI is more about managing the process to ensure human factors is really integrated across all the HFI domains and an integral part of a systems engineering approach."

The MOD is constantly reviewing its 'capability gaps' to ensure it's prepared for new types of offensive activity

The profile of HFI within the MOD has increased as DE&S has expanded its team of human factors specialists from two a couple of years ago to 14 this year. However, it's still a small

team for the huge range of complex projects the MOD undertakes – buying, supporting and supplying vital equipment and services for the Royal Navy (RN), British Army and Royal Air Force.

Laird noted: "In addition to developing HFI policy and processes, our main role in DE&S is to work with project teams to promote HFI best practice and support them in their engineering projects. It's important that we get involved as early as possible so we can ensure HFI is firmly embedded in the lifecycle of any procurement."

Steve was recently involved in a research project for the Defence Science and Technology Laboratory (Dstl) to understand the level of awareness of HFI in the MOD's three Front Line Commands – where the Chiefs of Staff for the Army, RN and RAF have responsibility for developing their service to deliver military capability. Steve said: "In general, there was a lack of awareness about the requirement for HFI, which shows we need to do more to communicate this. We need senior commanders in the Front Lines to promote and trigger the HFI process. Ensuring that requirements associated with the human component of capability are understood and defined from the onset is key. We call it the 'golden thread': the higher the level of requirement that's set at the beginning, the more uptake there will be throughout the acquisition process."

In addition to communicating the importance of HFI, human factors practitioners in defence are also facing the challenge of getting the best up-to-date research to support the development →

PROJECT: LYNX WILDCAT AW159 HELICOPTER

Issue: To develop an ergonomic cockpit and data integration design to prevent high crew workload.

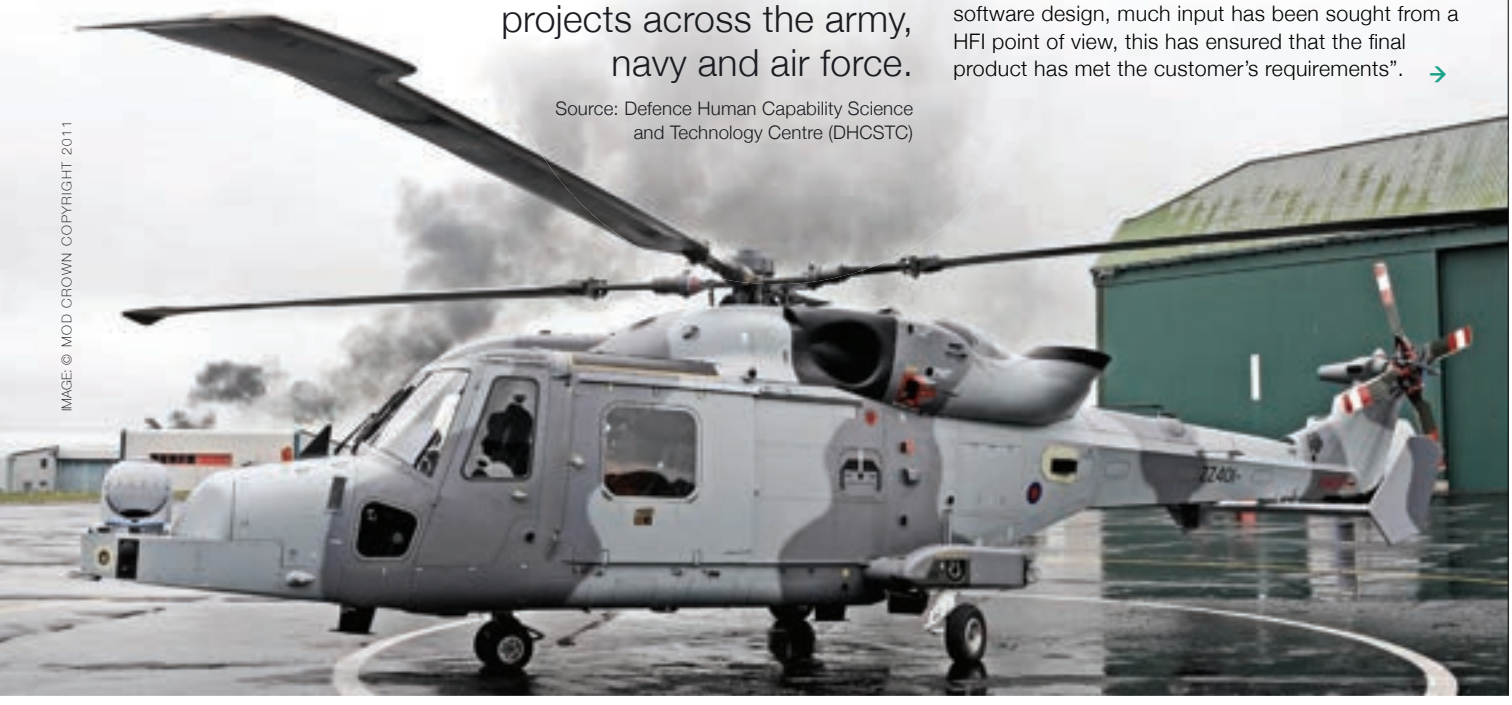
HFI benefits: The resulting cockpit and display reconfiguration allowed the crew to perform their tasks effectively, achieving high situation awareness without excessive workload.

Details: Although the upgrade of the Lynx helicopter to the Lynx Wildcat AW159 gave crews more sensor capability, there was a lack of data integration across the various sensors and displays that had the potential to create excessive workload for the two cockpit crewmembers. Therefore considerable effort went into designing the ergonomics of the cockpit and displays to ensure that the information from the various sensors was combined effectively. This involved cockpit cabin mock-ups to assess ergonomics, rapid prototyping of displays using the Virtual Applications Prototyping System and using the Engineering Development Simulator to allow simulation of tasks using realistic sorties that were then assessed using an Ergonomics Assessment Rating Scale.

A DE&S Lynx Wildcat customer said: "The Wildcat project has had a high level of HFI input from the start. This has essentially saved time and reduced redesign/re-work in the Design and Manufacture phase. As part of the Wildcat mission system software design, much input has been sought from a HFI point of view, this has ensured that the final product has met the customer's requirements". →

● Case studies that show the project risk and cost reduction benefits of implementing Human Factors Integration (HFI) within various MOD projects across the army, navy and air force.

Source: Defence Human Capability Science and Technology Centre (DHCSTC)



of methods, guidance and standards, particularly as the nature of warfare is changing rapidly. With the increase in asymmetric conflicts and the emergence of new forms of cyber warfare, the MOD is constantly reviewing its 'capability gaps' to ensure it's prepared for new types of offensive activity.

Although the UK Government's announcement last year of a £16.5 billion boost for defence spending was welcomed, there is an ever-present efficiency challenge. However, for human factors practitioners, pressure on budgets provides a renewed emphasis on getting more from the capability the MOD already has, and that means getting more from its military personnel – which is where human factors plays a critical role.

Gareth Shaw, Industry Co-Chair of the Defence Sector Group, explained: "Due to a reduction in the number of armed forces personnel in recent years, there is an evolving requirement to do more with less. The appropriate application of technology and consideration of human factors will ensure delivery of military capability by dramatically increasing the capability each person can provide. A huge number of technologies will underpin future capability including increased use of Artificial Intelligence (AI), increased automation and autonomy, improved data processing and visualisation, increased networking and interoperability of systems, increased use of robotics and developments in wearable technologies."

Gareth added: "The increased use of these technologies, and the adoption of development approaches such Agile methodologies, will require developments in HFI processes, tools and guidance. AI is an example of a huge growth area where standards will need to evolve to ensure it's implemented effectively to support human-machine teaming."

Through the development and promotion of HFI process, standards and guidance, the Defence Sector Group (and the legacy MOD Industry HFI Working Group) has made a significant contribution to the development and acquisition of some of the UK's most advanced military systems. The ability to share best practice and novel approaches with other CIEHF sectors will serve to support refinement of future process, standards and guidance and therefore support development of the next generation of military capability. ●




Chris Kelly, Gareth Shaw, Laird Evans and Steve Harmer
are leading members of the CIEHF's Defence Sector Group

IMAGE: © MOD CROWN COPYRIGHT 2010

PROJECT: PELVIC PROTECTION FOR SOLDIERS

Issue: To provide an adaptable solution that balances protection against wearability.

HFI benefits: Systematic human factors analysis led to a solution that balanced the level of protection against the impact on soldiers' tasks and wellbeing, which has a high uptake and is very effective in use.

Details: The pelvic region of a dismounted soldier is particularly vulnerable to injury from Improvised Explosive Devices (IEDs) so the Army raised an Urgent Operational Requirement for pelvic protection. However, the protection not only needed to resist penetration but also permit normal movement for the soldier while engaged in the full range of operational tasks, without chafing, injury or causing undue thermal or other stress on the body. It must also fit all shapes and sizes of military personnel.

The MOD recognised that getting the comfort and utility right was essential to ensuring that the protection would be worn so it initiated a process of iterative human factors assessment and trials using levels 1 & 2 of the Human Factors Assessment Framework including field trials, as well as a controlled laboratory trial using participants and manikins to provide objective data on human physiological and cognitive responses.

This led to a tiered solution which allows users to consider their options before selecting what to wear: Tier 1 (for routine use by all troops) meets comfort requirements with low physiological burden and minimal movement constraint; Tier 2 (for higher risk situations) offers more protection; Tier 3 (for use during IED disposal) offers the most protection.

The tiered approach led to high utilisation rates in service and has resulted in significant reduction in pelvic injuries from IEDs.

IMAGE: © MOD CROWN COPYRIGHT 2009

PROJECT: QUEEN ELIZABETH CLASS AIRCRAFT CARRIER

PROJECT: ASTUTE CLASS SUBMARINE

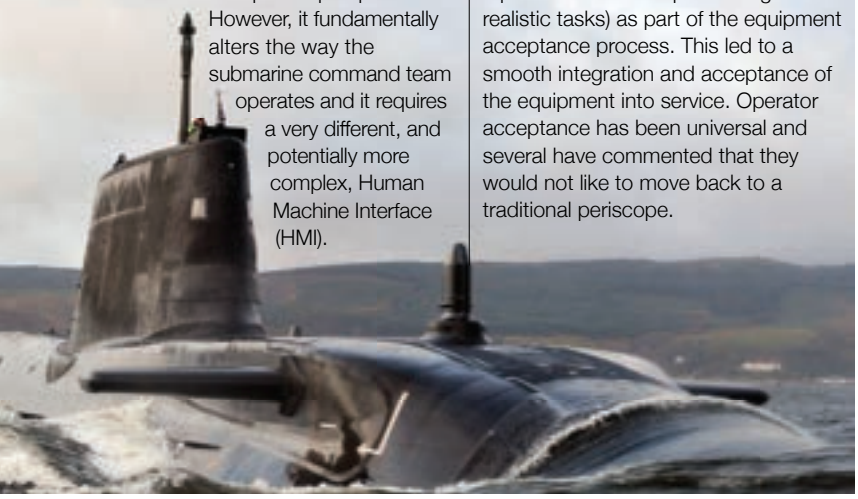
Issue: To ensure the usability of an optronics console to successfully replace the submarine periscope.

HFI benefits: User interface problems identified from previous experience of automating the periscope function led to a comprehensive HFI approach to develop the console for the successful optronics mast system used on Astute class submarines.

Details: Replacing a conventional periscope with a non-hull-penetrating mast carrying optical sensors offers many advantages including reducing the risk of detection and removing a constraint on control room layout and the location of the periscope operator. However, it fundamentally alters the way the submarine command team operates and it requires a very different, and potentially more complex, Human Machine Interface (HMI).

The development of the optronics mast incorporated human factors input from the earliest concept stage, and the requirements for the user interface were based on a task analysis and a clear understanding of how the facilities would be used as part of the overall submarine operation. HMI designs were preceded by mock-ups and prototype designs. At each stage, multiple operators were involved in assessing and critiquing the HMI with their feedback being directly incorporated into the design process.

Throughout the submarine design, the integration of the consoles into the submarine control room was a formal element of the HFI programme which included operability trials (with representative users performing realistic tasks) as part of the equipment acceptance process. This led to a smooth integration and acceptance of the equipment into service. Operator acceptance has been universal and several have commented that they would not like to move back to a traditional periscope.



PROJECT: TALISMAN VEHICLE TRAINING

Issue: Developing cost-effective training for personnel.

HFI benefits: Analysis demonstrated that a low-fidelity simulator based on commercial equipment could provide a cost effective way to enhance the training of teams operating the Talisman route clearance system. The costs of early HFI were more than compensated by downstream benefits.

Details:The Talisman vehicle is used by the Royal Engineers for route proving and clearance, including mitigating Improvised Explosive Devices (IED) threats. Training for Talisman teams traditionally takes place in the Jordanian desert, but this does not cover all training scenarios such as encountered in built up areas.

The Talisman Training Advisory Team (TTAT) recognised this limitation on the human component of Talisman capability and commissioned a Training Needs Analysis (TNA) to explore the feasibility of additional training to supplement live training in Jordan. This drew on earlier work (including human factors work) already completed during system development.

The TNA demonstrated that the essential procedural skills could be trained using low cost commercial hardware to create an easy-to-assemble training simulator in the UK and to both prepare teams for desert training as well as covering training scenarios not available in the desert.

According to TTAT: "The simulator has significantly improved the training progression of Talisman Squadrons since its introduction. It provides a safe environment to deliver initial collective training, so that individual soldiers understand their role and position within a Talisman Troop prior to live training in a collective environment. There was a marked increase in the start standard of Talisman troops' skills that had benefited from pre-Jordan simulation."

Issue: To influence system design to minimise ship manning levels.

HFI benefits: Manpower is one of the Navy's biggest costs and MOD investment in the design of the human component of the ship's company is predicted to yield significant through-life manpower cost savings. Costs of early HFI investment were compensated by downstream benefits.

The Queen Elizabeth Class (QEC) aircraft carriers are the Royal Navy's biggest and most powerful surface warships. Through-life affordability was a key design driver and since manpower represents a major cost, there was an early focus on optimising the design of the total system, that is, both the crew complement and the equipment.

Work in the earliest phase identified major manpower drivers, notably relating to flight deck operation, weapons handling and catering. In each area, the design concepts were optimised by working with other disciplines to optimise the design of the working spaces, the equipment and the work to be performed, in order to ensure effective and safe operation of the ship in all scenarios while containing manning requirements.

Modelling of complement numbers enabled the human factors requirements – including accommodation, catering, escape and evacuation – to be determined to a high degree of confidence, and these aspects of the design have not needed subsequent re-scaling despite changes in customer business practice, unlike the costly changes that have been common on other similar projects.

As a result, the ship's company of the QEC has been held at approximately the same number as was needed to operate its predecessor, despite QEC being a more capable ship of more than twice the size and able to operate and support at least twice as many aircraft. Direct savings in predicted through-life manpower costs amount to around 70 times the cost of the manning modelling.

Coping with complexity

Clinical decision making has always been challenging and there's recognition that it's an advanced skill, the hallmark of the expert practitioner. But the changing role of pharmacists means they're expected to become skilled decision makers at an early stage. **Helen Vosper** discusses a valuable new resource from the CIEHF which aims to help them

Decision making is, to a large extent, a function of time, or perhaps more specifically, experience. However, there's much more to it than this but precisely what this 'more' entails isn't clear; understanding is tacit, with even experts struggling to articulate how they make decisions.

The decision making environment in modern health and social care is increasingly complex and there are lots of reasons for this. Information overload is likely to be one element. Studies suggest that the amount of information available is critical to a clinician's self-perception of decision making capability; too little information and the decision maker feels uninformed, too much and they feel overwhelmed. Both circumstances occur commonly during modern health settings and sometimes it can feel as though we're drowning in data while conversely, sometimes accessibility of information may be limited, especially in remote and rural settings. Clinical decision making has always been high stakes but perhaps never more so than now, given public awareness of adverse healthcare outcomes.

In their book *Still Not Safe: Patient safety and the middle managing of American medicine*, Wears and Sutcliffe offer some insight into how organisational development has exacerbated the problem (see page 30 of this issue). Safety controls in healthcare increasingly rely on standardisation and eradicating variation through use of standard operating procedures, viewing departure from such procedures as 'medical error'. Frameworks for decision making have developed in the same way, encouraging statistical and technical approaches which may not work in complex situations where information is limited and nuanced. This is even more problematic for newly-qualified practitioners who have limited experience to draw on.

While most new healthcare practitioners find the transition from education to the workplace challenging, it is particularly marked for pharmacists, largely as a result of their limited clinical exposure on most undergraduate courses. The first major clinical experience in most pharmacists' careers is during their pre-registration year which is assessed through a national pre-registration examination. Successful completion of the pre-registration year allows pharmacists to enter the national register.

CIEHF's 'Coping with Complexity' guide about decision making

Decision making has been highlighted as a particular cause of anxiety and, in recent years, this has been exacerbated by the changing role of the pharmacist. When the primary pharmacist role was dispensing, decision making often centred around an initial consideration of whether a patient needed referral to a doctor. New, enhanced clinical roles now see pharmacists often as independent prescribers, taking responsibility for patient outcomes and frequently making difficult therapeutic decisions in the face of uncertainty and incomplete data.

To support this increase in both public and professional expectations of pharmacists, the General Pharmaceutical Council (GPhC) has developed new standards for initial education and training of pharmacists. Key changes include: incorporating the skills, knowledge and behaviours to enable pharmacists to independently prescribe from registration; new learning outcomes linking with the continuum of development into post-registration practice; increased emphasis on key skills including professional judgement, management of risk, diagnosis and consultation skills.

Interestingly, Covid-19 has accelerated this ambition. Graduates of the class of 2019 have seen their pre-registration training significantly disturbed and will not sit their pre-registration exam until March 2021. However, they have already been provisionally registered and are still facing the pressures of clinical practice. Health Education England (HEE) has responded with the Interim Foundation Pharmacist Programme (IFPP), described as: "A supportive, formative, trainee-led vocational training programme. The learning is predominantly based in the workplace reflecting on 'lived experiences' in your day to day practice."

All provisionally registered pharmacists are eligible to take part and each will be allocated an educational supervisor. The IFPP has involved the development of educational resources and this is where the CIEHF came into the picture.

Our Covid-19 response Gold Team was approached by David Gibson, Associate Dean Foundation Pharmacy at HEE. He was looking for some help with resources to support decision making in newly-qualified pharmacists. The CIEHF Covid-19 workstream has engaged with a range of different high-impact projects. What most of these have had in common is that they were developed by short-term working groups, delivering an initial output sometimes in a matter of days. When this project was assigned to us, we assumed this would be the same but the reality was quite different! After the project was handed over to the CIEHF's Pharma Sector Group, Dominic Furniss and I worked with David to come up with a plan.

We soon realised that this wasn't going to be a quick fix and we began with a systematic consideration of the decision making literature. This confirmed that advanced decision making is poorly understood and the literature was even more scant from the pharmacy perspective. In terms of what's known, pattern recognition is central. Furthermore, expert decision makers accept that their decisions will not always be correct and consequently identify cues that will allow early detection of errors. They will also have considered 'recovery strategies' to mitigate risk. In situations where clinical decisions are necessary, experts are constantly gathering and assessing information and using this to build a model of their 'problem'.

Our aim was to produce a framework that would help inexperienced pharmacists take a systematic approach to understanding the context in which they make decisions. Underpinning the development of this framework was the understanding that while decision making skill development is often tacit and therefore hard to unpick, it can be accelerated and there are three key elements when it comes to achieving this:

- Inexperienced practitioners can 'borrow' experience from peers.
- Using a structured framework for peer discussion helps us understand how others make decisions, that is, it starts to uncover implicit practice.
- Reflection is key for organising knowledge so that inexperienced practitioners can start to recognise patterns.

Other sectors such as aviation have existing frameworks that support all of these aspects. The resource we developed, called *Coping with Complexity*, essentially recreates this for a pharmacy-specific context. Using the tools in the resource, information can be gathered, shared, discussed and reflected upon, helping the users to understand more about their practice and support future decision making.

Pharmacists must frequently make difficult therapeutic decisions in the face of uncertainty and incomplete data

In order to improve usability and accessibility of the tools, we also sought to bring them alive by developing a number of personas that reflected a range of pharmacy contexts, and also a range of decision making expertise. Our personas were evidence-based as much as possible and based on real-life practitioners. At the webinar launch in December, we included a short video of a discussion between two of these practitioners: Hannah Beba, an expert diabetes pharmacist, and Emma Pearson, a more recently qualified pharmacist, currently on secondment to HEE as a Clinical Leadership Fellow. The discussion used the resource as a framework for discussing a complex Type 2 diabetes case and the video received a hugely enthusiastic response.

This is envisaged as just the start. We're now entering an evaluation phase and we'll also be presenting our experience at both the CIEHF's Ergonomics & Human Factors conference, EHF2021, in April and the UK Clinical Pharmacy Association conference in March.

Dr Helen Vosper is a Chartered member of CIEHF, a senior lecturer at Robert Gordon University and the co-chair of the CIEHF's Pharmaceutical Sector Group. **Dr Dominic Furniss** is a Pharmaceuticals and Patient Safety Champion for the CIEHF.

Thanks to Brian Edwards and the Pharmaceutical Sector Group for their help and support with the resource document. We're particularly grateful to Ravinder Bratch and Angela Carrington for their role on the review team.

Further reading

Download the *Coping with Complexity* resource from https://bit.ly/CIEHFComplexity
Watch the webinar launch of the resource at https://youtu.be/oYc37kjAqNI

IMAGE: PA

AI's potential for global health

Populations in low-income countries and resource-poor settings suffer much higher mortality rates and have significantly lower life-expectancy than their counterparts in countries with higher income. **Mark Sujan** asks whether Artificial Intelligence can help address these global health inequalities

In high-income countries, such as the UK, with suitably funded healthcare systems, the widespread digitalisation of health services and the introduction of artificial intelligence (AI) applications are expected to help tackle the most pressing problems, such as access to health services, long waiting lists and delayed diagnosis, while improving patient safety and patient experience. However, the development and deployment of these novel technologies relies on significant public and private funding. In the UK alone, the government has pledged £250m in public funding to support the most promising AI innovations in the NHS.

At the societal level, we need to consider whether access to advanced AI health products is a privilege of people living in wealthy countries or whether it should be regarded a fundamental right and powerful tool to address global health inequalities. The World Health Organisation (WHO) African region has the highest proportion of infant and maternal mortality where healthy life expectancy, that is, the number of years one might expect to live in full health, is 52 years. It's the only WHO region worldwide with an expectancy under 60 years.

The potential impact of AI

The application of AI has the potential to make a significant positive impact on population health in low-income countries. AI can support clinicians in their decision making, it can improve inefficiencies in the management of care processes and it can radically transform the way care is provided and accessed.

A significant concern is the serious shortage of qualified healthcare workers in all disciplines. For example, Ghana has a ratio of one doctor to 11,000 patients (in the UK it's about 2.8 doctors per 1000 patients) and has a total of 34 qualified radiologists. The use of AI applications could help address the shortage of skilled clinicians by augmenting the ability of less skilled healthcare workers, for example by analysing radiological images or by providing diagnostic decision support.

Similarly, AI tools using natural language processing can digest and synthesise the 100,000s of papers published in the healthcare literature every year (the research database Medline indexed around 950,000 new papers in 2019). In this way, AI can provide healthcare workers with up-to-date information and can contribute to the adoption and spread of evidence-based practice.

Mobile phones provide a real opportunity for offering personalised and more accessible care, especially in rural areas. Patient-facing symptom checkers can provide initial diagnosis in areas where the nearest clinic is a long distance away, potentially coupled with remote consultations. Smartphones can be converted into powerful diagnostic medical devices when combined with emerging trends such as wearables and medical sensor technologies. Such technology can be used both by patients, for example to monitor and communicate routine

vital signs observations, as well as by healthcare workers in the diagnostic process, for example by turning the smartphone into an ECG or EEG. This represents a step change for underserved and remote areas in low-income countries where access to medical devices is typically very limited.

AI technology can help to improve efficiency of logistical processes. AI scheduling can target supply chain inefficiencies and resource shortages that routinely affect and undermine the quality of surgical processes in resource-poor settings. Drones can be used to transport blood products and medical supplies between different clinics as and when needed. AI planning tools are being used to support and optimise scheduling of community health worker visits in rural areas.

Barriers to adoption

Despite promising pilot implementation studies and an appetite for healthcare innovation among health systems in many low-income countries, the barriers that need to be overcome are daunting. Finance is an important issue, with many AI products being funded and developed in wealthy countries. This means that the all-important data sets on which the AI gets trained is sourced from and represents populations in these countries. There is a high risk that bias is introduced in the data and that algorithms do not perform as well in other settings and countries. In addition, data coming from resource-poor settings tend to be less readily available and are often of low quality due to lower levels of digitalisation and electronic records use. This makes training and validation of AI products on local data more difficult.

Low-income countries are also plagued by more mundane problems. Less than 30% of health facilities in the WHO African region have access to reliable electricity supplies. Reliance on digital systems in such situations can cause serious disruption and patient safety risks. While smartphones are widely used, healthcare facilities suffer from persistent shortage of basic computer equipment and limited internet connectivity. Digital literacy among rural populations is very low.

Not only is there a shortage of skilled clinicians and essential equipment but also of qualified data scientists.

The use of AI could augment the ability of less skilled healthcare workers

A young African healthcare worker uses a tablet to update and check a patient's medical records

IMAGES: GETTY

These novel roles within the health system are essential for developing and deploying AI technologies in a safe and sustainable way.

What can human factors contribute?

The success of AI in addressing some of the most pressing global health inequalities will depend in no small part on our ability to inform the design and deployment of these technologies through studies of the local context and through meaningful involvement of users. We can't assume that users and the context of use in, for example, the NHS are similar, much less identical, to those found in many resource-poor settings. User populations have different requirements, such as the need for content adapted to local languages and cultures. Clinicians might use different practices and medical terminology, and there are different levels of clinical expertise available and different types of support needed, potentially with a greater emphasis on augmenting the skill of less qualified healthcare workers. Staff might be even less familiar with AI than their UK counterparts, and AI interfaces have to be designed for usability accompanied by suitably defined and realistic training requirements.

AI products and digital technologies more generally need to be designed to provide a good fit with existing clinical systems and health infrastructures. There is a need for technologies that are low cost and that have low maintenance. Where possible, the design of technology should exploit the widespread adoption of mobile devices and place less emphasis on powerful desktop computing technology.

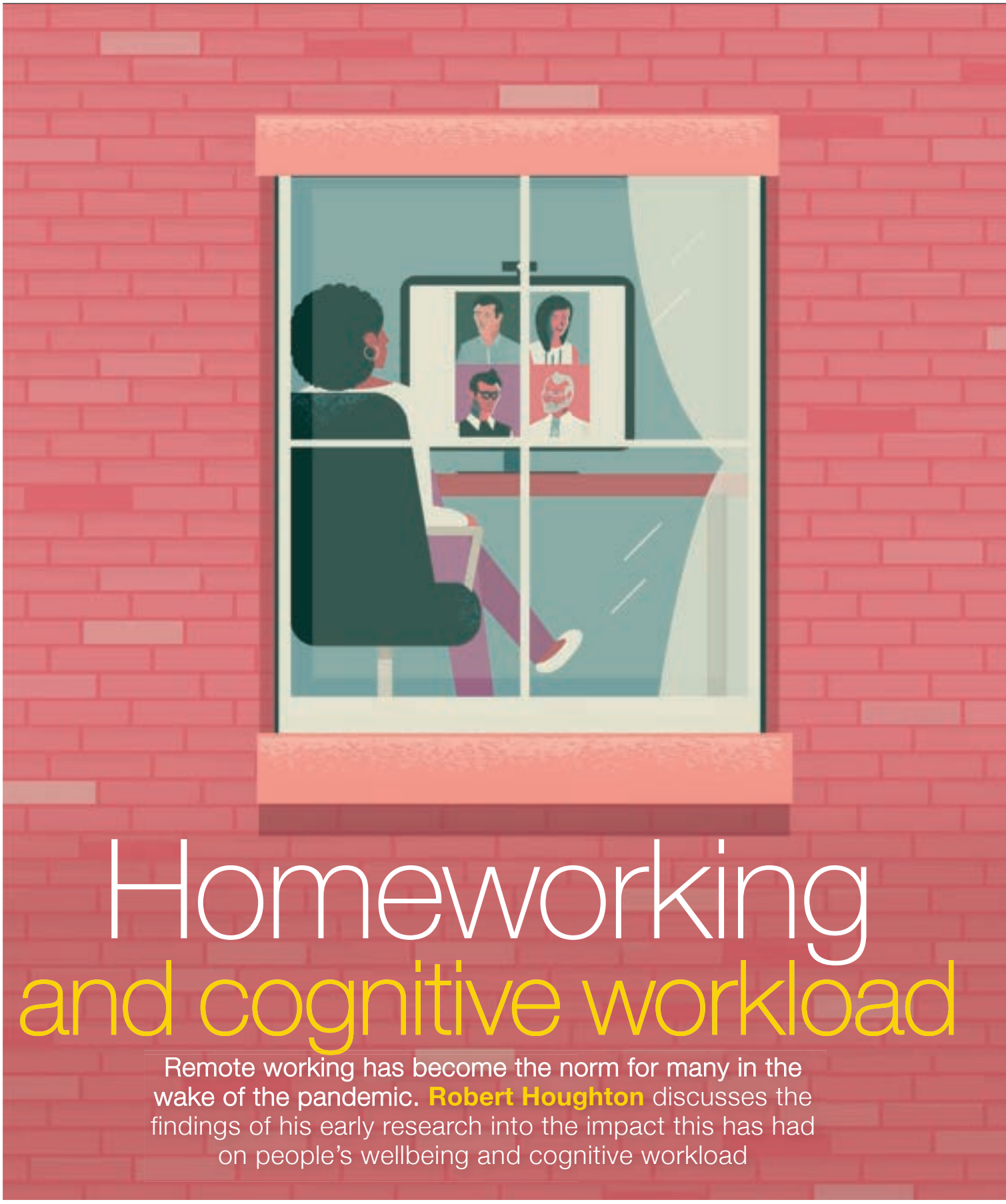
However, human factors expertise is at least as hard to muster in low-income countries as it is in the NHS, where there are about five qualified human factors professionals. This is a challenge and an opportunity for CIEHF to consider ways in which the Institute can partner with international and local organisations to provide input and support.

As part of the Institute's work on Digital Health & AI, we've partnered with the US-based Society for Health Care Innovation (SHCI). Lucia di Napoli, Assistant Dean at the School of Nursing at the University of Pennsylvania and a founding member of SHCI, says: "We have a lot to learn when it comes to understanding the momentum and energy around technology as a democratising tool for access and quality of healthcare such as in Africa, or how other countries are zipping ahead in the commercialisation of much of this technology and its possible consequences". This is echoed by Theresa Urban, another SHCI founding member: "Biases and ethical concerns have cultural implications and are not uniform across cultures. The West has to open its definition to include all cultures."

Mark Sujan is founder of Human Factors Everywhere Ltd, and a visiting academic at the University of Oxford. He leads the CIEHF's AI & Digital Health Special Interest Group.

Further reading

Society for Health Care Innovation website: https://www.shci.org



Homeworking and cognitive workload

Remote working has become the norm for many in the wake of the pandemic. **Robert Houghton** discusses the findings of his early research into the impact this has had on people's wellbeing and cognitive workload

It came as a shock to many of us when our world changed almost overnight. From March 2020 in the UK, when the first lockdown began, those who could were required to work from home exclusively and there was uncertainty as to when they would return to their workplace. As the months went by, it became clear that Covid-19 had changed how we work and the way we interact with work.

The research for my PhD involves looking into cognitive workload so I took the opportunity to include the effects of the changes to work brought about by the pandemic. Cognitive workload can be thought of as the amount of effort required by our resources such as memory, attention and perception to meet task demands. These demands include task complexity, time pressures and environmental factors such as noise and light.

A difficult transition

Almost instantaneously, Covid-19 had created an environment of both occupational and economic uncertainty. For many participants in my study, this has led to stress and anxiety which in turn, impacted motivation and productivity and had a negative effect overall on wellbeing. Additionally, for the self-employed, the Covid-19 restrictions were often paired with a loss of work or contracts and difficulty in securing new clients.

Digital meetings and communication are now commonplace and participants noted this overall had a negative effect on their wellbeing. For many, digital communication lacks sufficient connection and stimulation compared to in-person meetings. Online meetings may not meet our need to socialise and experience, and many individuals found them less satisfying. This was especially prominent amongst those whose roles included face-to-face interaction as a core part of their job, such as work in mental health and training. Participants also reported that digital meetings often overran so they found them particularly disruptive to their productivity.

Restrictions brought about by the pandemic have also resulted in drastic changes to certain occupations resulting in feelings of underemployment and role conflict. Whilst this affected individuals working in many occupations, the most affected group in this study was air traffic controllers. Air traffic has dropped significantly resulting in many aviation companies going out of business. With this reduction in air traffic, controllers found their job role changed overnight. Universally they reported their workload dropped so much they were no longer required to use their skills and training to truly control air traffic and they reported feelings of boredom and frustration stemming from a lack of challenge.

All participants reported feeling a sense of loss; a loss of variety, a loss of work, a loss of control. And with that loss came feelings of boredom and monotony due to cognitive underload. I asked all participants why they found their work, in pre-Covid times, fulfilling and interesting, and most of them reported variety as one of the things they enjoyed most. But in many occupations, people are now seeing the same tasks coming up again and again. Many individuals are now restricted to a single working environment, the home, and have been forced to carry out all work online. For many participants, the resulting boredom and monotony has led to a reduction in engagement and motivation.

Positive experiences

Whilst many participants in this study reported the negative impacts of Covid-19 on their wellbeing and workload, there were also some positives. The first of those being the creation of opportunities. Many participants discussed how the restrictions had forced them to work in different ways, to create new offerings or to fill time they previously didn't have. For example, many of the self-employed individuals interviewed had created digital products or transitioned to online work. They saw this as a positive for two reasons, the first being they could still earn a living, and secondly, it helped transition or modernise their business. Part of this was linked to necessity, that unless they digitised their content and resources so they could be accessed or delivered online, it's unlikely their business would survive.

It's important that we're aware of the impact the pandemic is having on our cognitive workload and our mental wellbeing

Other participants talked about the increased opportunities for training and practice, as well as having time for skill development. These led in many cases to an increase in feelings of wellbeing due to the ability to engage in tasks to ensure financial security, to improve job satisfaction and to carry out more enjoyable work-related activities.

Some loss experienced by participants was positive in that they lost aspects of their work they didn't like or enjoy. One example was work in open plan or noisy workplaces. Instead of experiencing a higher cognitive workload due to frequent distractions, participants could instead allocate all their resources to the task at hand. Many noted that overall they felt less stressed working at home and could pace their work better because they were free to take breaks when and how they wanted.

The home as a workplace

For those individuals who had never previously worked at home, some found it difficult to associate work with the home and situation was further complicated by things like childcare commitments. On one hand many participants enjoyed being at home as they could spend more time with their children but on the other, it meant having to take →

IMAGE: ISTOCK

We need to develop strategies to ensure homeworking is as stress free and productive as possible

time out of their work day to look after or home school their children. So cognitive workload essentially shifted to include not just work tasks but also those associated with the home. Other aspects related to balancing their own work with those of others in the home in regard to space and care commitments, leading to additional stress not present in the workplace.

Finally, many participants found not having to commute to work positively impacted both their wellbeing and their cognitive workload. The time could be spent preparing for or completing work and of course, there were financial savings from transport costs.

It's important in such a time of economic and organisational uncertainty that we're aware of the impact the pandemic is having on our cognitive workload and our mental wellbeing. We need to develop strategies to ensure homeworking is as stress free and productive as possible, whilst ensuring work maintains high levels of interest and satisfaction.

Homeworking can mean different things for different people

IMAGE: GETTY

Robert Houghton is a PhD student at Imperial College London researching the use of wearable sensors to measure psychophysiological states such as fatigue and cognitive workload. He has a background in organisational psychology and is a member of the Transport Risk Management Centre at Imperial College

INTERVIEW

Tina Worthy caught up with Robert to get more insight into his research

Hi Robert! What's your research looking to investigate overall?

My research overall has two branches, the first branch being the use of wearable sensors such as heart rate monitors and electroencephalograms to measure cognitive underload. Can they do it effectively, both in experimental and real-world contexts? How do people use and respond to such sensors? Do they see them as useful and trustful, or see them as a way companies could monitor their employees?

The second branch relates to cognitive underload. It's been poorly defined in the human factors and psychology literature, so my goal is to apply structural equation modelling to develop a well validated model of cognitive underload. This could be used to create a self-report measure to help understand the contexts and measure the level of underload in safety contexts.

Is this the first stage of your research and did it just involve participant interviews?

This is probably the second stage; I did some early data collection and analysis before Covid-19 assessing heart rate data and electrodermal activity using a smart watch-like device. The current purpose of the interviews is to gain an in depth and broad understanding of underload, across both safety critical and non-safety critical industries. I'm also using the interviews as a way to validate what little research we have on underload. I'll combine this together to help develop items for my measure of cognitive underload.

Are you planning on more quantitative assessment of cognitive workload?

Yes! Covid-19 restrictions permitting, I'm hoping to run some experiments using cognitive tasks at first to measure workload both physiologically through several wearable sensors and my own measure. If this goes smoothly and depending on the timing in relation to my finish date, I'm also hoping to collect data in either driving or flight simulators to assess whether my measure and the devices are suitable in more ecologically valid contexts.

Rapid innovation in a time of crisis

A 'hackathon' to quickly identify workable solutions to critical issues brought about by Covid-19 has resulted in some innovative solutions. **Subrata Bhattacharyya** explains how his team came up with an idea to increase quality control in medical devices.

At the end of August 2020, the Massachusetts Institute of Technology (MIT) hosted the *India: Turning the Tide* challenge, the seventh in a series of hackathons designed to create solutions to address critical needs during the Covid-19 crisis. According to the MIT Management Sloan School press release of 20 August 2020, *"India, with its population density and the scale of its informal sector is facing some unprecedented and unique challenges that call for extraordinary leadership from the community. Many of the strategies that have been adopted at a smaller scale or in the early stages of the pandemic become practically impossible to sustain long-term, without trade-offs."*

The hackathon sourced problem statements in collaboration with partners to address this unique situation and structured the hackathon around four themes:

1. Promoting effective and practical solutions to support underserved populations.
2. Reviving the informal economy while mitigating the risks of the spread of the virus.
3. Strengthening healthcare systems for all while improving the lives of healthcare workers.
4. Curbing the spread of misinformation and fraud while expanding dialogue to make critical information available on time.

The challenge was open to the public and to teams from around the world - universities, private sectors, governments and NGOs among others. In this contest, there were more than 2000 participants from 60 countries.

I entered and was allocated the broad track "Combating poor quality control and fraud during the pandemic". Quick adaptability in a challenging situation and working effectively as a team with multiple stringent timeframes was the key to success. All participants of each track were identified and everyone was given an hour to form their groups. I teamed up with five others with different disciplines from Australia, India and USA that hadn't met before. We brainstormed, identified a specific area, researched, worked, effectively communicated on the allocated roles, and after 48 hours of continuous team effort came up with an innovative idea for the final three minute pitch to the MIT judges.

Effective quality control is an important part of the production process and it's mostly done manually. Literature revealed that in India, during the Covid-19 pandemic, many pharmaceutical companies operated at around 50% of staff capacity. To ensure workplace safety, employees maintained social distancing and avoided physical contact with the products, resulting in insufficient quality control.

Investigation revealed that a number of branded companies unknowingly used fake raw pharmaceutical ingredients after having purchased them at a suddenly inflated price. The counterfeit products not only caused business harm to those branded companies but of course were not effective as medical products to the patients.

To ensure compliance with the requirements of social distancing and to simultaneously ensure the quality of pharmaceutical products, the idea of quality control using automation was proposed. Product quality would be checked in its raw state to minimise loss and remote visual quality control would ensure workplace safety for employees.

The MIT judges were convinced that by using computer vision and machine learning, it could be possible to accurately recognise a trademark and company name ensuring the correct identity of the raw materials. By creating algorithms for recognition and training models, it could be made to work. We also demonstrated that the same concept of automation during quality control could be applicable to personal protective equipment manufacturing industries in India, where there was a similar type of counterfeit issue.

Cost-benefit analysis indicated that by identifying quality issues early in the supply chain, it could not only reduce risk to the customers but also reduce quality related costs dramatically. Currently, the team is working on putting the proposed solution into practice.

Subrata Bhattacharyya is a Chartered Fellow of CIEHF, Fellow and Chartered OHS Professional of the Australian Institute of Health & Safety, Fellow of the Chartered Management Institute and Fellow of the Royal Society for Public Health. He has more than 25 years' HSE management experience and a record of effective leadership in construction, power, steel and chemical industries.

Further reading

"Creating a scalable remote product quality monitoring system in medical devices supply chain" was a winner of the MIT Covid-19 challenge hackathon, August 2020. See https://covid19challenge.mit.edu

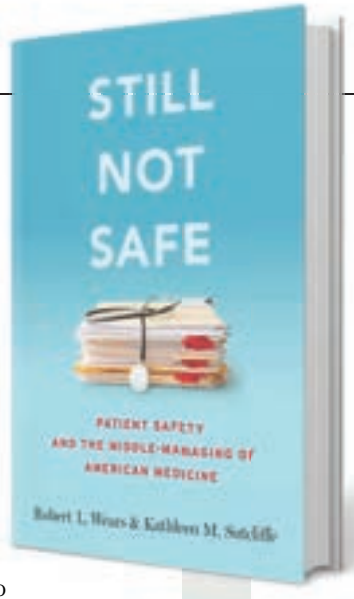
BOOK REVIEW: Still Not Safe

A potentially transformative book describes itself as 'the story of the rise of the patient safety movement' and suggests that, in no small part, the derailing of the patient safety agenda has arisen from the side-lining of safety specialists. **Helen Vosper**, **Paul Bowie** and **Al Ross** explain more

Twenty twenty was an extraordinary year in which to read an extraordinary book. Early on in the pandemic, we received an email from a colleague that expressed some of the frustrations of working as a human factors specialist in healthcare: "During the Francis Inquiry into the causes of failings in care at Mid Staffordshire NHS Foundation Trust, the people who presided over safety and quality monitoring at the time of the failings were 'given the keys to the solution truck' and commissioned to write the reports and make the recommendations". (Summary of output: More of the same, plus 'Duty of Candour').

The broader context of the email was that the pandemic had brought a brief moment of clarity. Those involved in managing the delivery of health and social care realised that flexible adaptation in the face of a myriad of resource/demand mismatches (termed 'work as done' in safety science) was now a clear system strength, rather than the poor cousin of compliance with standard operating procedures. Indeed, we're seeing continuing evidence that trade-offs and workarounds are commonplace and being discussed openly though not always agreed upon; the cancellation of elective surgery (violating waiting time commitments) and flexing theatres to contain ICU beds in a risk trade-off against overwhelming ICU capacity being one very public example. Does this mean that the massive stress on health systems caused by the pandemic and the necessity of adaptive working has rid us of the misconception that systems are inherently well designed and resourced? Will they therefore work best when rigid protocols and procedures are followed and fail mainly due to human fallibility? Or will this 'Safety I' paradigm come back in its own second wave...?

And so to this book: *Still not Safe: Patient safety and the middle-managing of American medicine*. In an interview at the end of 2019, one of its authors Kathleen Sutcliffe (whose



Still not Safe: Patient safety and the middle-managing of American medicine

move into patient safety was prompted by personal experience of 'medical error'), posed the question: "How do you critique a movement you care deeply about without undermining it?" The authors wanted to make things better, and Sutcliffe asserts a belief that 'better' is possible, but not without a "more critical analysis than is being done currently". This book offers a summary of that analysis.

While the discourse largely relates to the USA, it could just as easily be about the UK. Those of us involved in applying human factors to health will recognise immediately the view of patient safety as a movement. Despite our supposed additional insight, many of us talk about the Institute of Medicine report To Err is Human (TEIH) as the birth of the recognition of healthcare-related harm, and use 'scandal stories' like Mid-Staffs and Morecambe Bay as the hook for engaging with our healthcare 'clients'.

Still Not Safe reminds us that the concept of medical harm was well known long before TEIH but that what the report (and its media exposure) did was bring it to public consciousness. Now the public (and the media) were aware of the problem, 'scandal' followed 'scandal'. The need to be seen to act was combined with a desire to control healthcare spending. The result was the imposition of bureaucratic regulation, aiming for control through organisational hierarchies and rule-based processes, and viewing care processes as production lines akin to those in factories.

This, in effect, took control away from the clinicians who until this point had largely been self-regulated. Wears and Sutcliffe assert that, in an attempt not to completely relinquish control, clinicians opted to take up the tools of management, becoming hybrid clinician-managers. This is of enormous significance for those of us involved in health human factors for a number of reasons.

Firstly, it explains why safety scientists are kept on the sidelines: if clinicians can also be managers, they can also be 'Human Factors Specialists'! Secondly, it goes a long way towards explaining why the evidence base for patient safety improvement is limited. The application of bureaucratic management principles to health and social care results in an approach that sees no value in the individual case, believing that insight comes from studying the properties of the aggregate. The principle of valuing the group over the individual good is the same principle which can render evidence-based medicine problematic. The realistic and contextual is jettisoned in favour of the 'all things being equal' best practice ideal. The safety scientist would take a different approach, realising that context is everything, and the real value-based practice is embedded in the messy details of everyday work; the very bits that get lost in the aggregate.

Bureaucratic managerial control asserts that variation is bad. If it exists, someone must be doing something wrong. 'Improvement' involves eliminating the variation and sometimes, censure. Through this lens, 'error' is a discrete cause of adverse events, again disputed by safety scientists. They would be more likely to view 'error' as an interaction between person, task and environment, and an inevitable and emergent outcome of a complex sociotechnical system.

So far so good. *Still Not Safe* skilfully argues the case for health and social care organisations employing human factors specialists. That's great for us within the profession to see. What's much less comfortable for us to read is the recognition that we may be part of the problem. As the book points out, attempts by safety specialists to enter the debate has often resulted in our 'soft-pedalling' on key messages like those above, trying to make ourselves (and our methods) more acceptable to the medical researchers dominating the safety research agenda. Is it time to stop?

On a final note, those of you reading *The Ergonomist*, or attending the Institute's webinars will have seen that the pandemic has provided the opportunity for a different dialogue with the health sector. We're hopeful that the development of the new Learning Pathway for Health and Social Care will allow that to be extended. Maybe we'll be able to use this to move beyond suppression of systems thinking and finally eradicate the myopia around 'human error'! Any Learning Pathway needs mentors, something we know will be a challenge in health. Questions have been asked about whether cross-sector mentoring is possible – we're agreed that it most certainly is, and *Still Not Safe* would be an excellent primer for anyone wanting to familiarise themselves with the challenges and opportunities in this vital endeavour. ●

Context is everything, and the real value-based practice is embedded in the messy details of everyday work

Note: Many will consider Robert (Bob) Wears as a valued friend and colleague. Bob was an emergency room physician who could legitimately claim to be an expert in safety; a PhD in the Dynamics of Resilience in Complex Work Systems was among his many qualifications. His published output demonstrates his commitment to helping fellow health professionals 'understand better'. He died unexpectedly in 2017, a huge loss to those who knew him, as well as those who learned so much from his work. This book is a fitting parting gift to those who continue the struggle.



Dr Helen Vosper is a senior lecturer in Human Factors and Ergonomics at Robert Gordon University, **Paul Bowie** is Programme Director (Safety & Improvement) at NHS Education for Scotland and **Al Ross** is a Senior Lecturer in Human Factors in Health Care at the University of Glasgow.

Further reading

Robert L Wears and Kathleen M Sutcliffe, 2019, *Still not Safe: Patient safety and the middle-managing of American medicine*, Oxford University Press

IMAGE: ISTOCK

The programme

09:30 Orientation: The event opens with a run-through of the day and lively introductory videos from the Jobs Fair Exhibitors.

10:00 Topic Talk: The first of two panel sessions about the work of human factors professionals. We'll be featuring healthcare, the workplace, product design and user research. There's also Q&A time.

12:00 Jobs Fair: A pick 'n mix time for attendees to meet and chat with any or all exhibitors in their individual Zoom rooms and to find out more about what they offer.

14:00 Topic Talk: This second panel session about human factors work focuses on technology, manufacturing, defence, transport and careers in academia. There's also more Q&A time.

16:00 Career Clinic: An open session for attendees to meet the CIEHF and the panelists and ask any questions about their individual pathway options to a great career. Closes at 17:00.

What's included

- ✓ A digital copy of our Careers Guide.
- ✓ A digital delegate pack from our Jobs Fair exhibitors.
- ✓ The chance to listen to and talk to our presenters about what it's like to work as a professional in the discipline.
- ✓ The opportunity to find out about jobs, schemes and openings direct from employers and course providers.
- ✓ Direct access to CIEHF to talk about career pathways and membership options.

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Human factors in automation

Automation offers significant opportunities for improvements in efficiency, cost effectiveness, quality and reliability as well as avoiding putting people at risk working in hazardous environments. Examples can be seen in every industry from the development of autonomous vehicles, the use of robots and drones for industrial purposes, automation of drilling in the oil and gas industry and the introduction of automation in healthcare, among many others. Often, automation allows activities to be carried out that would not otherwise be possible.

Automation however nearly always changes, rather than eliminates, the role of people. If the impact on the human is not clearly understood and taken into proper consideration in the design and implementation of highly automated systems, there can be significant risk, if and when technology fails to perform as intended. This risk, and the associated challenges for system design and implementation, has been recognised and understood in the human sciences community for many decades.

Some industries – aviation, nuclear power and some aspects of manufacturing – are already sophisticated and knowledgeable in this area, though it seems not to be adequately appreciated in other sectors. Recognising the need for raised awareness as well as guidance, the CIEHF has recently initiated a new project to develop a White Paper on the topic of 'Human Factors in Automation'.

CIEHF White Papers aim to represent a consensus view of Institute members about a complex topic within the scope of competence of the discipline. As CIEHF is one of the largest national bodies representing the interests of human factors professionals, its White Papers are widely read and influential. That's certainly been the case with the papers published by the Institute over the last three years: *Human Factors in Barrier Management*, *Human Factors in Health and Social Care*, *The Human Dimension in Tomorrow's Aviation System* and *Learning from Adverse Events* (free copies of all of these are available to download from the Institute website).

Drawing heavily on examples and stories to illustrate the content, the new document will be written for non-specialists and is intended for use across sectors and application domains. The target audience is anyone involved in making decisions about, or implementing, highly automated systems.

A kick-off meeting was held in mid-January and included interested parties from the automotive, rail, healthcare, oil and gas, mining, defence and nuclear sectors. A steering group comprising myself and a number of topic leads was formed and a programme of work is being developed. The intention is to organise some form of event to allow the CIEHF membership to discuss and offer opinions, hopefully in March or April.

In the meantime, if you would like to find out more or get involved with the project, I'd be very pleased to hear from you. Even if you don't want to actively take part, we would greatly appreciate suggestions in three areas:

1. What you would consider the key scientific – and especially experimental, or at least research-based - papers relevant to human factors in automated systems published over the past 50 years or so. As a professional discipline, human factors places great store on being grounded in good science. That's certainly the case in the more traditional areas of the discipline, such as physical ergonomics, though in the application of systems thinking, the experimental science-base can be more difficult to establish.
2. Examples where the human and automated elements of a system have been well integrated leading to a highly successful outcome.
3. Examples of incidents with automated systems where there was some significant human factors contribution. The incidents could have had actual adverse outcomes, or it may be that adverse outcomes were only prevented through the fortuitous – rather than designed and planned for – intervention of people.

A new white paper is being developed that examines the role and impact of human factors in automation. As **Ron McLeod** explains, there is a real need for guidance to raise understanding about the interaction between automation and people, and to enable such systems to succeed

Ron McLeod is an independent human factors consultant with more than 35 years' experience as a human factors professional. Please email him at ron@ronmcleod.com

Further reading

Learning from Adverse Events: https://bit.ly/CIEHFAdverseEventsWP

IMAGE: GETTY

Spring into action

By the time you read this, we may still be in the depths of winter or possibly we might be seeing a glimmer of spring. Hoping for the latter, you may be, like many other members, full of enthusiasm to make changes, to look into a new career or to focus on your professional development.

In 2020 we saw many more applications for professional membership than in other years, as more people may have had time to reflect on their goals, put the paperwork together and submit their application. Others may be interested in increasing their employability or work opportunities by raising their professional profile. If you've thought about upgrading your membership, and you think now is a good time to do it, we'll be happy to help you if you need it.

If Chartership is your goal, you may find our webinar 'Busting the myths around Chartership' helpful (log in to MyCIEHF then look for the Webinars menu item). Feel free to contact me for a chat or to ask any questions you may have.

If you're fairly new to human factors or would like to expand your knowledge, you could consider enrolling for one of the CIEHF-accredited training courses. There are many online options and the course providers will be happy to provide further information. For those of you looking into formal studies, please consider one of the CIEHF-accredited MSc courses. And we have a growing number of free and paid for on-demand online events that cover a huge range of topics.

To find out more about different careers in human factors, what a human factors practitioner might do on a daily basis and the opportunities different sectors provide, make sure you attend our online Careers Day 2021. It's the only event in the UK (and possibly worldwide!) focusing on careers in human factors and a brilliant opportunity to speak to other members who are very happy to share their experiences and offer helpful advice. Hope to see you there!

Iris Mynott
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07702 542166

Support for members by members

We always knew we had a friendly membership but the pandemic has brought this out in abundance. Our many online gatherings see members demonstrating enormous generosity of spirit by providing help and support to others.

Our *Communities* online forum is seeing many thoughtful and insightful written responses to questions and discussions, especially where members are asking for help and advice.

Our Regional and Sector Group Zoom meet-ups are proving to be great opportunities for members to learn, discuss challenges and just generally catch up. As one attendee recently put it: "What a great way to spend an hour!"

To all our members who are doing so much to help and support other members – thank you.

CIEHF events at a glance

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, 4 March 2021, online	A well-established and popular event giving real insights into a career in ergonomics and human factors, for students, new graduates and all those looking for a change of direction.
Ergonomics & Human Factors 2021	Mon-Wed, 19-21 April 2021, online	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.
Comfort Congress 2021	Thu-Fri, 2-3 September 2021, Nottingham	A CIEHF-supported, cross-sector event exploring comfort in transport systems seats and interiors, beds, noise, vibration and temperature, and wearables.
SafeComp 2021	Tue–Fri 7-10 September 2021, York	A CIEHF-sponsored event discussing the state-of-the-art in the safety, security and reliability of critical computer systems and applications.

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


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THE ROAD TO A TRANSPORT REVOLUTION

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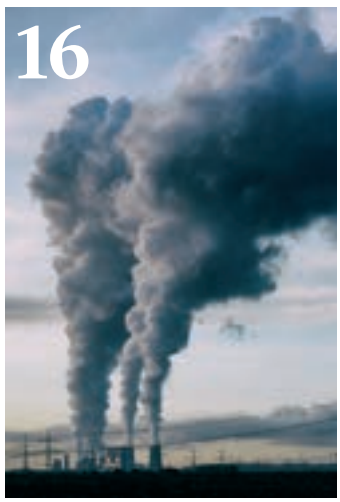

RESEARCH MATTERS

CIEHF NEWS

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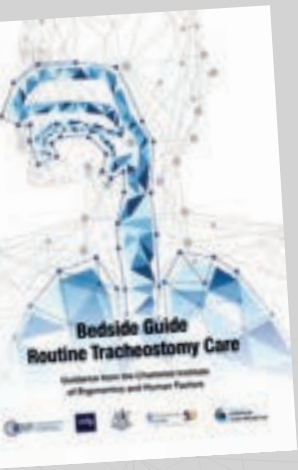
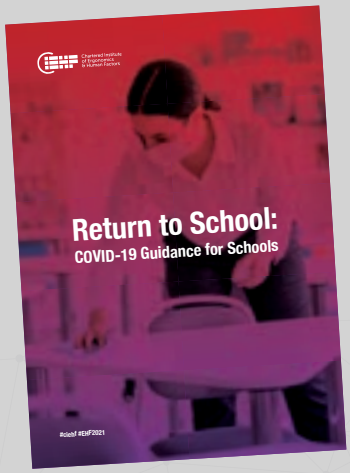
THE HUMAN FACTORS RESPONSE TO COVID-19

Human factors is a science that combines, physiology, psychology, engineering and technology for improving life, wellbeing and performance.





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Chartered Institute of Ergonomics & Human Factors

covid19.ergonomics.org.uk

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FROM THE PRESIDENT

Partnership and inclusivity

Chris Ramsden
CIEHF President

president@ergonomics.org.uk

What a year it's been. I am proud and feel very privileged to be taking over as your President at this exciting and challenging time.

Firstly, I would like to thank Amanda Widdowson for steering us through these challenging times ably supported by our amazing staff at CIEHF Towers. I would also like to thank the sage advice and guidance provided by the Executive, Council and Committees who, despite the pandemic, have supported Noorzaman Rashid, our CEO, in steering the Institute in such a way that we tripled our new members last year and are fast becoming recognised as the most vibrant network for human factors professionals anywhere in the world.

As the undoubted 'wash ups' begin, analysing lessons learned from Covid-19, CIEHF is in an excellent position to build on and develop our partnerships working with the many national and international organisations with whom we collaborated so successfully over the past year.

I believe that collaboration and partnerships are key to success and am looking forward to bringing closer the design and human factors professions so that we can move forward together in producing products, services and lived environments that improve the quality of life for all.

Creating a more equitable and inclusive barrier-free society is my passion, with my attempts to make a difference starting back in 1981 with Professor Heinz Wolff at the MRC/Brunel, establishing 'Tools for Living'.

Forty years ago, the worlds of design and human factors were, to paraphrase an old statement, "two disciplines separated by a common language". Today this situation is improving, although there's still a great deal of work to do. Amanda's 'Design for Everybody' project and the forthcoming development of our UX Learning Pathway are major steps on the path to achieving this goal.

We are also actively creating a more representative and inclusive Institute through engaging members from backgrounds that are less well represented. This is reflected in greater diversity in our speaker line ups, panels, authors of CIEHF reports and representation on working groups including Council.

I hope that you will all join in our activities and with a such a dynamic team behind us… "You ain't seen nothing yet!"

Collaboration and partnerships are key to success

FROM THE EDITOR

Learning lessons and moving ahead

As the vaccination programme continues to roll out to increasing numbers of the population, we consider what the post-pandemic world looks like and the part that human factors can play, in an interview with Professor Sarah Sharples. Continuation of working from home is the reality for many and a piece on digital eye strain reminds us that we need to look after ourselves while Ben Pyburn reminds us why we need to maintain vigilance if were to stay safe online.

Technology and accessibility for older adults through good design is the topic of a piece by Professor Peter Buckle, and our cover article looks at the human factors issues of autonomous transport in the air, sea and on land. The challenge of building a mental model to navigate complex built environments is explored as is the issue of getting public engagement in air pollution.

Bryn Baxendale describes the learning points of a study carried out during the setting up of a Nightingale Hospital and we hear how healthcare teams can work better together from Professor Chris Frerk.

We find out about the challenges of carrying out research under lockdown and finally, we celebrate the life and influence of Professor Nigel Corlett, who gave so much to the discipline.

Tina Worthy
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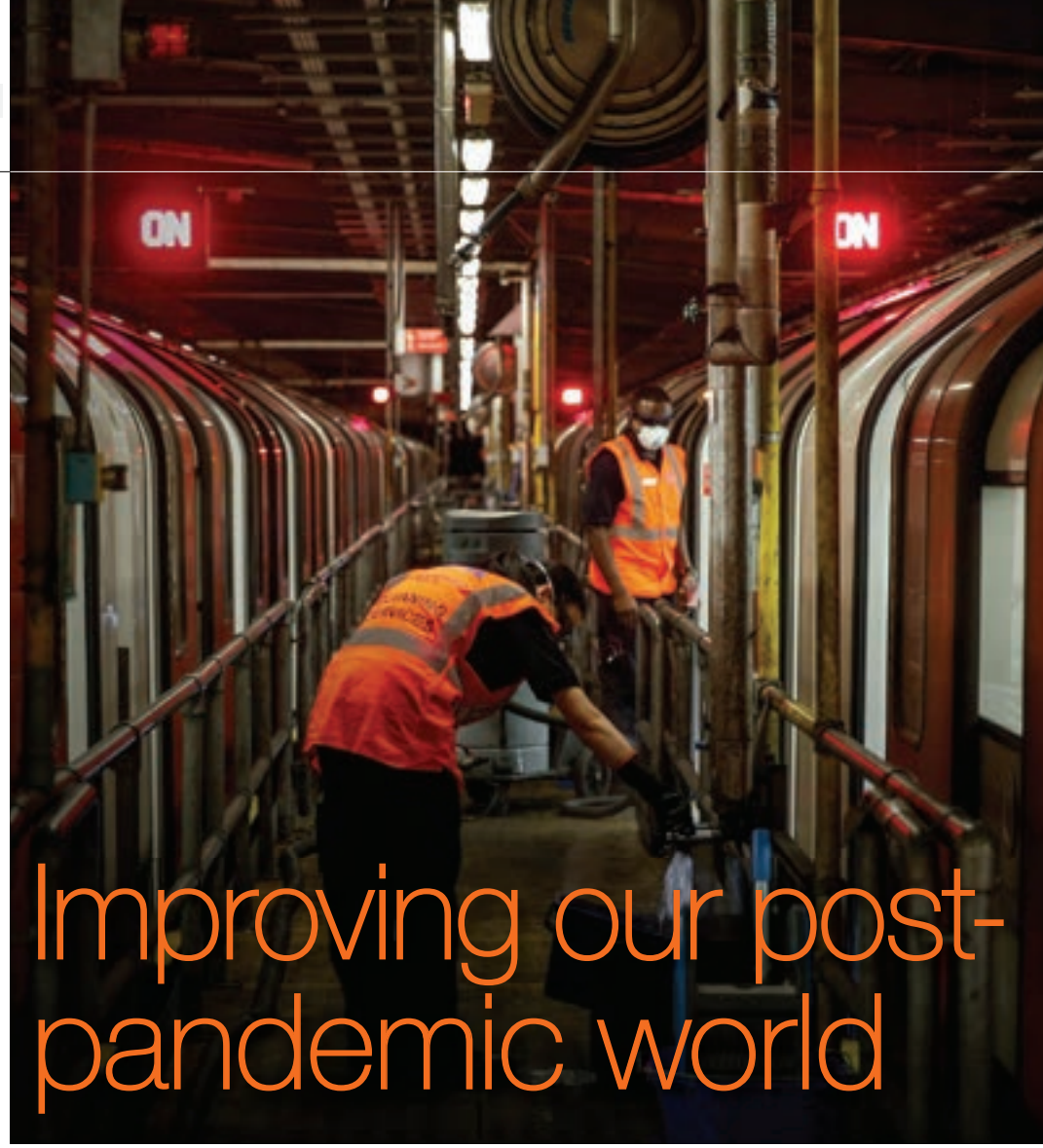


Improving our post-pandemic world

The coronavirus pandemic has caused dramatic changes to the way we live and work and the long-term effects of the Covid-19 outbreak are still to be fully revealed. As the world adjusts to these shifts, we look ahead to the challenges and opportunities where human factors could have an impact

The post-Covid recovery will touch many corners of our lives, encompassing economic, societal and wellbeing concerns, as well as issues of sustainability and climate change. Creating effective solutions to such unprecedented problems will mean finding a way to balance these different and delicate strands.

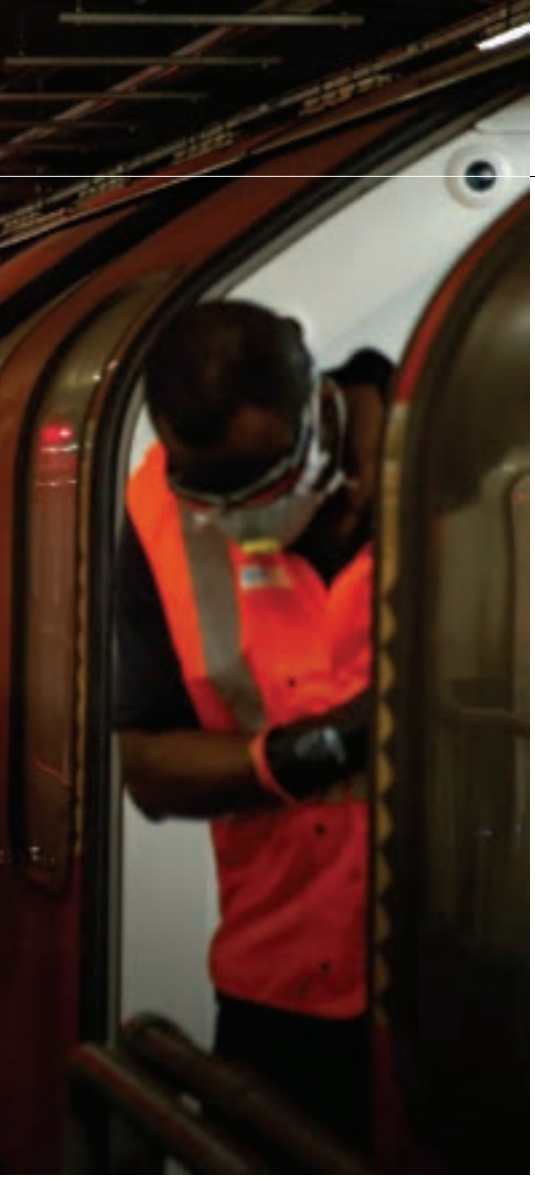
The future of human factors in this post-pandemic world is a topic that has been examined by Professor Sarah Sharples and was the subject of her presentation for this year's Institute Lecture. While the pandemic has increased public engagement with science and research, it's also had an effect on the way we perceive the world around us which will need to be taken into consideration as we design and plan for the future.

"We need to design for safety," said Sarah, "but what we're seeing is that it isn't enough. This is something that's in the public consciousness but the asymptomatic transmission of Covid is a really difficult challenge for the community to understand. As well as making our environments as safe as possible, we have to make people *feel* safe and recognise the impact of their behaviour on the overall situation. It requires a very different type of intervention that human factors can hugely inform."

The uncertainty around Covid presents another challenge. The public's mental model of coronavirus has changed as the pandemic has unfolded and more has become known about how the virus is transmitted. But with science still to find clear answers to all our queries, it raises the question of how an effective model can be communicated that helps minimise the further spread of the illness. Sarah said: "We refer to the notion of a 'mental model', which is our internal representation of how something works. From a human factors point of view, we believe that will have an influence on behaviour but we've also got uncertainty in our data and uncertainty in the science. I think there's an additional role there for human factors in thinking about how we can effectively and helpfully communicate uncertainty."

Sarah's work in the transport sector provides an example of the issues that lie ahead and how human factors expertise can play a key role in overcoming them. The demand for greener solutions will need to be balanced with the public reticence to return to public transport and increased anxieties about safety. The threat of climate change and the question of how to decarbonise transport is already one of the issues at the centre of planning the transport of tomorrow. Sarah explained: "How can we encourage people to think about their travel from an environmental point of view. How can we enable people to travel by public transport and how do we design it to be accessible and inclusive? We also need to think about the way we design interaction systems in conventional cars and those which are highly automated. There's some fantastic work being done within the ergonomics community looking at the design of technology for automated vehicles, both from the perspective of the safety and comfort of the user but also the carbon impact of the vehicle."

While public transport could be a useful weapon in the fight against climate change, the pandemic has left



Employees of Transport for London work during a deep clean operation of trains used on the Victoria Line of the London Underground network

many people nervous about sharing trains and buses again. Confidence has to be restored and passengers need to feel as safe as possible in their chosen mode of transport. "We need to do this in a very honest way," said Sarah. "It's not about communicating safety when it isn't there – we need to communicate the implemented interventions that have effectively delivered safety to support an individual's choice. That means everything from how you guide people to be confident they're safely socially distanced within a vehicle to thinking about how you communicate the effectiveness of ventilation in a public transport situation. I also believe we'll see more people using active travel, like walking, cycling and using e-scooters. We need to understand how to design these interventions to encourage people to try these different ways of travel but also make sure they're safe for them and for other road and pavement users."

The trade-offs which apply in transport are also mirrored in the transition to homeworking. A hybrid model of employees splitting their time between home and offices could come with the added environmental cost of having to heat both homes and workplaces. There are also financial implications to be considered along with issues of productivity, wellbeing, transport and working hours.

"Some very complex trade-offs are going to be playing out," said Sarah. "The role of human factors could be through the design of technology to address some of these things; supporting our wellbeing, making things cheaper or influencing our choices around carbon reduction. We can also use human factors to influence decision-making which might be around organisational culture as well as individuals."

The Covid situation has already shown the huge potential of ergonomics and human factors to drive improvements across many levels. A key part of the human factors response to the pandemic has involved what Sarah describes as "going back to basics". The sudden shift from offices to homes left many people relying on improvised workspaces, putting a new emphasis on areas which no longer attract a lot of active research. Issues surrounding posture, rest breaks and eye strain took on a renewed importance, and knowledge which had been built up over the decades was applied to improve homeworkers' wellbeing.

The rapid response to the pandemic by the human factors community was a tangible example of the positive difference the discipline can make, particularly in healthcare. Work on the design of ventilators, built on decades of work on medical devices, has been particularly helpful and showed the value of human factors. As the long-term effects of Covid gradually emerge, effective design will continue to have a significant part to play in ensuring accessibility and inclusivity.

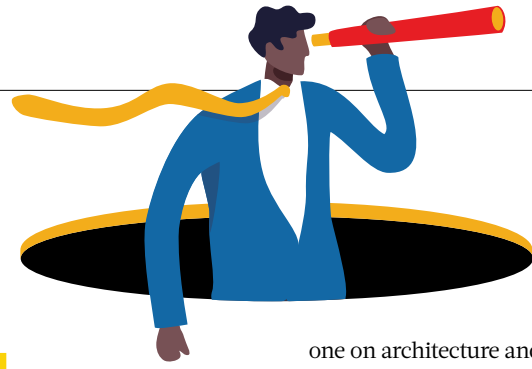
It's our moral responsibility to learn the positive messages that this difficult experience has to offer

Professor Sarah Sharples from the University of Nottingham. Sarah has been appointed Chief Scientific Advisor at the Department of Transport from July 2021

"We don't really know how the long-term impact of Covid is going to play out from a mental and physical health point of view. Sadly, it's likely that we'll see long-term effects and new and different types of disability for which we'll need to design effectively. This interacts with the economic and societal recovery as well and we also can't take our eye off the ball in terms of the sustainability agenda."

For some people, the different working habits sparked by the pandemic have been a rare positive amid a bleak year. The challenge for the future includes finding a way to incorporate the new thinking and flexibility which has come out of the crisis to make lasting improvements to people's lives. "It's our moral responsibility to learn the positive messages that the very difficult experience of the pandemic has to offer us," said Sarah. "We need to work out how human factors can help get the right balance between retaining the good things about how we work now but also recognising the things we're missing and how we can build those back in again. There's an awful lot that human factors has to offer and what will really advance things is to continue working in multidisciplinary teams and embedding the value of what we're doing."

IMAGES: GETTY / ISTOCK



CHIEF EXECUTIVE'S PERSPECTIVE

Emerging from the pandemic stronger

We began 2021 with the same gusto we ended 2020, including running a heavily packed programme of online events - almost one a week. Our online visibility and marketing has seen up to 350 people registering for events. What is really exciting is that 20% or more are international participants, contributing to our reputation as the most vibrant ergonomics and human factors network in the world.

Our Ergonomics & Human Factors conference, EHF2021, will see the same level of international participation as did our recent Careers Day. We have been approached by several societies around the world and we will collaborate with them in bringing together international panels of speakers. Currently we're working with the Indian Ergonomics Society on a survey to measure the impact of Covid-19 on small and medium-sized enterprises in India and the UK. We've joined the Australian Association for Artificial Intelligence in Healthcare and the Society for Healthcare Innovation in the USA. Let me know if there are other international networks in other sectors you feel we should pursue.

Our webinars on automated vehicles run by Joseph Smyth hit over 200 participants as did the event on *Neuroergonomics and Fast Jets* put together by Suzy Broadbent. All past events are available on demand (visit https://events.ergonomics.org.uk/events/list/). I'd like to thank all of our Sector Group Leads and Special Interest Group Leads for planning nothing short of an inspiring programme.

We're collaborating with several UX and service design groups around the world and will be launching a special event on *Demystifying UX* which will examine how this discipline is evolving and its link to ergonomics and human factors.

We will be publishing advice on vaccination programmes aimed at an international audience which will be followed up with a more detailed guide building on research a small group of members are undertaking. This work is led by Janette Edmonds, Helen Vosper and Paul Bowie from our Healthcare Sector Group.

In response to schools reopening, a short guide was prepared by Courtney Grant for teachers (see https://bit.ly/CIEHFReturntoSchool). Collaborating with parents and school children, we created an infographic to help nudge good hygiene (see https://bit.ly/CIEHFReturntoSchoolInfographic).

The CIEHF has strengthened its capability as a virtual organisation

Jim Taylour, leader of our Children's Ergonomics SIG is completing a report on "Reinventing the classroom" and Julie Rainey will be running an event on biophilic design which reflects the growing interest in architecture and design within our membership.

We can expect more exciting publications during the remainder of the year. This includes a paper on cyber security led by Amanda Widdowson and one on architecture and design being prepared by Lilian Antonio, Kirsty Angerer and Ed Milnes. Another publication I'm really looking forward to will be on mixed reality technologies and human factors in industrial, healthcare and educational contexts, led by Bob Stone.

As we emerge from the pandemic, the CIEHF has strengthened its capability as a virtual organisation. A new Learning Management System and a new Membership Information System combined with refreshed website will take us to the next level of evolution as a world class membership body. These new systems will be in place before the end of the year.

Member surveys have shown that there is support to continue online events. Having said that, we will endeavour to bring a limited number of high quality in-person events to members at a regional level working with Regional Network leads from 2022.

Finally, you may have noticed that the CIEHF is very busy on Twitter, and LinkedIn in particular. We encourage members to make comments and create discussions, engaging new audiences which helps to garner interest in our profession and attract new members. But most importantly being active on LinkedIn helps members to develop their own profiles and gain more recognition. There are many good examples on how members active on LinkedIn have been invited to participate as speakers at various conferences and on podcasts, as well as winning business. LinkedIn is also the number one platform for people looking to recruit staff and to look for professional help. You can learn more about setting and improving your LinkedIn account through our on-demand Masterclass (see https://events.ergonomics.org.uk/event/lifting-the-lid-off-linkedin-masterclass). ●

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noorzaman rashid

Fighting back against fraud

The rise in online activity has been followed by an increase in scams exploiting the digital world. **Ben Pyburn** describes how he fell victim to a fraudster and explains how he believes the human factors community can help in the fight against cybercrime

I recently lost my life savings through a socially engineered online banking scam. The experience was humiliating and totally heart-breaking but after a couple weeks of struggle I was lucky enough to be reimbursed in full because I could prove I took necessary precautions during and following the scam.

A huge amount of money is lost through cases such as my own. If you want to steal millions a year, take it from thousands of people, thousands of pounds at a time. There isn't the time or resources for law enforcement authorities to effectively tackle cyber fraud on a case by case basis. I found this out first hand. My case was only reviewed by Action Fraud Police after 30 days. I received an automated email saying there was no line of enquiry to pursue.

Lengthy correspondence with my bank and replaying the event continuously in my mind made for the perfect user test. The more I reflected on the decisions I made, the more I became convinced my errors could have been prevented or mitigated with simple adjustments to my online banking structure. These were often small human-machine interaction adjustments that I would recommend to prevent operator error in my line of work. This process, and fantastic support from the CIEHF community, inspired me to look more holistically at how human factors can decrease human error – which is thought to account for 52% of cyber security breaches, according to the Computing Technology Industry Association. A model from The *Psychology of Internet Fraud Victimisation: A Systematic Review* helps give a more complete picture of the different 'deceiver and receiver influences', factors and variables that can be targeted and manipulated to try to prevent human error.

'Dispositional factors' such as personality and loneliness are anecdotal rather than evidence-based and are difficult to improve. The only realistic way to reduce deceiver influence is to limit exposure to it. This is becoming increasingly difficult as cybercrime is not just limited to highly skilled 'hackers' but any criminal with access to phones, computers and the dark web to provide a fraud playbook. Deceivers will use tried and tested scam routines and use common textbook marketing strategies, such as Cialdini's six Principles of Persuasion to form shared scripts.

These scam routines are usually rolled out indiscriminately. Since everyone is a target, experiential factors can only be improved with mass education projects. Even those who are more tech-savvy aren't actually less likely to be scammed in the long run on average because they interact with technology and are exposed to different types of fraud so much more. Educating the masses seems to be the chosen approach to fight cybercrime. This is challenging because of the sheer scale of education required and the evolving nature of these scams.

Focusing on education to improve experiential factors is the most important but not the only strategy to fight cybercrime. Decision making cues could be greatly improved by a third variable: designer influence – people designing interfaces and systems that actively work against the receiver and deceiver influence. I have no doubt a lot of time, effort and money goes into a bank's user experience (UX) and security departments, along with a long list of universal cyber security codes that must be abided by. However, UX/human factors and cyber security must work together within and between individual banks to tackle cybercrime. Ethical hackers play the role of criminals to shed light on vulnerabilities in security systems, networks and infrastructure. Similarly, human factors can shed light on socially engineered vulnerabilities through user testing with modern scamming techniques.

Online banking in an ideal world should try to prevent even those who know nothing about cyber security from getting scammed. Banks shouldn't just try to cover themselves with 20 pages of incomprehensible terms and conditions but help prevent human error by combining cyber security with UX and human factors.

Ben Pyburn is a Human Factors Engineer at Rolls-Royce plc and a cyber security and fraud prevention enthusiast.

Further reading

G Norris et al, 2019, The Psychology of Internet Fraud Victimisation: a Systematic Review, *Journal of Police and Criminal Psychology*, https://doi.org/10.1007/s11896-019-09334-5

6 Principles of Persuasion: www.influenceatwork.com/principles-of-persuasion-are-not-just-for-business

IMAGE: GETTY / SHUTTERSTOCK

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The conference is organised by the Chartered Institute of Ergonomics & Human Factors, and with the support of ComfDemo under the European Union Horizon 2020 Clean Sky 2 programme (No 831992)

Chartered Institute of Ergonomics & Human Factors

Nottingham Trent University

Women in engineering

The underrepresentation of women in STEM (Science, Technology, Engineering and Mathematics) is long-running and unresolved. While progressions have certainly been made in many of these fields, there are still disparities between men and women when it comes to both education and employment uptake and opportunities.

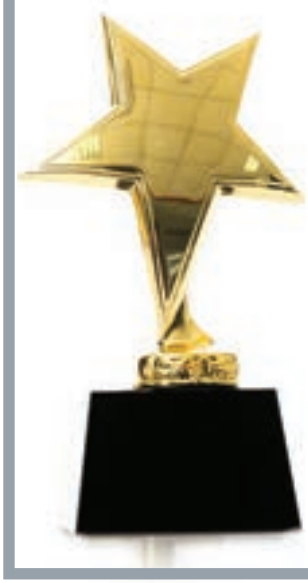
Education plays an integral role in dictating the numbers of girls and young women who consider and pursue a career within the UK engineering sector. According to the most recent data collected by UCAS, the Universities and Colleges Admissions Service, although UK STEM university courses still show a 65%:35% split in take up by male and females respectively, some minor improvements have been noted. For instance, the number of female students who have graduated from STEM core subjects at degree level has grown by 2% since 2016.

However, despite their small numbers, female engineers have created some of the most useful inventions that impact modern life.

Elizabeth Bragg was the first officially recognised female engineer. She received her degree in Civil Engineering from the University of California, Berkeley in 1876. Nina Graham became the first British woman to receive an engineering degree in 1912 when she graduated from the University of Liverpool with a degree in Civil Engineering. But a century before this in 1812, Tabitha Babbitt, a tool maker, invented the circular saw. Ada Lovelace worked alongside her mentor Charles Babbage in 1840 to produce the first computer algorithm. Lovelace was a mathematician and physicist, and she is today recognised as having greatly contributed to the development of Babbage's first technological general-purpose computer, which he named the Analytical Machine.

Maria Beasley invented a machine that enabled hoops to be put on barrels, speeding up their manufacture and patented improvements to life rafts in 1880. A few years later, Josephine Cochrane came up with the concept of a mechanical dish-washing machine which she patented and mass-produced. In 1903 Mary Anderson created a design for the first windscreen wiper after taking a taxi journey in New York during which the driver kept having to slow down to open and close the window to clear it of rain.

With countless other inventions and innovations attributable to women through the intervening years, let's open up more opportunities and encourage a greater equality of talented engineers in all sectors. Find out more at www.stem.org.uk and https://vemcoconsulting.com/female-inventors-who-inspire-us.



Let's celebrate!

Let's celebrate together the impact our discipline makes and its success in all aspects of life by recognising the people behind it. Our professional awards recognise excellence across a number of categories. This year, we've moved the nomination window forward so we can celebrate the winners in an online event in the summer.

Quality postgraduate work by students is recognised through nomination by course leaders for the Best Student Project Award. Excellent work by an early career human factors professional is celebrated with our New Ergonomist of the Year Award.

Outstanding project work by a group is recognised by our President's Award, whilst our Innovation Award is given for any project or programme of work that's made a significant and innovative contribution to the discipline in relation to a product, system or facility.

Two Lifetime Achievement Awards are given: one for significant academic research and development and the second for outstanding practical application of human factors.

A special Communications Award is given for an effective and impactful one-off communication of information through digital or print media. Finally, we recognise the contribution to our work of our amazing members through our Volunteer of the Year Award. Nominations can be submitted now until 3 May 2021. For all details, see **awards.ergonomics.org.uk**.

Lessons from Nightingale London

A year ago on 3 April 2020, the NHS Nightingale Hospital, London opened with capacity for 500 ventilated patients. With their specialist human factors expertise, **Bryn Baxendale** and colleagues conducted detailed observations during the early days and reflect here on some of the key learning points and work system issues that came about

Although not used to capacity, during the design and early use of the NHS Nightingale Hospital, London (NGL) multiple interacting challenges emerged in relation to setup, logistics, communication, staff recruitment, training and the clinical operating model. The NGL Education and Training Programme Leads identified the value of using human factors expertise to help align the design of a unique working environment and clinical operating model and to prepare and orientate staff and ensure safe, effective practices and wellbeing.

The systems approach

Human factors has been widely championed within healthcare, particularly in terms of improving patient safety and the design of healthcare systems. Methods and tools have been developed to understand and improve the interaction between tasks, tools and technologies, organisational conditions and the wider environment during the process of care delivery, including applications to the Covid-19 pandemic and responses. Key to human factors is a systems approach used to understand how elements of the overall work system change and adapt over time. At NGL, three senior academics with human factors expertise remotely supported three human factors specialists embedded in the facility for three weeks to conduct detailed observations and support aspects of organisational practice or planning.

Jobs, tasks and roles

Job and workforce configurations were redesigned to meet an increase in workload due to an expected influx of patients and clinical challenges presented by the unfolding pandemic. The staff to patient ratio was reduced to mitigate the shortage of specialist critical care nurses and doctors, and professional roles were redefined to alleviate the demands on physical and cognitive workload. New clinical roles were established whereby volunteers and unregistered staff could perform specific tasks such as patient washing and turning, mouth and pressure care, proning and taking blood samples. Some staff with specific skills or expertise were allocated to provide medical device and equipment support.

Ultimately, all staff faced novel circumstances adopting new roles and levels of responsibility and accountability, in a unique environment with unfamiliar equipment, colleagues, procedures and practices. Some risks associated with these new circumstances were mitigated via a rapidly evolving education and training programme that employed structured, practice-based simulations to aid staff preparation but training struggled to keep abreast with adaptations required.

Critical care staff had to take on an unfamiliar supervisory responsibility for other staff, often not knowing who was trained to do what tasks, how to provide appropriate supervision and what the expected standards of care were within this novel clinical model. Deconstructing a more holistic approach to patient care into multiple tasks allocated to different individuals or teams risked standards of care, with some reports describing missed care episodes. For example, regular mouthcare and checking of a patient's skin and tissue viability, ordinarily done by experienced staff when washing and turning patients, was documented less consistently by inexperienced volunteer teams performing this task separately for one patient after the next.

Human factors involves using job design methods and tools to understand and

analyse the goal of the task carried out by skilled professionals, and the physical and cognitive demands introduced, including the need for sufficient rest and recuperation. It examines the interrelationships between tasks and how these enhance or degrade system goals (such as quality of care, patient safety, efficiency). One key lesson is that future rapid set-up or redesign of healthcare facilities, with or without introduction of novel clinical models of care or new ways of working for staff, would be likely to benefit from incorporating human factors expertise to optimise system and staff performance and wellbeing.

Workspace, equipment and work design

Many issues were identified and addressed as the NGL came into operation. Supply issues around medical equipment and consumables resulted in non-standardisation and unfamiliarity with human-device interfaces even amongst experienced staff, often adding to their cognitive workload to an extent that had not been fully anticipated.

There were issues that went on to create risks 'downstream'. For example, the area for donning and doffing personal protective equipment (PPE) was not designed to support a full-shift worth of staff preparing to enter the ward simultaneously. This led to the separation of staff groups through staggered start times and hindered attempts to include shift and team briefings as part of the handover process. This compromised the provision of consistent and regular updates about new and changing ways of working and was a barrier to senior staff meeting and supporting their less experienced colleagues.

IMAGES: GETTY

Some simple workspace interventions, identified by the human factors team, should have been foreseeable and addressed early. These included labelling emergency buttons, providing seating capacity and suitable writing surfaces, and ensuring access to stored consumables with consideration given to labelling. Many human factors tools and methods to assess and ensure that physical spaces are designed to support work tasks and processes could have been of benefit at NGL and are worth consideration for future design of health and care environments including future surge capacity provision for further pandemics.

View outside the NHS Nightingale hospital at the ExCeL Centre

Understanding 'work as done' generates intelligence about emerging system resilience and performance

Adaptation, learning and improving

NGL developed a learning system, employing Bedside Learning Coordinators (BLCs) whose role was to source and implement improvement ideas for clinical practice in a rapid and agile manner. The BLC's observations aimed to trigger continuous improvement related to Standard Operating Procedures, responses to infrequent or challenging situations, or work environment changes. Limitations included a tendency to fire-fight rather than identify underlying system-level issues. This was underpinned by a lack of consistent structured observations and categorisation of data, lack of monitoring the efficacy and outcomes of adaptations, and problems with communication and documentation of observations within the clinical area caused by needing to wear full PPE.

Incorporating human factors expertise in the design (staffing, data collection, feedback mechanisms) of an overarching learning system would enhance the ability to recognise and monitor short and longer term adaptations to complex, uncertain and ambiguous demands, as well as to measure effectiveness. Gaining a better appreciation of 'work as done' alongside mismatches with how clinical work is sometimes 'imagined' offers valuable insight into adaptations and, from the human factors perspective, generates intelligence about emerging system resilience and performance under challenging or dynamic conditions.

Considerable potential

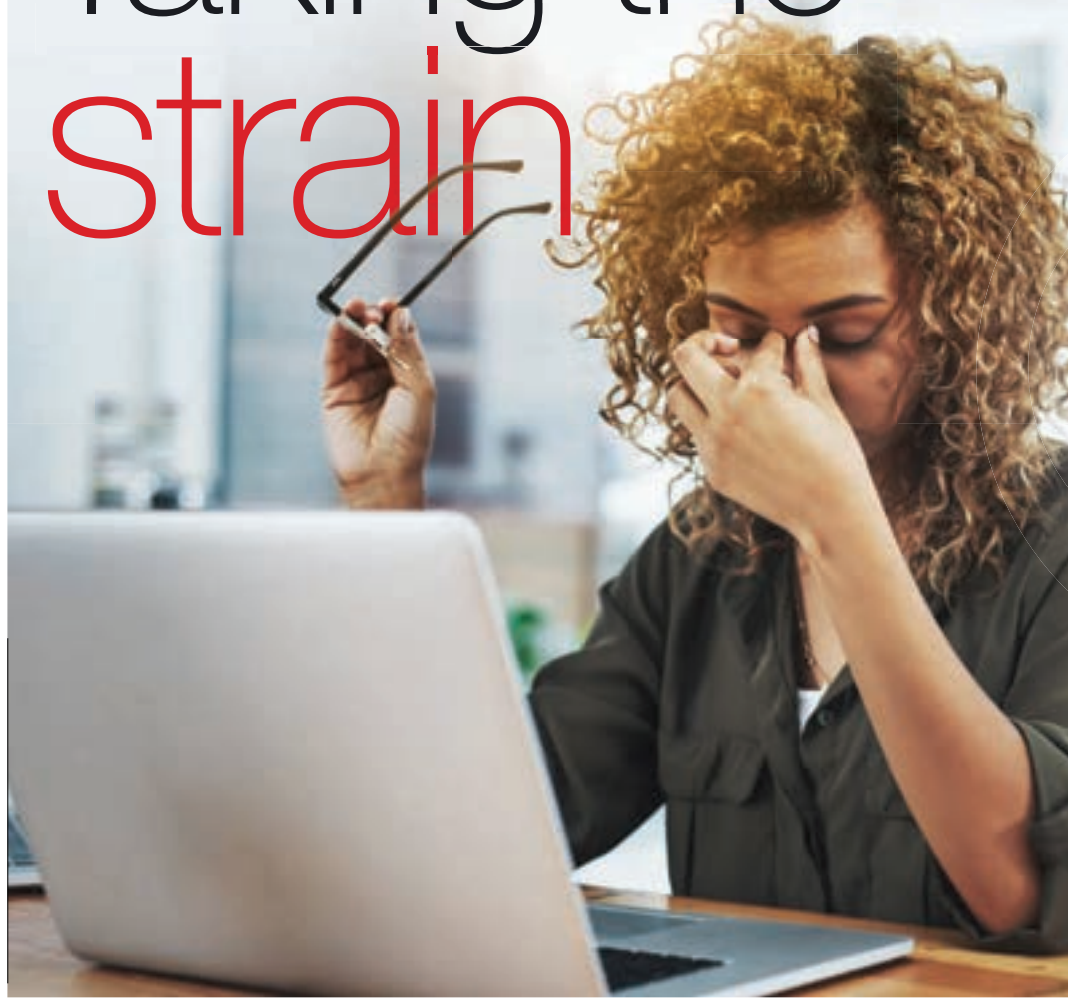
Human factors is commonly introduced as part of education and training programmes within healthcare but its expert application still remains under-exploited relative to other safety-critical environments and workplaces. The involvement of human factors experts is often considered late in the life cycle of service (re)design programmes, reflected in our work at NGL where the work, physical and organisational systems were already designed and being placed into operation.

We've underlined some of the unique advantages of applying human factors to the design of work, workspaces and systems from the outset. In combination with other established practices, such as Quality Improvement, human factors has considerable potential in helping to ensure that healthcare systems work right first time, emphasising the value this has on staff wellbeing, and in the longer-term saving time, money and lives. This has relevance for on-going and potential future challenges faced in sustaining the resilience of healthcare systems during times of exceptional pressure and demand that seem set to continue for the foreseeable future.

Bryn Baxendale is a Consultant Anaesthetist at Nottingham University Hospitals NHS Trust and Simulation Lead, HEE. **Dr Patrick Waterson** is Reader in HF and Complex Systems at Loughborough University. **Al Ross** is a Senior Lecturer in HF in Healthcare at Glasgow Dental School. **Emma Crumpton** is an independent consultant. **Clinton John** works at University College London Hospitals NHS Foundation Trust. **Jo Simmons** is a Chartered Ergonomist and Human Factors expert, a qualified nurse and works at the CHFG. **Gyuchan Thomas Jun** is a member of the Human Factors and Complex Systems Group, Loughborough University.

Taking the strain

The global pandemic has been the catalyst for changes in the way we work. For many of us, spending more time on digital screens is the reality, coupled with hybrid working practices, which is leading to the development of eye problems for many, as optometrists **Debbie Young** and **Sarah Arnold** explain



The impact of COVID-19 has radically increased the time we spend looking at digital screens. According to a study for Vision Direct which polled 2000 people in Britain, the average time spent on digital screens is now more than 13 hours per day. Repetitive and prolonged computer screen viewing can lead to chronic physical and visual problems which, when left untreated, may lead to stress and anxiety.

Employers have a duty to ensure that the occupational health and safety requirements of their staff are met. The escalating reliance on technologies, coupled with less control over the work environment, has presented employers with new challenges. 'Eye-gonomics' is the missing agenda in outdated Display Screen Equipment risk assessments and looks to optimise occupational vision and structure work environments and practices to nurture sustainable eye comfort and visual function.

Christina Marriott, Chief Executive of the Royal Society for Public Health states, "Some form of home working is likely to continue for millions of people and we urge employers to take the necessary steps to ensure their staff can work from home as safely and healthily as possible."

Digital eye strain

Whilst excessive screen work is unlikely to lead to any permanent harm to vision, digital eye strain is now the most common computer-related repetitive strain injury among office workers, surpassing carpal tunnel syndrome and tendonitis. Digital eye strain, also known as computer vision syndrome, describes a group of eye and vision-related problems including dry eyes, tired eyes, headaches, blurred vision and is associated with musculoskeletal issues.

Spectacles must be fit for purpose. If the magnification power of the spectacle lenses is too strong, the wearer will intuitively lean forward to see their screen clearly, which can compromise their posture. Conversely, the opposite can occur. We instinctively position our eyes to optimise clear viewing; wherever your eyes look, your body will follow.

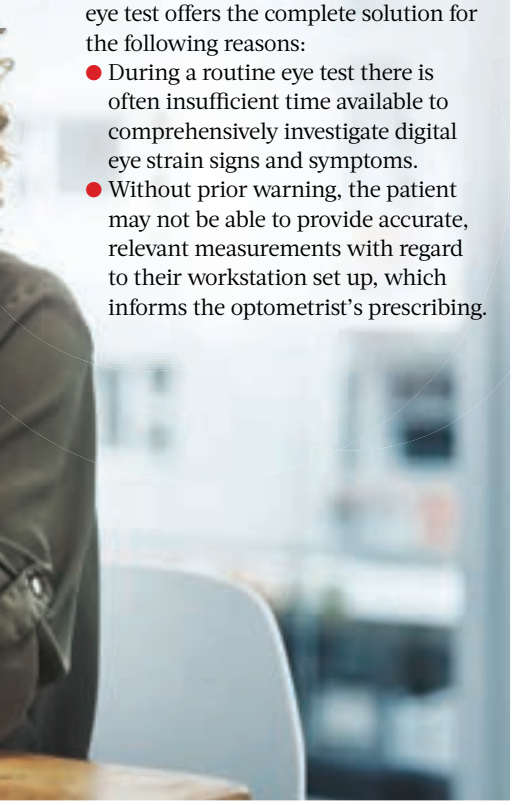
Varifocal wearers are prone to neck and shoulder problems when working on computer screens. This is because they lift their chin to enable clear screen vision through a very limited area within their lens. With digital screen time rising, it's essential that both the correct prescription and lens type are worn to mitigate musculoskeletal neck and shoulder ache. Prolonged sub-optimal working postures can lead to a variety of problems, culminating for some in serious, debilitating long-term injuries.

IMAGES: ISTOCK

Digital eye strain increases proportionally with screen time with reports estimating that up to 90% of screen users may experience symptoms. In July 2020, the College of Optometrists reported that millions of people could be suffering from a range of eye problems dubbed 'coronavision'. The number of patients coming into our optometric practices experiencing symptoms of digital eye strain has increased by 30% since lockdown.

Solutions to overcome digital eye strain require a holistic approach. One size does not fit all and multiple factors must be taken into account for each individual. Most symptoms can be resolved by making specific 'eye friendly' physical, environmental and behavioural changes which will include introducing management strategies to alleviate dry eyes, tired eyes and headaches, coupled with having regular eye examinations. But whilst eye examinations will test for disease and check the spectacle prescription, advice given on digital eye strain is often limited and generic. In our emerging technological climate, it's no longer enough to consider a routine eye test offers the complete solution for the following reasons:

- During a routine eye test there is often insufficient time available to comprehensively investigate digital eye strain signs and symptoms.
- Without prior warning, the patient may not be able to provide accurate, relevant measurements with regard to their workstation set up, which informs the optometrist's prescribing.
- The professional advice received is verbal. Research shows that patients retain only 14% of verbal information in a clinical setting whereas, if information is in an illustrated written format, 80% is retained.



Minimising risk

The Health & Safety at Work Act 1974, makes it clear it's the employer's duty "to manage and reduce the risks which employees are exposed to when they carry out their work". In May 2020, the Health & Safety Executive updated their guidance stating, "Employers have the same health and safety responsibilities for employees working from home as for any other employees. If you have staff working at home, you must still manage the risks to their health from Display Screen Equipment (DSE)." Employees also have a duty to comply with the instructions and systems that their employers put in place to manage their risks. Providing employees with tailored, evidenced-based, self-help strategies and best practices will go a long way to minimising potential risks.

Equipping employees with good 'eye-gonomic' and ergonomic advice is key. If digital eye strain and associated neck problems are to be avoided/ safely managed, screen users should be advised to:

- Wear appropriate spectacles, (prescription, lens type, tints and coatings). This will encourage a neutral and sustainable head posture.
- Ensure screen distance and screen height are correctly set for comfortable viewing.
- Minimise screen glare using the appropriate ambient lighting (screen placement, task lighting and natural day light).
- Employ appropriate strategies to manage dry and tired eyes.
- Practise good wellbeing working habits including frequent short (20-20-20) breaks and longer breaks, away from the screen.

Historically, some DSE assessments have been carried out in-house. Working from home or hybrid working is here to stay with 94% of organisations now offering their staff some form of flexible working. This raises new challenges for DSE assessors. The use of digital screens is ubiquitous for both work and social purposes, so new approaches are needed to reduce the risk of digital eye strain.

Although many businesses may be uncertain about the best way to manage the risks faced by their workforce using DSE, help is at hand with outsourced, sustainable innovations. One such innovative approach is offered by *Eyes for Work*, the first optometrist-led UK company to provide organisations with large scale, cost effective, targeted risk assessments. Each *Eyes for Work* report identifies those with digital eye strain symptoms and offers each employee a personalised package of tailored ergonomic and wellbeing work practices.

Most symptoms can be resolved through 'eye friendly' physical, environmental and behavioural changes

After completing a quick and easy online questionnaire, a report is delivered to each employee which encourages safe and healthy working and facilitates optimal visual performance. Follow-up assessments allow companies to track the digital eye health of their workforce. To find out more, please visit **www.eyesforwork.co.uk**
Email **info@eyesforwork.co.uk**

Deborah Young is an independent prescribing optometrist with a special interest in medico-legal work.

Sarah Arnold is an optometrist and academic and was an AOP Optometry Lecturer of the Year 2020 Finalist. Her special interest is in visual impairment. Together, in 2020, they set up and now run *Eyes for Work*.

Further reading

Digitized: The Daily Impact of Digital Screens on the Eye Health of Americans, www.thevisioncouncil.org
Management of Digital Eye Strain: Coles-Brennan C. et al Clin Exp Optom 2019; 102;18-19 https://pubmed.ncbi.nlm.nih.gov/297974531

A breath of fresh air

Air pollution is cutting short lives around the world and taking a toll on the environment. **Barry Kirby** examines how human factors has a role to play in helping us all breathe a little more easily

It goes without saying that we all need air to breathe. From the time we're born until the day we die we'll inhale and exhale 24 hours a day. But how often do we stop and think about the quality of the air around us? And what can we do about it? That's exactly what Professor Paul Lewis, Sam Lewis and I explore in our paper, *Do You Think Air? Public Interest in Air Pollution*, delivered at this year's Ergonomics & Human Factors conference.

The paper is part of our internally funded wider research programme, which is dedicated to air quality in the UK. Not only does the paper reveal the current levels of public interest on the topic of air pollution but it also gives us meaningful data and insights which – led by ergonomics – can be used to develop longer term behavioural change methods that will ultimately benefit long term health.

Air pollution is an issue that impacts both our health and the environment. Despite this, it's a topic that often takes a back seat, especially when there are more pressing issues dominating the news headlines. But the reality is, air pollution is the leading environmental cause of early deaths worldwide. The World Health Organization estimates that poor air quality contributes to 5% of all deaths globally, while epidemiological studies have also shown that long term exposure to air pollution can reduce life expectancy, mainly due to its impact on the cardiovascular and respiratory systems.

Two of the most damaging pollutants, in terms of our health, are fine particulate matter (PM2.5) and nitrogen dioxide (NO_2). Although there are statutory obligations to ensure that concentrations of specified air pollutants are kept below certain limits in the UK, we continue to have levels of NO_2 above legal limits. And this comes at a cost.

According to the Royal College of Physicians, the mortality burden of air pollution in the UK is greater than 20,000 while annual costs to society are estimated to be more than £20 billion. Alongside new legislation and cleaner technologies, the UK Government recognises that behavioural change is crucial for tackling air pollution. Understanding public knowledge of air quality is fundamental to the success of government policy and communications around air pollution. It's also key for driving positive change.

As the area of focus for our study, we wanted to gain a deeper understanding of public interest and awareness surrounding air pollution. So, using Google Trends, we collated monthly air pollution-related search data between January 2010 and September 2020. We aligned this with monitored air pollution levels and BBC News UK website headlines as a proxy to media coverage over time.

Our results show that public interest in air pollution has increased gradually over the last decade. This rise in public interest directly correlates with increased media coverage of air quality. Our study also reveals that

public interest also correlates – to a far lesser degree – with changing levels of air pollution. This informs us that, when it comes to air pollution, enhanced communication and media coverage is crucial for influencing human behaviour. Our results show that behavioural change is not just important, it's wholly necessary for driving down air pollution in the UK.

The choices we make (such as how we heat our homes and what car we opt to drive) and the way we behave (including how frequently we use transport, how long our engines are left idling and how often we burn materials) all have a significant impact on air quality. It's our job as human factors practitioners to raise awareness of the impact of these everyday choices – which we so often carry out on autopilot – and to implement systems that will influence behaviour for the better.

The visualisation of data and insights is another important role for human factors practitioners. It's one thing to obtain valuable information on air pollution but our role is to communicate it in a way that's easy to interpret, enticing to engage with, relatable to everyday living and simple to act on.

It's our job as human factors practitioners to start with "Why?". If we want to encourage behaviour change, then we need to be asking, "Why is this data important to the general public?"

Changing ingrained beliefs, behaviours and habits is not easy. But if our goal is to encourage change for the better then it's important that we go beyond the data to show people "why" a change is crucial, "what" they can do, and "how" adopting changes can make a positive impact. In essence, it's creating that meaning, or narrative, that humanises the topic and spurs change. And this behaviour change lends itself to both policy makers and communities.

We know that legislating our way out of a current state won't work unless it's is coupled with systems and activities that are easy for the general population to adopt. The reality is that when it comes to changing behaviour, people typically want to know what's in it for them. So, if legislation is the 'stick', the activities act as the 'carrot' that attracts people to adopt these new habits and behaviours.

Behavioural change is not just important, it's wholly necessary for driving down air pollution

Coal burning power plant

IMAGES: GETTY

These same principles also apply to the wider issue of climate change, although the involvement of human factors practitioners is largely still at the awareness stage. The sheer scope of the topic means that it's hard for someone to see how one person making a change can have an impact. But again, it goes back to good reasoning (data), actions (systems and processes), and a narrative (meaning). We need to show people "what" is happening, "why" there is a problem, and "how" they can help make a difference, in a way that's relatable.

To keep morale and momentum high, it's also important to inform people about the elements that are outside of their control and to reassure them of the impact of their small changes and habits. As more organisations start making business changes with climate change in mind, and as governments steer more towards a people-based agenda, then the role of human factors practitioners looks set to become even more important in helping these challenging targets become a reality.

Which brings us back full circle to our research paper. The results show us that the next step for reducing air pollution in the UK is to provide high quality data and information for both decision makers and the public at large to inform and shape more positive life choices.

Barry Kirby is a Human Factors Consultant and Managing Director at K Sharp Ltd, as well as the host of 1202, The Human Factors Podcast.

Further reading

Search for *Do You Think Air? Public Interest in Air Pollution* at https://publications.ergonomics.org.uk

The road to a transport revolution

Autonomous transport is on the horizon for road, sea, air and rail travel but how are the different sectors speeding up the journey by learning from each other? What are the issues that need to be considered when we look at the self-guided vehicles of tomorrow?

Autonomy in transport continues to be like the pot of gold at the end of the rainbow. We can see it and we are gradually moving closer to it, but the prospect of mass deployment of the technology in the real world remains tantalisingly out of reach. Perhaps that's not surprising: after all, the race towards the holy grail of travel without human intervention has always been a marathon rather than a sprint. In cars, its recent genesis has been in developments such as cruise control and ABS; in aviation, autopilot has existed for decades. It's always been a case of progress by increments.

What we are seeing though, is the various transport sectors – road, marine, aviation and arguably rail – drawing from each other more than before, sharing ideas and some technologies. They are moving from automation to autonomy at different speeds, though in many ways learning from each other. When does one become the other? Human factors specialists would argue that this probably happens when a machine becomes capable of taking its own decisions. However, on that measure, we have had autonomy in some areas for hundreds of years; the steam engine, for instance, brought the centrifugal governor to maintain a constant speed.

3D rendering of an autonomous container ship run by artificial intelligence

Today of course, the technology is much more sophisticated and we are able to use developments such as digital innovation to push the boundaries of what we can do. Modern autonomy also has to deal with the boundaries of human acceptance. Once again, this isn't new. When rail passenger services were launched in the 19th century, a widespread cohort of travellers believed that the human body could not physically cope with speeds above about 20 miles per hour.

When cars adopted anti-lock brakes, the notion that they deliberately stopped braking in order to protect the vehicle and passengers was terrifying for many. The fact that worries over these and similar technological developments were eventually allayed means that we have become much more sanguine about autonomy but we still have anxiety when things move outside their normal operational range. An example of this is the autopilot on an aircraft or on a ship; we're happy to know that it's in use because we know that if anything goes wrong the pilot or captain is there to take back control. So we're happy with the automation but not the autonomy. This very human-centred barrier always presents a challenge.

The key question is: what do any of these systems do when the unexpected happens? Can they cope with it safely? The stark answer is yes – sometimes.

The whole history of human factors is filled with examples of incidents where the machine assumed something was happening when it wasn't, or something else entirely was going on. Countless air and car disasters stand as a testament to that. Needless to say, there's an awareness within the autonomous technology sector of the need to move carefully and at the speed of human acceptance. In Norway, for instance, a new generation of autonomous ferries are to be deployed to carry goods across fjords, replacing millions of kilometres of road transport and saving thousands of tonnes of CO_2 annually.

The ferries will be deployed from 2022 but the regulators have made it clear that they must be satisfied that a sufficient level of safety has been achieved before they will issue operating approval. The services will initially operate with a reduced crew onboard and then, over about two years, the first vessel will gradually build up its autonomous capability. Approval for fully unmanned operations is expected during 2024. At all times, the vessels will be connected to a Remote Operation Centre onshore.

If autonomous systems can be proved to work safely and satisfactorily across different forms of transport, then big societal changes are possible. "I think we need to focus on the benefits," says Neil Mansfield, Professor of Human Factors Engineering at Nottingham Trent University and a Past President of the CIEHF. "We could, for instance, have cars that never need to find a parking space because they can work 24 hours a day. These systems also create the possibility that they are better at the rather boring task of flying and driving under normal conditions and they improve the efficiency of the driver."

The most effective designs elegantly combine technology with usability

Neil Mansfield, Professor of Human Factors Engineering at Nottingham Trent University and a Past President of the CIEHF

Neil, who's deeply involved in the autonomous transport sector, also envisages autonomy offering more passenger choice. "I think we could imagine a situation where people may not choose the quickest road route anymore. They might go for the safest route, or the smoothest or most comfortable one, or one that allows them to arrive at their destination at the right time. "As they will be able to choose how they use their time in the vehicle, they may even choose to go by the most picturesque route so that they can enjoy the view during the journey. There is a huge amount of opportunity there."

The potential efficiencies offered by autonomous vehicles have been clear to see in sectors of the economy such as agriculture and mining. Self-controlling tractors, developed long before their modern car equivalents, can spray crops with enormous accuracy, reducing the need for ploughing and sewing as well as avoiding seed wastage. Onboard sensors even mean that every plant can be given its own slightly different dose, so avoiding costs and run-off. That also means the plants are healthier and pollution is reduced.

Wagons in mines have also benefited from autonomy, though, as they generally run on a fixed one-way route, this does not need the level of sophistication seen in other industrial environments. The implications of something going wrong simply aren't as serious as they might be in other industrial applications.

"What we've seen in human factors and ergonomics is that where we have a well understood system, we're able to design it so that it's very reliable," explains Neil. "The problem comes when things move outside their normal parameters. How far outside those do you go? →

IMAGE: SHUTTERSTOCK / GETTY

Cars are currently very, very safe under all normal driving modes and even in collisions if things are within normal bounds. But if a tree falls on you, then that's well outside the design parameters. You will always get extreme events. Where you have a human in the loop, that human is much more adaptable in terms of being able to take a decision at that point."

Neil continues: "If the vehicle is purely being driven by a programmed system, then that system will try and take the most appropriate decision at that time. But those decisions might not be the same as those taken by a person." He concedes that the decision the machines make might be safer than with human intervention but there is another theory often advanced in human factors: that when you automate something it leads to a reduction in the skill of the person who would normally undertake that task. "But then you could ask if we really need people who are skilled in areas that have been automated when we can now apply their skills in terms of learning in other areas."

How far away are we from fully autonomous transport systems that we can use in a day-to-day context? In some ways, they are now with us and in some cases – as with tractors – have been for decades. Driverless trains, shuttling passengers between terminals, are in use at some airports including London Gatwick. And anyone in London will be familiar with the Docklands Light Railway, now an essential part of the capital's public transport system. Their practical benefits and safety have long been proven.

The rollout of autonomous road vehicles has yet to be properly implemented but when it happens, it's likely to take place by increments. Initially, we're likely to see the use of these in constrained environments such as motorways, where traffic movements are much more predictable. The same is true of city centres, where, by necessity, speeds tend to be slow. For the moment however, humans are mainly sharing responsibility with the machines. We're still some distance from so-called Level 5 autonomy, where the technology has complete control.

A driverless DLR train pulling into the platform

You can buy a Tesla now and it comes with technology capable of controlling both lateral and longitudinal vehicle motion

Joe Smyth, a Research Fellow at Warwick University and an authority on human factors research on travel

"At the moment we have Level 2 capable vehicles in the consumer domain, which is partial driving automation," says Joe Smyth, a Research Fellow at Warwick University and an authority on human factors research on travel. "You can buy a Tesla now and it comes with technology capable of controlling both lateral and longitudinal vehicle motion under certain conditions, whether that be a highway or a discrete area. But the user is still ultimately responsible for monitoring both the environment and the driving system and has to be ready to take back control at any time without hesitation.

"It's effectively lane keep assist and adaptive cruise control merged. At present the UK Government is pursuing the legal framework to introduce Level 3 capability. This changes the dynamic from an entirely shared responsibility during Level 2 operation, to where the human can disengage from the monitoring tasks for prolonged periods in Level 3 operation. However, the fallback-ready user has to be available to take back full control within an agreed timeframe if the vehicle encounters something it can't handle or it leaves the domain in which it was designed to operate."

If and when it arrives, full autonomy in its various forms – road, shipping, aviation – will hopefully address one particular issue: humans are not good at shared responsibility and at dividing their attention between multiple tasks. Once we break a task up into different components, our workload increases significantly, making the job harder. This is a feature of Level 2 automated driving, where both the environment and automated systems have to be monitored. In other words, it can be more cognitively intensive to supervise the machine rather than just to do everything yourself. Another issue is that prolonged monitoring leads to boredom and therefore a level of human inattentiveness creeps in.

Will we ever reach complete autonomy across various transport sectors? We may not. It could be that to respond to all possible events in all circumstances, some degree of human intervention will be required.

"I don't believe we will go from one system instantly into a new level of autonomy," says Neil, "We will continue having the debate at higher and higher levels of sophistication. But as a species, we like to innovate and do new things all the time. We want things to be different. There's always that desire to make things better and more efficient. The most effective designs elegantly combine technology with usability, with the human needs and motivations being met." ●

Further information

Joe Smyth has led a series of webinars about automated driving systems. Visit events.ergonomics.org.uk for the chance to watch recordings on-demand.

The neuroscience of navigation

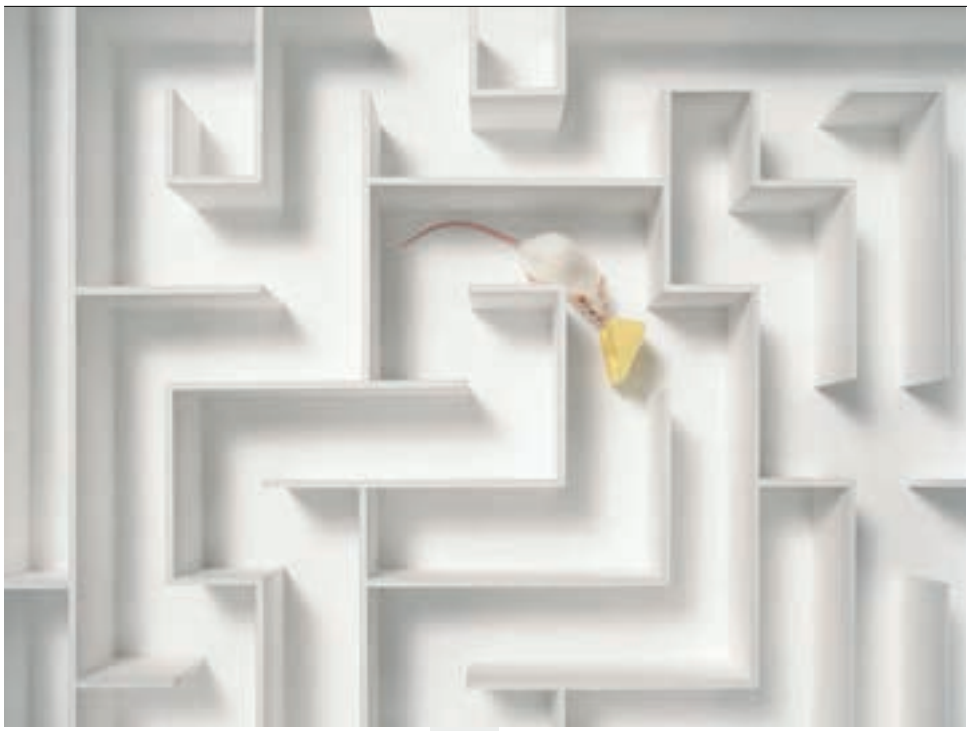
Neuroscience provides insight into how we navigate. These insights have significant implications for how we should design our built environments and navigation assistance technologies to make it easier for people to find their way around. In the first of a two part interview, **Nigel Scard** talks with Professor of Neuroscience **Kate Jeffery** to find out more

What are your current research interests?

My work as a neuroscientist is focusing on how the brain makes a map of space. When you walk around the environment you have certain perceptions, knowledge and information that comes in and your brain assembles this and uses it to build a map of where you are and then remembers that map for future use. We're trying to understand the mechanics of that map: how it works, where in the brain it's built, how the information comes in, what happens to it and where it's stored. To do that we study rats and mice because we can actually record their neurons, and they make the same type of mental maps that humans do and as far as we can tell that's something that evolved a long time ago.

How does this relate to design?

We're learning a lot about the brain from rats and mice and a lot of what we're learning has the potential to be useful for design, where we're trying to make it easier for people to find their way around. One of the things I want to do is to try and extract, from the findings from neuroscience, things that might be useful in design. One of the really important things that comes out of our work is the fundamental importance of the sense of direction to building the map. Knowing which way around you're facing is critically important to knowing where you are, and if you don't make it easy for people to do that, you don't make it easy for them to build mental maps. I've noticed as I'm walking around built spaces like train stations and conference centres, they're often very difficult to orient in because the information →



Environments with symmetrical layouts and enclosed spaces make it harder to build an integrated mind map

→ your brain likes to use is not there. For example, the spaces are quite symmetrical so it's not obvious from just looking, which way round you're facing. There may be signs but your sense of direction doesn't use signs.

From studying rats and mice we've found that there are things that are important, like the shape of the environment or things that introduce asymmetry such as a big difference in the lighting between one end of a space and the other. There also needs to be a very obvious linkage between spaces. If it's easy to see how a room that you're in relates to the adjacent rooms, for instance if there's a glass wall between them, then it's much easier to build a map that has lots of rooms in it. But if you're in an environment which has lots of enclosed spaces so that wherever you are, you can't really see your surroundings then it's much harder to build an integrated map. A lot of our buildings are like that - hospitals, for example. A hospital has a lot of small windowless rooms and you very quickly get confused and horribly lost, frustrated and stressed.

How can the research findings have more impact?

There are a variety of ways. One of them is to inform the specifics of design but the other is the methodology of scientific enquiry. Something I've discovered in my dealings with architects, designers and planners is that our way of gathering information is very different. An architect will often say they design something this way for a given reason but when I ask them where that reason comes from, they'll say it's experience, and then when you ask them what kind of experience, it boils down to something like "I asked my architect friends and they agreed that it seemed like a good idea". It's passed down from architect to architect. They might say "this type of building has this effect", and yet it's never been demonstrated that that's really the case. There's a lot of scope for development of beliefs that don't have any factual basis. We're now at a point where we should be moving beyond that and where it should be possible, with our modern data collection and analysis methods (high speed computers and virtual reality) to really test whether or not a particular idea has the effect that people think it has, before spending millions building it.

The trick is to find a way of layering information so people with different needs can use them

So there's a bit of a cultural disconnect between the way the scientific and design communities operate?

Yes, I think designers could learn from scientists but it's a two-way dialogue. The real world operators can influence science in the way that they suggest ideas and hypotheses to be tested because there's a lot of creativity and thinking outside the box. Scientists sometimes narrow down and focus on paradigms that work well in an experimental setting but which aren't always useful.

How might we be able to better assist navigation for people with accessibility needs?

I think neuroscience has a lot to say about that, and not just the obvious accessibility issues like visual impairments but also there are individual differences in how people process information. There tends to be a one-size-fits-all approach to design problems, assuming that everyone who doesn't have some kind of disability are a kind of cookie-cutter stereotype, all processing information in the same way. But really, when you look at individuals, people navigate differently. Some people prefer to use a mental map and a global sense of orientation and other people prefer to use local objects and landmarks that they anchor their actions to, so they maybe don't care so much about the overall orientation or the overall relationship between things. And some people do rely heavily on signs, which of course, if you have a visual impairment is much harder. The trick is to find a way of layering all these different types of information so different people with their different needs can use them, whilst ensuring they don't interfere with each other. It's a really interesting and difficult problem and I think attention is focusing a lot more on that these days.

Don't landmarks help people develop that overall sense of orientation?

Yes, they do but we don't fully know which landmarks. For example, for your head direction system, which is the compass system in the brain which

works out which direction you're facing, the studies in animals suggest that system prefers to use landmarks which are a long way away because they don't change their relative direction as you're moving around. If it's a mountain far off in the distance it's always in the same direction relative to you, no matter how much you walk around. We don't yet fully know what types of landmarks are useful for the sense of direction and what aren't. For example, a picture at the end of a big hall - is that useful for the head direction system or not? It probably is but we don't have any evidence yet.

Are there any downsides to digital navigation aids, such as apps on smart phones?

There's a lot of speculation about this. Some say it's terrible that we're not having to navigate for ourselves, that we're going to lose function in our brains. But we don't have any evidence for or against that. My own sense is that there are pluses and minuses from the point of view of your own cognitive function. It's true that if you're navigating with your phone, you're not attending so much to the outside world, you're not making a mental map so much. On the other hand, often when you're trying to navigate in the real world you just get completely lost and you don't end up forming a mental map anyway. If you have a phone, it's helping you understand the relationships of the regions you've been in and so maybe it's supporting your mental map. But phones aren't going away, people will use whatever makes the process easier. I'd like to see the development of app technology so it works with the mental mapping system. This would make the easiest thing for people to do, also be the thing that helps them build a good mental map that anchors them in the real world.

If you have a good mental map of your surroundings, you feel more comfortable in it. Whereas if you don't, that's a less satisfying, less happy state to be in. If we want people to really enjoy their urban environments, we need to help them with this.

Is there any evidence of generational differences with regards to compass directions?

I think it's quite likely there is a generational difference. For those of us who grew up with paper maps you had to have a sense of compass directions to line the map up correctly, whereas the phone does that for you. So, I think quite plausibly people are losing that connection to the global directions and I think that might make it harder for them to make larger scale mental maps.

This interview will continue in the next issue.

Spaces are often very difficult to orient in because the information your brain likes to use is not there

Kate Jeffery is a Professor of Behavioural Neuroscience at University College London. Her area of special interest is the neuroscience of navigation. Kate chairs the Cognition and Navigation Special Interest Group (CogNav) of the Royal Institute of Navigation.

Nigel Scard is a Human Factors Specialist at Liv Systems. He has an interest in neuroscience and its potential application for human factors and is a member of the CogNav group.

Making tech work for older adults

With ageing populations across the world expected to increase, it's time to think more about the needs of older adults to ensure future design of technology is truly inclusive

Eventually, life becomes cruel to us all. It's a simple biological fact that the older we get, the frailer we become, leading to associated problems such as mobility, loneliness, poverty and social isolation. Ever more sophisticated social interventions by public agencies and governments can help and technology can also be liberating, especially when it properly considers human factors within its design. However, things could be radically improved. The needs of ageing populations are still not being given the attention they deserve.

As the numbers grow, so does the problem. A recent paper, published in the journal *Health* and involving researchers from the Philippines, Japan and the United States, pointed out that the world is experiencing a dramatic shift in sociodemographics. In the 30 years from 2015 to 2050, the proportion of the world's population over 60 years old will nearly double from 12 to 22%. Last year, those aged 60 and above began to outnumber children under five years old.

Much of this growth in an ageing population is due to more advanced medical and nursing interventions. But as the paper recounts, as people live longer, a larger percentage will suffer from a range of multiple chronic conditions including dementia, diabetes and hypertension.

All this presents challenges for human factors. Professor Peter Buckle, Principal Research Fellow at Imperial College London, is a past President and Fellow of the CIEHF. He's also an authority in this area, having studied inclusive design and its relevance to older people as well as issues of technology and ageing. "In terms of technology, it's been well recognised that innovation is often driven by those whose primary target audience are early adopters", he explains. "They're the people with a lot of technological skills, interest and awareness and that's the market that the innovators are aiming at. But by the time the product migrates through to others and to older people, it may have been developed in a way that's not compatible with inclusive design."

Peter points to the near-ubiquitous example of digital home technology – phones, central heating control systems, TVs and so on – which appeals to early adopters but may have residual design problems when it comes to older people using these devices. "I

Solving usability problems is always second best to designing them out in the first place

Professor Peter Buckle, Principal Research Fellow at Imperial College London

think it's a pretty poor show. These problems have been around for 30 or 40 years and inclusive design still isn't being factored in at the earliest stages of development. Solving usability problems is always second best to designing them out in the first place but in human factors terms, this process doesn't happen early enough."

How, though, can this be addressed? Peter sees education as a potential answer. "Those who are driving innovation need to think more carefully about the intended user population down the line. That does happen at times but not nearly early enough; it's almost as if it's an embedded problem."

Another human factors issue for older adults is the built environment. If they have limited mobility then poorly planned living spaces can work against them, leading to isolation and depression. Peter has also studied this in conjunction with the Royal College of Art. "There's some really good work going on in connection with how, for instance, you can design environments for people with limited vision so that they can enjoy places safely without lots of trip hazards. The irony is that if we design in this way, it actually makes it better for everyone. But that often gets lost; as long as there's some sort of an early market for an innovation, then the designers tend to go for that. That's a great shame because almost by definition it's going to be very hard to re-engineer these things later on."

One argument he often hears is that older and less mobile people will be assisted by others. "To a certain extent, that does happen, and it's fine if you've got grandchildren who can come and sort your TV out. But one of the things that the current Covid pandemic has shown us is that when people are isolating or shielding, the technology falls apart pretty fast. Problems arise and those affected can no longer rely on others to fix them. When you remove the opportunity to have that one-to-one contact, they start to struggle. And that can happen at a time when individuals really need the technology for things like Zoom calls."

The key, Peter believes, is for product designers to factor in worst case human factors scenarios at the very beginning. "The first question I would ask is, 'who is this not designed for?'. If they haven't thought about that, then they probably haven't really thought about who it *is* designed for. Then I'd also ask, 'what happens if it goes wrong?' In honesty, that happens to all technology. The third question relates to when it should not be used. By asking these three questions, designers are forced to really consider the end users and if the product has actually been created with those people in mind."

He believes this extra effort at an early stage in the process is well worthwhile. "There are no shortage of human factors methods you can use, whether it be design or focus groups or working with end users. You just have to realise that you need them and then get out there and work with them."

IMAGES: GETTY

Elderly couple using a remote home control system on a digital tablet

The University of Cambridge has created a tool to assist with this process. It allows you to see what percentage of the population are excluded by a design by looking at many metrics, such as font size and dexterity. Using such tools enables a designer to see very quickly that a lot of the things people are using will be almost impossible for an older population to use when they have vision, hearing or touch/dexterity problems.

If this landscape seems bleak, then it's worth remembering that there have been successes alongside the failures. Buses, for instance, take human factors into account with steps that can be lowered, and toilets are now being designed intelligently. "These things become absolutely crucial in determining whether

Designing for people with limitations actually makes it better for everyone

or not people will go out," says Peter. "If we don't facilitate this as a society then we create social isolation. But there are some good things going on as well. Tripping and falling are huge, huge problems for older people and I was involved in a study with the University of Leeds to look at how technology can help with this and with countering aspects of that isolation."

Peter sees the CIEHF as having a role to play in addressing these issues in future. "As a professional body, we have a responsibility to make sure that these messages are embedded with whoever we work with. Education is part of it too. We have to get the knowledge out there in the right way and at the right time."

Further reading

Pepito, J A, Locsin, R C & Constantino, R E (2019) Caring for Older Persons in a Technologically Advanced Nursing Future, Health, 11, 439-463

Buckle, P, Yeandle, S & Hamblin, K (2014) Human factors that influence the performance of the telecare system, AKTIVE working paper 7

Keeping the wheels in motion

Trying to progress research projects during lockdown necessitates a certain amount of creativity. Devising and accommodating trials and finding subjects takes stealth and tactical thinking, as a research student and his supervisor discover

It has been said that there are three types of people: those who make things happen, those who watch things happen and those who wonder what happened. Perhaps each of us is a mixture of all three. Alternatively, we may progress through from 'wondering', through 'watching' to 'making' things happen.

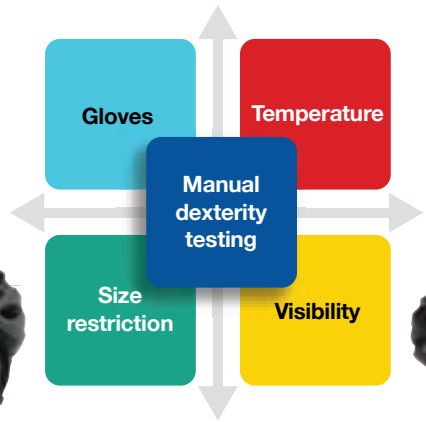
But life is seldom that simple and if it exists, such a sequence is probably non-linear, affected by influences which conspire against making progress and prone to relapse.

To be found in this space were Jonathan McDonald, a highly-motivated student going through a steep learning curve, and Arthur Stewart, an 'old school' academic whose lab sought new occupants and whose slowly diminishing intellectual and physical horizons threatened to blunt his once keen edge of all things ergonomic. Perhaps most profoundly, the Covid lockdown saw us, like all readers, in *terra incognita*, where all we know as normal had been turned upon its head.

The postgraduate ergonomics project idea was birthed when a year three undergraduate work placement brought Jonathan to the Robert Gordon University (RGU) Scanning and Ergonomics Lab, where, under Arthur's guidance he'd previously been a guinea pig for research on emergency escape from progressively smaller spaces. Subsequently, a six-week project in 2019 involved harness suspension from a lifting tripod and modifying the Purdue pegboard test for manual dexterity. These resulted in the development of a new shape tracing accuracy test which compared standing and harness-suspended task performance. The effect demonstrated in student volunteers was subsequently confirmed in industrial rope access technicians and was written up in *Applied Ergonomics*.

Jonathan's honours dissertation project involved task performance in unfavourable postures, where physical size restriction was enforced by large 'Lego-style' modular bricks.

Participants were randomised to standing, kneeling and stooping, and completed pegboard and hand tool dexterity tests, while discomfort levels were monitored. Women generally outperformed men at the pegboard test while men were better at the hand tool test. Men experienced greater discomfort than women and their greater shoulder and stature width resulted in a more extreme posture variation. Women had more clearance space inside the structures and this factor offset the greater male familiarity with the hand tool dexterity.



Like many good research projects, it uncovered more that we don't know, so the idea for a more detailed exploration of hand size and performance was born. When the world as we knew it changed in March 2020, with classes, tutorials and even graduation succumbing to the digital domain and the job

Arthur Stewart and Jonathan MacDonald, pictured left to right

Trialling the test conditions for a Purdue pegboard test in a restricted space

market in a downward spiral, it seemed logical to continue for a Master's degree by research (MRes).

After the first lockdown, restrictions eased making some things more manageable. RGU campus was open to postgraduates, although practical labs required special permission to visit. Added to this, Arthur unhelpfully chose to retire in the summer and much of the impetus for ergonomics teaching and research left with him. More positively, their mutual love of cycling enabled Jonathan and Arthur to enjoy socially-distanced tours in Aberdeenshire's quieter roads and discuss possible ways the project could develop. All the equipment required for a dexterity project was on campus but was portable. The novelty and key research question needed refining, and perhaps more crucially, the steady stream of willing volunteers had been effectively desiccated by lockdown. Mercifully, the university's response was to play into our hands: a delayed start date for the project, before which much reading, thinking and planning had already been done.

We were convinced hand size merited further investigation. Together with other factors such as clearance space, Personal Protective Equipment (PPE) and variable temperature, hand size might affect task performance and skill acquisition. We communicated over Zoom and Teams but made most progress mapping out a way forward on our cycle rides together. And so apprentice and retiree would wind their way through rural Aberdeenshire, punctuating their outings with stops for sustenance and intellectual discourse. Our journey was neither straight nor flat, but dotted with tight bends, steep gradients and the odd puncture.

What could take the place of the ergonomics lab or the lab bench to test workable ideas? Why, Jonathan's family garage of course! Some rearrangement of a small peloton of nine bikes was essential before he could begin. Basing his design on the validated hand tool dexterity test, his carpentry skills were put to use to develop a prototype for testing the influence of hand size via clearance space (enclosed space minus hand/forearm diameter). A stealth visit to campus under the cover of darkness to harvest essential equipment was ruled out, so a permission-seeking approach was pursued which was eventually granted. (This was one occasion where on campus parking was no problem).

A mock test was created and awaited volunteers to pilot. Meanwhile, the literature review considered how finger and hand dexterity is affected by different hand sizes, wearing PPE and how temperature affects task performance. A concept of the research was sketched out to guide our thinking.

It became apparent that some early published work is unavailable digitally, and currently beyond reach. If this challenge amounted to cycling a Lakeland pass (*Honister* or *Hardknott*, for example), then obtaining ethics approval would no doubt be a veritable *Alpe d'Huez!* Without ethics permission, experiments would not be insured by the University, so no data could be collected until this was rectified. Due to the ethics committee rotating different academics on the panel, mostly without any specific knowledge of ergonomics, past permission is no guarantee of future permission, hence the need for the most comprehensive justification. This would include the degree of adjustability of the apparatus and precise protocol for testing, the nature of the volunteer sample and how this will be recruited, the number of trials an individual can be reasonably expected to undertake, and the type of statistical tests used to analyse the results.

Like many good research projects, it uncovered more that we don't know

Happily, piloting the apparatus can be done before ethics permission is granted, and can take place simultaneously with the final shaping of the ethics application. The most pressing concern after the Covid risk assessment is recruiting a sample whose work involves dexterity. Different fields of the concept diagram might favour different groups with space limitation affecting some (such as surgeons and dentists) but not others (such as musicians).

It would be desirable to have a large enough sample to analyse task performance by gender to determine if this exerts a separate effect on dexterity beyond hand size. However, the unknowns loom large as to how many professionals we can test under the current circumstances.

While the journey so far has been an uphill struggle with no room for complacent freewheeling, it's been an exercise in largely self-propelled scholarship focusing on the possible and the practical – and in applying situational awareness to controlling the environment. In conclusion, we have *watched* what has happened, *made* some things happen, and eagerly *wonder what will happen* as the research journey continues.

Jonathan MacDonald is a graduate of Applied Sport and Exercise Science and current Masters by Research student at Robert Gordon University under the supervision of Dr Andy Hall and Dr Arthur Stewart.

Arthur Stewart recently retired after 37 years working across three UK universities and is a Fellow of the CIEHF.

New research reveals how human factors can help to improve the way in which surgical and anaesthetic teams work together and protect more patients from the risk of errors

Operating safely

In an operating theatre, two things are absolutely critical: concentration and teamwork. If these are lost, problems can arise very quickly. There's simply no room for error. Most operations are undertaken with care, diligence and extreme professionalism but that doesn't mean that things will never go wrong. Human bodies are complex. Sudden and unexpected problems may arise at any moment.

And for all the precautions that are taken, errors still occur. Human factors can play an important part in determining the ways in which surgical and anaesthetic teams in theatres work and how effective they are. A recently published academic paper on the subject, 'Human factors and the safety of surgical and anaesthetic care', examines how human factors and design can be used to improve the safety and effectiveness of surgery.

Most surgical procedures are safe and uneventful. According to United Nations and World Health Organization data contained in the paper, 234 million operations are carried out globally every year. But of these, up to 3% will involve a major complication and a million people will die during or in the days after the procedure. More than half of these complications are thought to be preventable. In the UK, there are suggestions within the profession that perhaps one in ten patients have some harm caused to them through interventions by healthcare professionals in hospital.

The authors of the academic report point out that team briefings before the clinicians and nurses go into theatre have been suggested as a way to convey and share information,

strategies and concerns. However, these briefings don't always happen and when they do, they may not happen at the most appropriate time. In this case, familiarity with emergency procedures may be more appropriate, though again, coordination and teamwork are vital if this happens. Simulated exercises, the report adds, are perhaps the most effective way of building this. Checklists, too, have "substantial potential" to improve safety and efficiency.

The paper also says that there are instances where the environment, team and tasks can be redesigned to improve performance and outcomes. Simulations can be used, including those from the fields of education and psychology. Even cardboard mock-ups of rooms and equipment can be helpful. It says that one barrier to the redesign to improve safety and efficiency of surgical systems is a shortage of experienced human factors practitioners to undertake appropriate projects. The paper also refers to the CIEHF's own *Human Factors in Health and Social Care* white paper from 2018 that says every NHS organisation should have access to an individual with human factors experience.

Professor Chris Frerk is a Northampton-based consultant anaesthetist who has been a trustee of the Clinical Human Factors Group charity for more than a decade. An Associate Member of the Institute, he works regularly with specialists across the UK trying to make healthcare safer through the application of human factors.

He points out that theatre teams are a lot more flexible now than they were 20 years ago. "In the past, the same people would work together in the same team on a daily basis for many years. Today, they may differ from day to day and from morning to afternoon. That means there is less understanding than there used to be of other people's roles and what bits of the task are mission-critical."

Team briefings, he adds, have been in use for more than a decade, having been introduced as part of a World Health Organization initiative. "Part of the reason for them is to flatten the hierarchy a little bit so that people feel able to speak up if they see something going awry. The briefings also allow surgeons to ensure that everyone knows what the likely critical steps in an operation are."

Another issue, Chris points out, is variation: two surgeons carrying out an operation for the same condition could well do it completely differently with different equipment. "If they don't articulate that to the staff, they won't get what they want when they need it, and briefings are about shared awareness." Having said that, he adds, briefings are getting better. "The question is whether any critical or unexpected steps are likely. It's working out a pattern of conversation that explains what will or might be needed."

He sees a role, too, for checklists, though he points out that in the context of surgery, these should be the same as in other industries: short and mission-critical. Mission-critical means making sure that nothing vital has been missed. "These lists are long and getting longer. They're sometimes designed by people who – although good intentioned – don't have an understanding of how they'll be used. "It's right that the questions we're asking in the final checklists are things that should have been done routinely. This is our final check that we are safe to proceed."

In reality, they should be used to guard against simple but potentially fatal human factors errors that can occur during surgery. These can lead to some of the commonest causes of death in operating theatres. They include not having blood available when it might be needed, not anticipating having to put in a breathing tube, or carrying out the wrong operation on the wrong person or the wrong side of the body.

The first thing on the checklist should be to look at the patient's name band and the operation consent form. You ask them for their name and date of birth. One person then confirms that information is correct on the band and another that it is correct on the form. You also ask what operation they're expecting. "Getting it wrong happens so infrequently that people insist they have checked," Chris says. "They ask what the point of doing it again is. It's not that you're expecting to find anything wrong but if you have a list, then it's all written down. In my case, for instance, I don't very often need to have blood supplies on hand. But if I'm doing an operation that does, I get to that item on the checklist and it asks me to make sure it's available. On 99 occasions out of 100 it's been done but if I've made sure, then I know that beforehand rather than halfway through the operation when it's needed."

Checklists should be used to guard against simple but potentially fatal errors that can occur during surgery

Professor Chris Frerk, consultant anaesthetist

While checklists can undoubtedly be useful, he warns of the risk of creating more and more of them, especially with the additional requirements from Covid-19. "People get checklist fatigue. If people think that the checklist is telling them how to do their job, then they can struggle with them. There are so many fail modes that humans are really good at stopping, that when one gets through, people are looked at as the bad guys. But in fact, they're actually the good guys, they're just working with a very, very complex system."

Chris says that he absolutely believes that human factors should be deployed more in theatre environments. Human factors is, he says, a safety science. "You can almost use the terms interchangeably. And yes, I do think things can be improved. It would be unreasonable to be satisfied with a system where we overtly harm some patients with serious consequences and cause minor harm to many, many more. Human factors really does have the ability to mitigate that."

Further reading

S D Marshall & A Touzell, 2020, Human factors and the safety of surgical and anaesthetic care, Anaesthesia https://doi.org/10.1111/anae.14830

IMAGE: ISTOCK

Obituary

NIGEL CORLETT

1922-2020

An early interest in mechanics led Nigel Corlett on a journey into engineering. But it was his concern for people that led him to become one of the most influential figures in the development of the discipline of ergonomics

Born Esmond Nigel Corlett in Great Yarmouth four years after the end of World War One, Nigel's first job, in 1939, was in the drawing office of a torpedo factory in Coventry. The building was destroyed in one of the bombing raids on the city in 1940 and the work moved to another town. A year later while he was still in his teens, Nigel wrote his first paper and saw it published in a mechanics magazine. Wanting to become more involved in the war effort, Nigel enlisted in the Fleet Air Arm and was in uniform from 1943 until the end of the war.

He went on to get a first degree in mechanical engineering before joining the West Midlands engineering company Wilkins and Mitchell in their washing machine division, eventually becoming their Chief Design & Development Engineer. During his time there, the company wanted to improve their product design to remove the need for instruction booklets. This led Nigel to conduct research into skills and training, followed by design of manufacturing equipment for human use, factory work and organisation, teaching and research into manufacturing systems. After nine years with the company including a spell in Australia and completing a Masters in Applied Mechanics from Sheffield University, he left to join the University of Birmingham initially as a Research Fellow in Production Engineering, gaining his PhD in 1960. This was probably one the first PhDs in ergonomics in the UK; the title of his thesis was *Human Factors in Machine Control*.

Nigel rose to become a pivotal figure in the field of ergonomics, both nationally and internationally. He was instrumental in setting up two university ergonomics groups, both in engineering faculties. Firstly at Birmingham, where he became Professor of Industrial Ergonomics in the Department of Engineering Production, and then at the University of Nottingham, where he was Professor and Head of the Department of Production Engineering and established, with Professor John Wilson, the Institute for Occupational Ergonomics.

Both ergonomics groups he founded gained international reputations and many scholars of note worked at them, including Ted Megaw and John Wilson, who both sadly died too young. But numerous others bear witness to how they were attracted to study with Nigel, inspired by his intellect, enthusiasm and encouragement. Strands of his legacy still exist at Birmingham and the Nottingham Human Factors Research Group is going strong.

Whilst at these Universities he also founded and led two MSc courses which linked ergonomics, work organisation and industrial applications. The Work Design and Ergonomics course at Birmingham was set up by 1963 and included the physical and environmental, mental and social considerations as well as methodology, managerial and some specialist aspects. He also established a strong international presence, including Visiting Professor roles at Toronto University (1992), University of Massachusetts in Amherst (1969–70) and Purdue University in West Lafayette (1965), USA and as expert advisor to Production Engineering Departments in the universities of New Delhi and Hong Kong.

Many people were attracted to study with Nigel, inspired by his intellect, enthusiasm and encouragement

Teaching and guiding students and new ergonomists was very important to Nigel. When asked in an interview with the US Human Factors and Ergonomics Society (HFES)

Nigel Corlett, pictured in 2018 and below, on the left, with his friends during the war

about his significant contributions to ergonomics, he said he "gained pleasure in looking after more than 40 research students and teaching over 200 MSc students the delights of being a specialist in ergonomics!" His love of his subjects and his students is remembered by many and in 1991, he was the first individual to receive the International Ergonomics Association (IEA) Outstanding Educators Award.

Involved in the invention and development of many tools and designs, Nigel's creations are now used by ergonomists around the world. Whilst at Birmingham in the 1970s, he co-designed (with R P Bishop) the Body Part Discomfort Scale as a technique for measuring postural discomfort. Commonplace now, the idea of measuring specific sites of discomfort, rather than someone's comfort level, was revolutionary at the time and made the identification of postural issues much more straightforward. Together with Lynn McAtamney, he developed the Rapid Upper Limb Assessment (RULA) tool, which was first described in 1993 in the journal *Applied Ergonomics* and is now an integral part of the assessment toolkit of physical ergonomics.

One of the most prized possessions that you could have whilst working at Nottingham was one of the original prototype 'Nottingham seats'. This sit-stand chair, designed by Nigel in 1989, particularly aimed to encourage a healthy posture and, whilst the production run was limited due to costs at the time, some of the ideas behind it can be seen in office chairs today.

Nigel's writing was both prodigious and hugely influential. Perhaps his most significant contribution was through the co-editorship, with John Wilson of the first edition of *Evaluation of Human Work*. This book emerged from a gathering in the mid-1980s of some of the leading minds in ergonomics for the 2nd International Occupational Ergonomics Symposium in Zadar. In the preface to the first edition, John and Nigel note that "we are primarily concerned with people at work" but that this doesn't rule out "contributions relevant to people's activities at home, leisure or on the road", foretelling, perhaps, the disappearance of the work-home boundary that we're all experiencing now.

Nigel's influence on the ergonomics and human factors community in the UK and internationally cannot be overstated. In 1992, Nigel was co-author of the HEPTEP charter (Harmonising European Training Programmes for the Ergonomics Profession) which set out the training elements judged as key for professional ergonomists in Europe. Following on from this work, he helped build the certification system and then led, as President, the newly-formed body responsible for implementing the system, the Centre for Registration of European Ergonomists (CREE). He chaired CREE from its first Council meeting in February 1993 until December 1998.

Nigel's multidisciplinary approach to the application of ergonomics also led to him being appointed to honorary roles beyond the engineering field, in the British Psychological Society and the Association of Chartered Physiotherapists in Occupational Health of which he was President from 1988-93.

Nigel was awarded a Lifetime Fellowship of the HFES and received accolades from the Institution of Manufacturing Engineers and many other professional bodies.

Nigel joined the Ergonomics Society (as the CIEHF was then) in 1963, and gave the Society Lecture in 1999, celebrating the 50th anniversary of its formation, looking at the growth of the Society over that time. He held many positions in the organisation, including chair of the Publications Committee in the mid-70s, Chair of Professional Affairs Board in the mid-80s, Chair of Council, and President from 1986-88. He was awarded the Meritorious Service Award for his work and was granted an Honorary Fellowship in 1991.

He was a founder and deputy editor of the *International Journal of Production Research*, and Editor-in-Chief of *Applied Ergonomics*. He was first published in the journal *Ergonomics* in 1961 and in 1994, having already published over 160 papers, the journal published a festschrift edition in his honour.

Nigel's answer, on being asked in an interview with the HFES, what advice he would give to someone considering ergonomics as a profession has stood many in good stead: "Recognise that it's a broad discipline, which you can approach from many directions. Get a sound basis in human factors, →

PANI LUEDER / HUMANICS-ES

A watercolour of a compressor by Nigel and in the lab in 1982, below

→ meet people in various branches of the profession and don't confine yourself entirely to one aspect. People are complex and to help them achieve what they are trying to do, you need to have a fairly complex background."

It seems that Nigel never completely retired. He was still publishing in his 90s, including self-publishing a forward thinking book written in the 1960s by his father (a head teacher) about his approach to education. He was an accomplished amateur artist and his paintings could occasionally be seen on display in Nottingham local exhibitions. He maintained contact with many friends and colleagues all over the world.

Close colleague, Professor Sarah Sharples, says: "Whenever I went to an ergonomics conference and people found out I worked at Nottingham they would pass on their best wishes to Nigel. Whenever he had thoughts or ideas about work that we could pursue or had read news articles that he thought would interest me, Nigel would take the time to contact me. His passion for ergonomics was unwavering and we've all benefited from his influence. Nigel was truly one of the founding fathers of the discipline and many colleagues have been in touch to share their memories. All of them remembered his kindness, his hard work and his enthusiasm for the multidisciplinary approach to ergonomics and engineering which can still be felt in courses taught at Nottingham today.

Nigel died aged 97 in November 2020 after a short illness. Married to Elaine, he was a devoted family man and the beloved father of his three daughters Sarah, Helen and Sophie, and grandfather of Susannah and Timothy. He was a much loved and valued friend and colleague to many and will be greatly missed but his legacy will live on for many more years to come.

Thanks to **Sarah Corlett**, **Sarah Sharples**, **Rob Stammers** and **Philippe Mairiaux** for their contributions.

Further reading

Corlett, A, 2007, A Different Assignment: the organisation of a successful school. 2nd ed. Published by lulu.com

Nottingham seat: www.bbc.co.uk/nottingham/content/articles/2006/08/24/seat_for_nottingham_feature.shtml

Nigel's paintings: www.humanics-es.com/corlett_paintings.htm

A giant of the discipline

"He was always a wonderful role model and leader in our discipline. I recall first meeting Nigel in 1975 and noted his ability to develop practical tools which have sustained their usefulness over the decades. His legacy will live on with his many students that he has mentored over his career."

Professor David Caple

"Nigel was respected for his knowledge, his humanity and for the standards he set. Any conversation with him on ergonomics matters meant that you walked away wiser than you were before. That we have the robust discipline that we have now is due to the sound foundations he helped set up in the discipline's early years. We've lost a quiet, great man and a real nice guy."

Murray Sinclair

"I'm a graduate of Nigel's first Work Design and Ergonomics course. He's my hero, role model and a giant of the ergonomics profession who will be deeply missed."

Professor Gavriel Salvendy

"Nigel was a true pioneer in ergonomics. His view of ergonomics required a much more multi-disciplined approach than previously believed – one that brought life and behavioural scientists into the process of providing new methods for design of all types of human-hardware systems. These methods, that had their roots in what Nigel was doing and writing about in the 1960s and 70s, provided the foundation stones for ergonomics as we practice it today. It was a real honour for me to know and learn from Nigel back then. I suspect that he's redesigning the heavenly environment to make it more satisfying to all who are lucky enough to join him there."

Emeritus Professor Don Chaffin

CIEHF joins AI Alliance

The CIEHF has been accepted as a member of the Australian Alliance for Artificial Intelligence in Healthcare (AAAiH). This provides an opportunity for our members, particularly those in the healthcare sector and the Special Interest Group for Digital Health & AI, to contribute their expertise to the work of AAAiH and connect with other members of the international alliance working in the rapidly developing field of AI in healthcare. Dr Mark Sujan, who leads the Digital Health & AI Special Interest Group, is the primary contact with AAAiH and members can contact Mark directly for more information about how they can be involved.

Dr Noorzaman Rashid, CEO of CIEHF, welcomes this new partnership opportunity, and says: "Artificial Intelligence, machine learning and robotics combined with our evolving understanding of neuroscience must play a bigger role in healthcare, in developing as well as developed nations. We're delighted to collaborate with AAAiH to influence change."

CIEHF members can expect to have an opportunity to:

- Participate in projects in the AAAiH Safety, Quality and Ethics Working Group
- Contribute to Codes of Practice/Policy Guidelines/Green Papers/White Papers
- Participate in other projects, national workshops and working parties
- Network and collaborate with members of the AAAiH

"We're looking forward to collaborating with members of the CIEHF. Their expertise in human factors is highly relevant to our research and to the implementation of safe, effective AI in healthcare", said Professor Wendy Rogers, Co-Chair of the AAAiH Safety, Quality and Ethics Programme.

Associate Professor Farah Magrabi, who is also Co-Chair of the Programme, said, "It's a global conversation that we need to have with experts such as CIEHF, where we can learn and together implement AI in healthcare that benefits everyone. We've been scoping Australian AI safety and ethics initiatives and our next step is to identify the issues at an international level, so we're looking forward to CIEHF participating in this activity."

AAAiH has an international membership with national goals. Established in late 2018, AAAiH has over 90 national and international organisations who have come together to build a singular national research and translational community with the capacity to translate AI advances into a sustainable AI-enabled healthcare system in Australia. The Alliance has four strategic areas of interest: Precision Healthcare, Consumer Health, Safety, Quality and Ethics, and Workforce. Members can contribute to one or more of the strategic areas. The Alliance has attracted global and local partners capable of developing leading edge research, technologies and resources alongside the industry leaders delivering them and the health services implementing them. Members cover academia, government, consumer, clinical, and industry organisations along with health provider partners in both primary and tertiary care. Find out more at **https://aihealthalliance.org**

IMAGE: GETTY

Library of learning

As we record almost weekly events on a huge range of topics in sectors such as healthcare, nuclear, defence and transport, not to mention the cross sector Masterclasses on human factors tools and techniques, we're building up a large resource of on-demand learning. Not only does it help with professional development and training but it keeps you up to date with the latest thinking by leaders in the field.

Even if you managed to be at a live event with the advantage that you can ask questions of the presenters and interact with the other audience members, there's a lot to take in. If you want to go back and check something out or just to listen again, we have full replays with all the chat, or videos with controls so you can skip to the bits you're most interested in. For paid events, just buy and ticket and the links will be emailed to you.

Go to **events.ergonomics.org.uk** for all details.

To be continued...

Did you know that whilst many of our members have the term 'Human Factors' in their job titles, many more don't? Anaesthetist, H&S manager, lecturer, nurse, Occupational Therapist, optometrist, SHE manager... the list of our members' job titles is almost endless! Your roles may already require continuous professional development (CPD) but we'd like to encourage you to consider undertaking human factors specific CPD as well. Whether you're looking to become a Chartered member of the CIEHF or would simply like to nurture your interest, reflecting on what you know already and what you may not know yet could be helpful in structuring your learning, and it may also open up new areas of interest for you.

Chartered members are required to record a minimum of five CPD activities for each calendar year and three planned activities for the following year in order to maintain their Chartered status. Those wishing to gain Chartered status are asked to provide a CPD record for the 12 months immediately prior to their application.

The CPD activities should be linked to the Professional Competency Checklist (PCC), which you can download from our website, and should aim to improve your proficiency (or refresh your memory!) where you see a need. Pre-Covid, CPD was often work-based or involved attending a course or an in-person event. Since we have to expect that the effects of the pandemic will continue, self-study and web-based activities can be flexible and accessible options. Please check our events website for upcoming events or on-demand webinars. Check our publications for material you may not have seen but which could make ideal CPD learning. You can find more information on CPD on our website.

Whilst we can only assess around 20% of CPD records of Chartered members every year, all members have access to a recording facility via their MyCIEHF account. Please feel free to use this tool to track what you've been doing and make plans for the future. If you have any questions on CPD, upgrading your membership or anything else, please get in touch!

Iris Mynott
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07702 542166

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

- Nick Woodier
- Natalie Abiodun
- Stephen Tipper
- Paul Wotton

Registered Membership

- Aaron Roberts
- Nadia Jouni
- Thomas Snell
- Kevin Wong
- Mark Harnett
- Tabitha Steel
- Tracey Milne
- Eylem Thron

Fellowship

- Neil Clark

Registered Consultancies

- Human Impact Ltd
- User Centric Design
- Mark Harnett Consulting

CIEHF events at a glance

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

EVENT	WHEN & WHERE	DETAILS
IEA2021	Sun-Fri, 13-18 June 2021, online	Learning and networking opportunities for the human factors and ergonomics community around the world.
Comfort Congress 2021	Thu-Fri, 2-3 September 2021, Nottingham	A CIEHF-supported, cross-sector event exploring comfort in transport systems seats and interiors, beds, noise, vibration and temperature, and wearables.
SafeComp 2021	Tue–Fri 7-10 September 2021, York	A CIEHF-sponsored event discussing the state-of-the-art in the safety, security and reliability of critical computer systems and applications.

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

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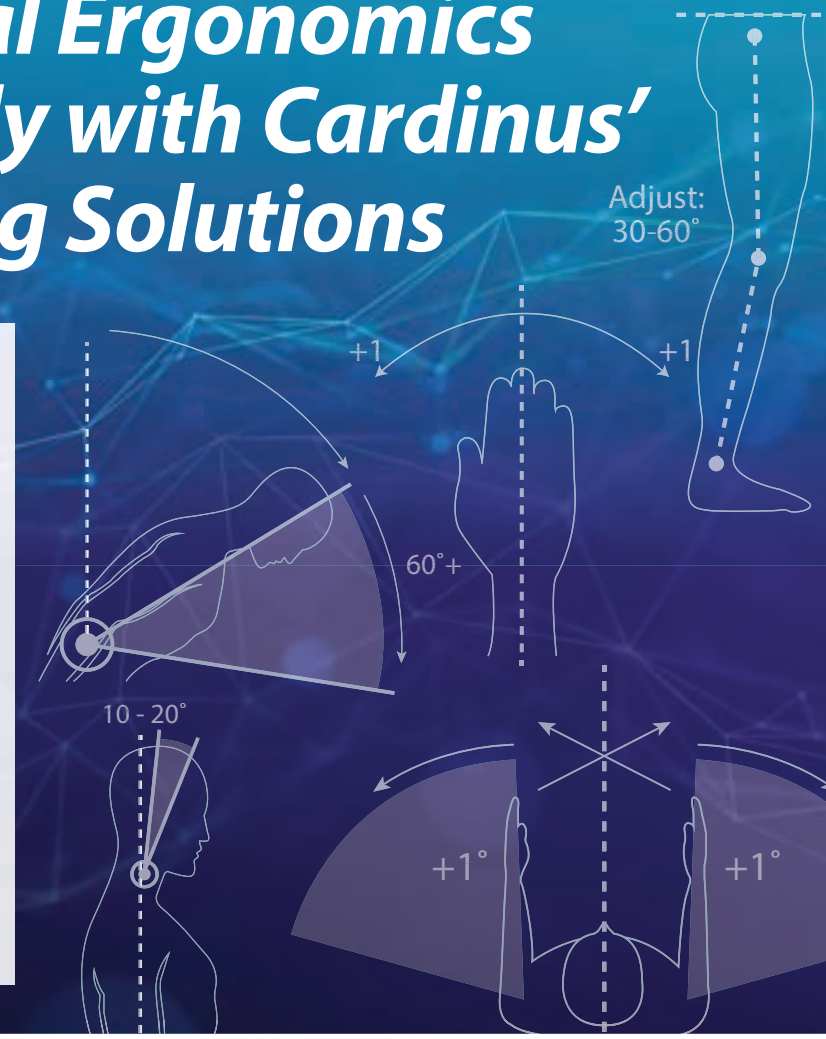

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- Working with relevant Human Factors methodologies applied in the nuclear industry for human reliability assessment (e.g. HEART, THERP)
- Developing, authoring and verifying Human Factor safety cases within a nuclear or high-hazard, safety-focussed industrial context

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FROM THE PRESIDENT

A growing reach and response

Chris Ramsden
CIEHF President

president@ergonomics.org.uk

My Presidency has certainly begun with a flurry of activity. I think everyone will agree that our Annual Conference was another triumph and testament to the hard work of the CIEHF team. Thanks to the presenters too for making it such an enjoyable three days with the combination of keynote speakers with practical presentations.

We've been receiving compliments from the many attendees around the world, in particular from ESSA, the Ergonomics Society of South Africa who complemented CIEHF for "...a seamless, high quality conference..." and commented on how colleagues from Nigeria, Tunisia and Kenya were also able to attend. This really reflects the CIEHF's global reach and in response to this interest, we'll look to collaborate with our international colleagues to develop joint initiatives and promote membership.

The Council of the Federation of European Ergonomics Societies met and discussed their move of headquarters to Brussels. CIEHF have been asked to be recorded as one of its founding members. The meeting included a very interesting discussion of what the term 'European' actually means and its geographical scope. All happily resolved but it's reflective of the importance of barrier free communications across countries and well as disciplines. Next on the list of international events is the IEA 2021 Congress and it looks like a very packed week with over 200 presentations and an additional 800 papers.

Tina and the team are working hard putting together the programme of events for this year and new Council member Courtney Grant and Past President Professor Sarah Sharples are currently preparing an online event for July, on the links between Human Factors and Equality, Diversity and Inclusion, to be followed up with a paper. Sarah will soon be joining the Department for Transport as Chief Scientist on secondment from the University of Nottingham.

Stay safe and stay in touch as we're always open to suggestions for new events, initiatives and opportunities.

We'll collaborate with our international colleagues to develop joint initiatives

FROM THE EDITOR

Insights into our developing discipline

Whilst the pandemic is still far from over, with summer this year comes the prospect of holidays and time in the great outdoors. Our cover feature by Oliver Hamlet and Amy Irwin focuses on their research into the cognitive readiness involved, should the need arise if things go wrong, in search and rescue efforts.

Covid-19 has forced many of us to do things differently, with no exception for Phil Lance and Charlotte Redden in their work on remote usability trials, and for Ed Oates who used crowdsourcing to research user interface design in defence. We look at support for healthcare workers provided through Project Wingman, and an article on the work of ergonomists post-pandemic gives us food for thought.

We continue our look at navigation in the built environment and dental hygienist Deborah Stratford highlights some of the human factors challenges in her sector. Javi Marichal gives us a practical guide to creating usable procedures and there's a discussion on the influence of technology on speech recognition.

Rick Heybroek looks back over his career and we celebrate the life and work of Jack Sandover.

Finally, we get a great insight into how ergonomics is developing in South Africa.

Enjoy the summer!

Tina Worthy
editor@ergonomics.org.uk
@ciehf

Thank you for your lounge

Project Wingman was the brainchild of a clinical psychologist and two airline pilots, connected through their involvement in airline mental health peer support programmes, who had a brilliant idea. Just as the NHS was facing its biggest challenge in living memory, here was a group of people perfectly placed to go in to hospitals to give NHS staff a morale boost: grounded airline crew. **Olly Chan** explains

"I want to give you all a warning..." Hearing that made me sit up and take notice. Where was this going? It was the 21st of April 2020 and I was in a lecture hall in a hospital in North London. On that day, although I was in my airline pilot's uniform, I knew I might never fly again, as my fleet had been grounded a few weeks before and the entire airline industry was facing an uncertain future due to the Covid-19 pandemic. But I was there as part of something that would give me more sense of purpose than I had felt in years and which would carry me and all my fellow volunteers around the country through the turbulence ahead: Project Wingman.

Coming from a medical family (my father was a surgeon, my mother a nurse) and as an experienced human factors instructor in my airline, where we often discussed the adoption of human factors in healthcare, I'm a firm believer that aviation and medicine have much in common. Both require high levels of training, are similarly technical, procedural, regulated and of course, both are safety-critical environments.

This project would give me more sense of purpose than I had felt in years

Olly Chan

Project Wingman was all about making the most of that kinship, using aircrew to set up airline-style First Class Lounges in hospitals where NHS staff could come for a break, to chat, to decompress. We would crew the lounges in uniform which would create a visual impact but also help develop the instant bond of trust because we were there for more than just service with a smile – our deeper meaning was 'tea and empathy', or in other words, mental health peer support.

I joined Wingman at The Whittington Hospital in North London, which was hugely meaningful to me as my father had been a young House Officer there before I was born. The Wingman lounge there had only been open a few weeks but local businesses were keen to support the cause and offer chocolates, cereal bars, coffee or exotic fruit tea, anything that might be really appreciated after a long shift. I'd only been there a short time when, crossing the road to collect some deliveries from another part of the hospital, I heard someone calling out to us. "I just wanted to thank you for everything you're doing, you can't believe how much it means to us all", they said. I was actually quite taken aback, after all I hadn't done much more than unpack a few cardboard boxes. But over the next few hours, as we spent more time in the lounge chatting to the staff that had already begun to make it their 'safe place', it began to sink in; the Project might be new but it was starting to make a difference.

And it was starting to grow. After The Whittington I moved to North Middlesex Hospital where the lounge became a shining example of what could be achieved when you combine aircrew-style problem solving with social influencing. On day one the lounge was a few chocolate bars on a table but soon it would put even the hippest of coffee shops to shame. The number of donations increased and, thanks to the amazing cakes from local bakers, waistlines would soon do the same. Also growing, as word of this new airline lounge spread, was the queue for a coffee, a snack, a quick conversation or words of comfort.

After a few weeks at North Middlesex I was asked to oversee the opening of a lounge in another nearby hospital, the Royal Free Hospital in Hampstead, and so there we were for launch day; our introduction to the hospital, some of the key people we would work with, and the space we would occupy.

Back to the 21st of April and the warning that came from the Chief Communications Officer, who continued: "I want to warn you that you are joining a family here and some of you will make friends for life..." Her words resonated with me immediately and were proven true from that moment on.

We were blessed in so many ways at the Royal Free. We were given a fantastic welcome, generously supplied with treats for our guests and we were in a space - an unused coffee bar in the staff canteen - that was ideal for what we wanted to create. The make-over began with some vintage travel posters and a guest book on a table at the entrance. Our biographies went up on the walls alongside atmospheric photographs of iconic aircraft such as Concorde. Inflatable flamingos appeared from somewhere. One of the team brought in a world map and every guest was asked to place a sticker to show us where they were from. Entire countries were quickly hidden behind coloured dots.

With Wingman now getting widespread media coverage, a nationwide team was created to manage the growing donations. Soon we were getting sofas, plastic pot plants, hampers, a hi-fi (what lounge is complete without a chill-out soundtrack?), a newspaper stand and daily papers and magazines! Posters of Caribbean islands were great conversation starters, a television crew came in to film our lounge for national TV news and we were even asked to host a 'hen night' (a table for coffee and cake for three) for one of the nurses who had put bigger plans on hold. Having airline crew in the hospital was causing great excitement and there was a real buzz in the lounge. People wanted to talk about anything to do with flying and the subject of human factors often came up too. Many people wanted to find out more about how human factors training is implemented in the airline world, which led to us being invited to observe simulator training of groups like resuscitation teams or physiotherapists and contribute to their debriefs.

An important principle of Wingman was that it was non-branded; volunteers came from almost every airline in the UK and we were united by our desire to support our NHS friends. What we didn't expect though was how much they, in turn, would support us. At the beginning we welcomed people to our lounge with a smile and asked them how they were but against a backdrop of airlines collapsing and widespread redundancies amongst volunteers, it wasn't long before people would come to our lounge just to check in on us. We really had joined a family, we really had made friends and we were taking care of each other the way that family and friends do.

At its height, Project Wingman had nearly 5,500 volunteers crewing lounges in 85 hospitals around the UK, and even reached as far as New York. The project is a registered charity and continues to support NHS staff, with a number of 'legacy lounges' remaining open and more recently, a mobile lounge in the form of a double-decker bus is visiting hospitals.

Lastly, the title of this article is from a message in our guest book: "Thank you for your lounge, it brings me peace". Many kind words were written, but to me these say it all. For more information visit www.projectwingman.co.uk

Olly Chan has more than 30 years of flying experience starting in the RAF where he flew the Boeing 707 AWACS aircraft before moving to the commercial sector, flying the Boeing 747-400 before converting to the Boeing 787 Dreamliner earlier this year. He's passionate about human factors, delivering training to fellow aircrew and other aviation work groups, and more recently to healthcare professionals.

IMAGE: SHUTTERSTOCK

Ergonomics perspective from South Africa

South Africa is alive with possibilities and opportunities for developing and growing ergonomics and the country is leading the way in its efforts to increase education, research and application of the discipline as **Sma Ngcamu-Tukulula**, **Andrew Todd** and **Jonathan Davy** explain

South Africa, also commonly referred to as 'Mzansi', is a vibrant multi-cultural country with a population of almost 60 million people spread over 9 provinces. South Africa has 11 official languages emanating from a diverse number of African cultures that contribute to the rich heritage of the country. People that have visited South Africa often marvel at how warm and welcoming her people are and how breath-takingly beautiful the landscape is. Its people are avid sports fans with soccer, rugby and cricket being just some of the widely followed sports that the country participates and excels in at international level. The 2019 rugby world cup win by the Springboks is but one testament to this.

South Africa is regarded as one of the more developed African countries and the second largest economy (after being recently overtaken by Nigeria). Sectors that drive South Africa's economy include finance (20% GDP Q3 2017), government (18%), trade (15%), manufacturing (13%), transport and communication (10%), and mining (8%). But despite being 27 years into its democracy, the country still reels from the legacy of apartheid, the effects of which are yet to be fully dismantled. So socio-economic strife remains a reality for the majority of South Africans and South Africa remains one of the most unequal countries in the world. This inequality is particularly evident along gender and racial lines. In spite of this, South Africans continue to explore the opportunities to improve the future for all who live in the country.

Platinum miners fitting a ventilation pipe in Northern Province, South Africa

The growth of ergonomics

Ergonomics has been practiced in South Africa for over 40 years in various industries including mining, military, manufacturing, railway, aviation, forestry, construction and in the informal economy. Although still a young profession locally, ergonomics is set to steadily grow in the upcoming years. This growth is mainly driven by an increasing awareness of the benefits associated with good ergonomics, together with the Ergonomics Regulations, brought into effect on 6 December 2019 under section 43 of the Occupational Health and Safety Act 1993 (Act No. 85 of 1993).

The implementation of ergonomics on the African continent remains relatively limited when compared to the rest of the world, partly illustrated by the fact that there are only three societies in Africa federated to the International Ergonomics Association (IEA): South Africa, Nigeria and Tunisia. But it's clear that there are exciting developments underway following the establishment of the network of African Ergonomics Associations (ErgoAfrica) in 2014, which is working to grow ergonomics on the continent by bringing together groups of academics in Morocco, Ghana, Ethiopia and Kenya. There are also ergonomics practitioners

in Botswana, Namibia, Niger and Zimbabwe, and recently the formation of a Portuguese-speaking ergonomics society network which now includes Angola, Mozambique, Guinea-Bissau and Cape Verde.

Challenges and opportunities

The integration of ergonomics in many industries locally and regionally remains poor but there is evidence of key sectors recognising the benefits of ergonomics which can be leveraged to improve the awareness of the discipline and contribute to its widespread implementation across the continent. Ergonomics research in South Africa is expanding and there are several key industries that recognise the need for ergonomics research nationally and regionally. The first is healthcare, which has seen increased collaboration between local and international researchers. Secondly, transport sectors such as railway and aviation are also investing in ergonomics research, principally through collaboration with local researchers and hosting annual symposia to share the latest research and practice. There is also growing collaboration between African researchers and European Union funded projects, particularly relating to issues of sustainability.

There is a growing interest and recognition of the discipline on the African continent, and with it an expectant increase in the demand for ergonomics education and awareness, applied research, and interventions to integrate ergonomics into work systems in practice. Although relatively slow, there has been an increase in the number of qualified and experienced ergonomics practitioners but more are needed to meet the fast-growing ergonomics requirements of industry.

Ergonomics in practice requires recognition and understanding of the local context when analysing, developing and implementing interventions. Given some of the unique African conditions, opportunities abound for practitioners and researchers to ensure that ergonomics methods, techniques and theories are context relevant and locally responsive to the particular challenges in Africa. There may even be scope to adapt or develop new Afrocentric approaches that can add to the large body of ergonomics knowledge that has mostly been developed outside the African continent.

Forestry workers felling pine trees in the Western Cape region of South Africa

Currently, Rhodes University is the only university in South Africa that offers a degree in ergonomics, with other institutions offering individual modules and courses. However, with the Ergonomics Regulations 2019 coming into law, there continues to be interest in expanding ergonomics education programmes and the provision of training that provides an overview of ergonomics, how to manage ergonomics risks and how to establish an ergonomics programme. Ergonomics training is offered by a host of local ergonomics consultants and professionals, as well as by tertiary institutions.

There are many opportunities for collaboration between South Africa, Africa and the broader international community. For example, the BRICSplus network of ergonomics societies (Brazil, Russia, India, China and South Africa) have established the BRICS catalyst for the promotion of collaborative research. Additionally, ErgoAfrica has been working hard to establish joint research funding applications and through European Union funded projects, there are increasing opportunities for collaboration between African countries and the EU. Critical to the success of these collaborations is the establishment of mutually beneficial and participatory research programmes that focus on building capacity for African countries to develop African solutions for African problems.

The development and application of ergonomics is timely and much needed on the African continent. There is cautious optimism that legislating ergonomics will be an important catalyst in introducing the discipline to organisations in all industries where it has the potential to improve productivity and create much-needed jobs that can stimulate the African economies. Placing an emphasis on South Africa and Africa developing Afrocentric ergonomics education, research and practice, will allow the continent to contribute to a different trajectory for the discipline in the coming decades.

The Ergonomics Society of South Africa

The Ergonomics Society of South Africa (ESSA), formed in 1984, is a non-profit organisation and a federated member of the IEA. Run by volunteers from academia and from practice, ESSA's activities aim to:

- Build awareness and understanding of what ergonomics is and its associated benefits.
- Contribute to the development of the scientific practice of ergonomics.
- Provide resources for the advancement of ergonomics in South Africa.
- Facilitate and grow strategic partnerships.
- Through the ESSA professional affairs board, certify ergonomics professionals in South Africa, while ensuring the professional and ethical practice of ergonomics as recommended by the IEA.

Anyone can become a member of ESSA, including professionals and students from other disciplines or interest groups. Please visit **https://ergonomicssa.com** or email **ergonomicssa@gmail.com**

Sma Ngcamu-Tukulula is Vice President of ESSA and a human factors/ ergonomics specialist and managing director at Smart Ergonomics.

Andrew Todd is a senior lecturer at Rhodes University, Treasurer of ESSA, past president of ErgoAfrica and chair of the International Development Standing Committee of the IEA.

Jonathan Davy is President of ESSA, a lecturer at Rhodes University and the editor of the society's journal, *Ergonomics SA*. His research interests are in sleep wake behaviour and the effects of sleep loss on human performance.

IMAGES: SHUTTERSTOCK

Reimagining ergonomics in a post-pandemic world

The pandemic has led to a major shift in all aspects of life; many businesses and industries have had to change models, and research and education have had to move online. **Tianqi Gao Smith** and **Boyi Hu** discuss the impact this could have on our profession.

The Covid-19 pandemic is distinct from the previous pandemics and financial crises. Compared to the 1918 influenza pandemic, the 2013–2016 Ebola pandemic and the 2008 financial crisis, the world is much more integrated in the current era. Individuals and businesses are adopting and adapting to new and existing Industry 4.0 technologies more than ever to overcome the new challenges that the pandemic has generated and to conform to newly issued government policies, such as shutting down of certain local service businesses, quarantine, isolation and social distancing. These technologies include artificial intelligence (AI), the Internet of Things, big data, virtual reality, cloud computing, autonomous robots, 3D scanning and printing, and biosensors.

A significant percentage of the working population has now experienced remote services powered by these technologies, for example, through video conferencing, online shopping and tele-medicine. Although these abrupt behavioural changes may not be easy initially, we eventually become familiar and come to depend on these service formats in time. From this perspective, the pandemic is a catalyst for change.

As the social and technical demands and supplies of various industries, research and education entities rapidly update, the ergonomics profession, which is by its nature linked to them all, will also inevitably adapt.

Industry

Catalysed by the pandemic, many occupations within the service industry are being created to satisfy urgent needs and abrupt modifications are being made to traditional business models, many of which may never return to their pre-pandemic states. In these cases, many would not have had a chance to be accessed for occupational risks. So three tasks for ergonomists post-pandemic are:

1. To assess these newly emerged job tasks for injury risks, as well as how they interact with the updated workflow dynamic.
2. To design or redesign job tasks or the work environment for safe and effective adaptation to these new workflows.
3. To integrate emerging technologies for more ergonomic workflows.

Using the grocery industry in the food retail sector as an example, it hosts over 1 million workers in the UK and over 2.5 million workers in the US. As the pandemic significantly affected food accessibility, panic shopping became a phenomenon. Online shopping, home delivery or curbside pickup spiked as consumers attempted to avoid visiting the traditional bricks-and-mortar locations. Consequently, staffing of grocery delivery and curbside pickup significantly increased amidst the pandemic.

Although the profitability of these new business models remains unknown, the technological advancements in AI and automation could bring the current operational costs of grocery delivery and curbside pickup down enough for it to become a perpetual option for the industry and its customers. With these changes, comes an urgent need for ergonomists to assess workers' injury risk exposure thoroughly, to evaluate the delivery and pick-up process, to create injury prevention and intervention plans, and eventually to suggest changes to the job tasks, work processes or work environment from a systematic, engineering and/or administrative perspective.

A possible alternative is to use robots and automation to reduce manual effort, perhaps widening the scope to offer jobs to people with a more diverse range of physical abilities.

Research

The temporary cessation and limitation of in-person research during the pandemic created challenges as well as opportunities for ergonomics researchers. Methodologies had to be rethought as human subject experiments are an essential part of

Parcel delivery worker preparing for the next stop

- Assessing or creating new ergonomic risk assessment tools for new job tasks that emerged during the pandemic to satisfy policy updates and behavioural changes.
- Understanding how humans interact with new technologies, such as AI and co-bots, in terms of possible long-term productivity, safety and worker satisfaction.
- Gaining experience in remote research with those who find it difficult to travel due to cognitive or physical limitations, so expanding the potential participant base.
- Expanding ergonomics services that transitioned online during the pandemic to become routine services post-pandemic, such as risk assessment via video analysis.

As social and technical demands rapidly update, the ergonomics profession will also inevitably adapt

ergonomics research. For example, allocating or locating adequate space for proper social distancing while conducting research could be difficult and many research boards required human subject research to move totally online for a time.

Consequently, despite the initial obstacles, updated scheduling, space allocation and experimental processes were created to accommodate the situation and satisfy the research needs. Instead of in hallways and on bulletin boards, recruitment flyers were distributed via email lists or virtual forums. Communication with and compensation for subjects took place via mobile devices through text messages or mobile apps. And subject screening, informed consent and surveys were conducted electronically via video conferencing or electronic forms. These functional alternative research processes may continue to benefit researchers post-pandemic.

New strategic ergonomics research questions in future may include:

- Possible lasting psychological impact of the pandemic and its influence on human cognition and behaviour. For example, the socially acceptable distance between humans and between humans and man-made intelligent agents may become greater post-pandemic.

Education

A prospective ergonomist needs to cultivate skills such as analytics, problem solving and communication, and develop knowledge and understanding of engineering, economics, physiology and psychology. They need to learn and understand a system or a specific industry in short periods of time and keep up with an increasing working knowledge.

Whilst the transition to online learning during a pandemic is not obstacle free, it may be opportune to ergonomics education in reaching a larger audience with fewer barriers and limits such as time and location. Many educational programmes have now established or bettered their remote-learning platforms enabling the possibility that some of the online programmes and courses created will continue post-pandemic.

However, moving the training platform online and equipping the teaching facilities and students with necessary hardware and software to learn online is one thing, but there's also a need to identify how best to ensure that the education quality and outcomes from traditional in-person interactions are maintained. For example, students who choose scientific disciplines also benefit greatly from laboratory-based, hands-on experiences and from in-person interviews or focus groups.

From another perspective, the online transition of ergonomics education means a global audience can be reached, which may help to standardise ergonomics certification programmes deemed challenging pre-pandemic due to local cultural and regulatory variations. Online ergonomics education could also reach secondary schools so students become aware of the ergonomics profession at a younger age. Institutions, in facilitating learning and teaching online, will need to provide continued support for hands-on experiences, near-peer interaction, mentoring and other skills that may be difficult to pick up through online interactions.

As things continue to change during 2021, prospective and current ergonomists should look forward to developing their understanding of Industry 4.0, cultivating data analytics and machine learning techniques, and preparing to work with others that perform job or tasks in new fields that emerge during or post-pandemic.

IMAGES: ALAMY / AUBURN UNIVERSITY

Dr Tianqi (Tenchi) Gao Smith is an Assistant Professor at the College of Medicine and Science at the Mayo Clinic in the US and a Senior Health Services Analyst at the Mayo Clinic Robert D and Patricia E Kern Center for the Science of Healthcare Delivery.

Boyi Hu is an Assistant Professor of Industrial and Systems Engineering at the University of Florida.

Teaching aspiring engineers

Inspiring innovation

The mission of the Campaign for Science and Engineering (CaSE) is to ensure that the UK has the skills, funding and policies to enable science and engineering to thrive. The CIEHF is one of over 115 scientific organisations including businesses, universities, professional bodies, and research charities that CaSE represents.

In May, CaSE published 'Inspiring Innovation', a briefing putting forward recommendations to enable high-quality science education in schools across the UK. With the UK set to increase its public research investment to £22bn by 2024/25, CaSE says it's vital that an increasingly diverse group of people should continue to be inspired to become scientists and engineers and all young people should gain the skills to take advantage of advances in research and innovation, whatever their background. See **www.sciencecampaign.org.uk/resource/inspiringinnovation.html**

Recognition for student work

CIEHF's award-winners have just been announced in an online ceremony and will be profiled in the next issue of *The Ergonomist*. Our awards include those that recognise excellence in research, practice, innovation, communication and project work. Student project work is also rewarded through CIEHF's Best Student Project Award. Other ergonomics organisations are also recognising the great work carried out by those undertaking study.

Abdulazeez Uba Muhammad, a Student Member of the Human Factors and Ergonomics Society of Australia, has won the 2020 International Ergonomics Association / Kingfar award for Student Research in Human Factors and Ergonomics Issues in Industrially Developing Countries. Abdulazeez's master's level research is called "Vehicle Occupant Accommodation Based on Nigerian Anthropometric Data" and he's now conducting PhD research in the same area focusing on child vehicle occupant safety.

The US Foundation for Professional Ergonomics (FPE) has also recently given a student award to Sara Wolf and Franzisca Maas from the Institute Human-Computer-Media, Julius-Maximilians-Universität Würzburg in Germany, who won the 2020 Dieter W Jahns Student Practitioner Award. Sara and Franzisca completed their project in cooperation with the Department of Anesthesia and Critical Care, University Hospital of Würzburg. In their project, Cassandra, a decision support tool for clinical assessment and reasoning in a user-centred design process, was used:

Staged photo of an anaesthetic team interacting with Cassandra in the simulated environment

- To understand the complex, safety-critical context of operating room (OR) crises based on User Experience (UX) theories.
- To develop a decision support tool for diagnosis and treatment guided by UX theories.
- To evaluate the developed solution and theoretical framing in a simulator-based study.

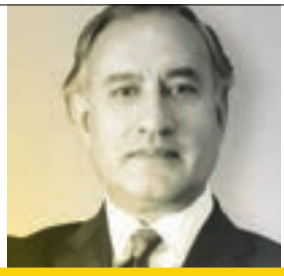
Sara and Franzisca were the first to develop a decision support tool that takes into account the diagnostic process and the treatment during OR crises. Their design was based on an analysis of the greater context involving the physical and social environment as well as human beings' constraints and givens (such as psychological needs or cognitive limitations). Find out more about the project at **https://bit.ly/2Szn9yr**

If you're a student and are interested in applying for the FPE Student Practitioner Award 2021, you have until 31 July 2021 to submit an application. See the Foundation for Professional Ergonomists' website for more details at **http://bit.ly/DWJstudentaward**

Award for outstanding contribution

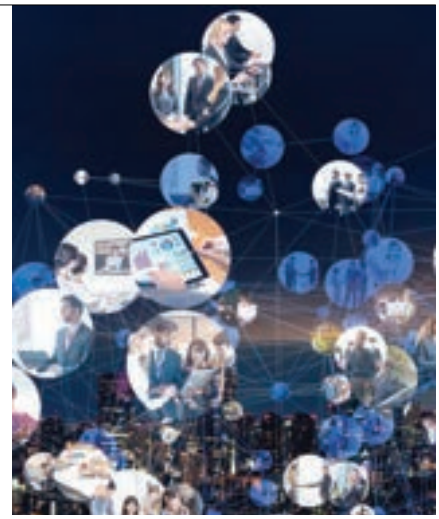
The Foundation for Professional Ergonomics have judged their Ergonomics Practitioner of the Year Award, which recognises those who have demonstrated outstanding contributions to the practice of ergonomics through their professional lifetime achievements and/or specific implementation projects. Previous winners include CIEHF's own Tom Stewart, Peter Buckle and Bob Bridger.

The winner for 2020 is Brian Peacock. Brian's long career in industry and academia includes 18 years in academia, 15 years with General Motors' vehicle design and manufacturing organisations, and four years as discipline coordinating scientist for the National Space Biomedical Institute/ NASA. He's a licensed professional engineer, a licensed private pilot, a certified professional ergonomist, and a Fellow of both the CIEHF and the US Human Factors and Ergonomics Society. He's currently a consultant in ergonomics and systems engineering and teaches at two Singapore universities. Find out more at **https://bit.ly/3wwRhsS**



CHIEF EXECUTIVE'S PERSPECTIVE

Our vibrant growing professional network



The CIEHF is leading the way in creating thought leadership by engaging members and working with other allied professional bodies, academics and researchers from around the world. *Vaccinating a Nation* (**https://bit.ly/VaccinatingaNation**) is another great example of the CIEHF working collaboratively to create a publication that is recognised internationally. This guide is about how to set up a safe vaccination programme using human factors principles. Published in April, it's aimed at an international audience and has been, or is being, translated into Spanish, Persian, Hindi, Bengali and French. We're now looking for volunteers to translate it into Russian. The guide is also available through the World Health Organisation. The accompanying interactive infographic is an innovation that has enhanced the user experience for this guide and we will adopt this method increasingly.

Creating thought leadership in the form of guides, white papers, articles and infographics has acted as a strong catalyst for attracting new members not just from the UK but internationally. Increasingly, larger organisations are looking to pay for employees to have CIEHF membership. Manchester NHS Foundation Trust has set up a Human Factors Academy and expect around 50 staff to join. NHS Education for Scotland are looking to sign up around 30 members this year, and the Healthcare Safety Investigation Branch is amongst other organisations who have paid for staff to join.

We aim to produce around 30 guides and reports each year to share applied practice and challenge thinking on how human factors can be used in business and industry. If you'd like to discuss leading a small writing team to prepare something that will make a difference, CIEHF can help and support you. Please don't hesitate to contact me directly on how to go about this (whatever the subject). I'm looking forward to several such guides driven by members including one on Cybersecurity led by Amanda Widdowson and another on Equality, Diversity and Inclusion led by Courtney Grant and Professor Sarah Sharples. Later in the year, Professor Bob Stone will be preparing a White Paper on virtual reality. Nichola Adams, Kirsty Angerer and I are working on a new series of three guides with Professor Andrew Thatcher (South Africa) and Professor Rosemary Seva (Philippines) to be published by the International Ergonomics Association. The series focuses on the 'C' suite or executive level, operational managers and organised labour and staff groups.

Increasingly CIEHF's work, sharing thought leadership to promote our discipline, is being recognised

Increasingly CIEHF's work, sharing thought leadership to promote our discipline, is being recognised. This month we won a HIROC/IEA2021 award for our work on ventilators led by Professor Sue Hignett and Dr Mark Sujan. Our work in response to Covid-19 has been shortlisted for a UK Associations Excellence Award (see **www.associationexcellenceawards.co.uk/finalists/**). It doesn't stop there! Our Defence Sector Group, the MOD/HFI Group led by Laird Evans and Steve Harmer, has also won an international award for their work in integrating human factors into the design of complex systems through the production of a range of standards and policy documents over several years.

Just as we go to print, I can let you know that Dr Patrick Waterson has won the IEA/Elsevier John Wilson award. This award recognises major contributions in applied ergonomics to the design of work, systems, technologies and environment which lead to improvements in system performance and wellbeing.

Our conference, EHF2021, held in April was a great success. Keynote speakers including Richard Browning from Gravity Industries and Kritina Holden, Technical Fellow at Leidos at NASA Johnson Space Centre helped us take a glimpse into the future and look at how human factors might be used. Professor Sarah Sharples and Professor Peter Hancock provided us with some great historical as well as future insights on how our profession might develop. These contributions were inspirational - I can't wait for EHF2022 to meet you in person.

Noorzaman Rashid
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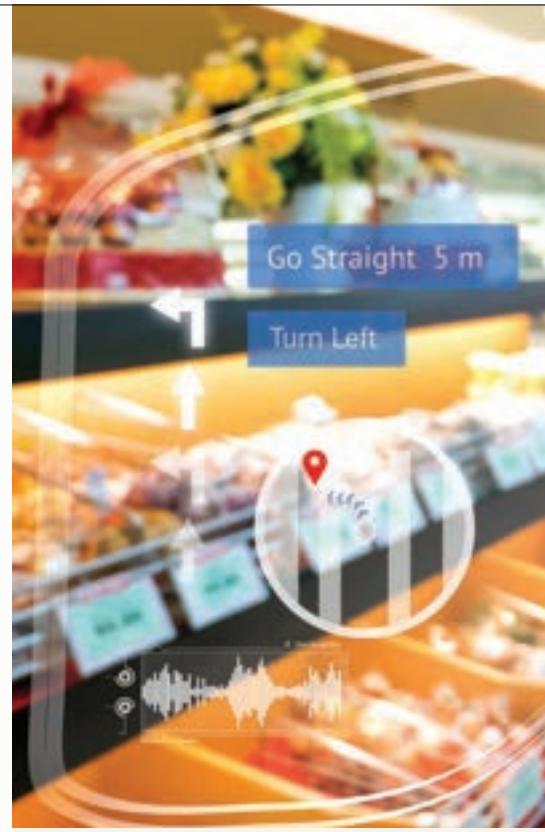
noorzaman rashid

The neuroscience of navigation

In this second of a two part interview, **Nigel Scard** continues his discussion with Professor of Neuroscience, **Kate Jeffery,** to find out more about our ability to navigate our built environment. They explore how traditional methods of assistance such as compass points and signage can help, alongside additional information that technology now offers



How can we help people navigate 3D multi-level spaces common in our urban environments?

There's been some work looking at people's propensity to get confused in multi-level buildings. One reason might be that people don't process vertical distances so effectively but it might also be that the different levels often resemble each other. Just as we find in horizontal spaces which resemble each other, our mental maps are confused by that. So to stop that confusion you'd to try to make each level look really different, perhaps giving different levels different shapes with different directional cues. You can use different colours but that doesn't work so well since the spatial system doesn't care about colours.

How can we improve the connection between underground and surface level locations, for instance knowing where we'll emerge when we exit an underground station?

One of the things you're deprived of when you come up from underground is that you have no compass information, you have no idea which way you're facing in the world at large. There are signs telling you what the different exits are but if you don't already have the knowledge of what those mean, it's not very helpful. But you may know, for instance, that when you come out of a certain station, you want to head north, so if you had some compass information it would make it easier. Also, if you had that information, the first time you go into that space you could become oriented in such a way that lets you make a mental map of that space so that the next time you go to that space you have a better understanding of where you are. That's a really good example of the type of built space that I think could be improved by taking into account the kind of information the brain needs. One thing that I'd love to see is a compass rose at the top of every escalator. It would be interesting to start to add that sort of information and see if it makes people's experience better.

Do you see common mistakes in signage design to assist wayfinding?

One mistake is assuming people know where they're going. For example, when you come up the escalator into the Piccadilly Circus station concourse, there are signs indicating exits for different streets, which presupposes that you know which street you want to take. You may not have memorised the names of the streets but you may know that you want to go north up to Oxford Circus for instance. However, you wouldn't know that Regent Street would be the road to take.

Other issues with signs are that there may be too many of them, sometimes the text is too small or there is a sign as opposed to something more naturalistic that would have helped you orient more easily. Signs have their place but they're also very difficult to process cognitively, they rely on the language centres of the brain which are evolutionarily very recent, so it's hard work and if you don't speak the language or you're visually impaired then they're useless. So, I'd like to see a lot less signage and a lot more naturalistic

AR could be used to help navigate many environments in different ways

design if we're going to improve navigation in our towns, cities and buildings.

What are the likely future developments in navigation assistance technologies?

Well, phones will get better and one improvement would be for them to work as well indoors as outdoors for finding your way around. But I'm quite intrigued by the possibilities for Augmented Reality (AR). Instead of having your information source in a device you hold in your hand, you have it integrated through your glasses, mixed in with your perception of the world - I think that technology will come along pretty quickly. I love technology but I prefer when it works with my own cognition rather than as an alternative to it so it's more seamless and more efficient.

How could AR smart glasses be used to assist navigation?

Even just arrows superimposed on people's view would be a start, you could either follow the arrow directly or go exploring based on that type of help but for people who like compass directions it would be useful to know which way was north. Also, you could make use of the overlay capacity. So for example, you could look at a building and by adjusting a setting make the building transparent so you could see though it to what's behind it. You could make a 'glass' city this way.

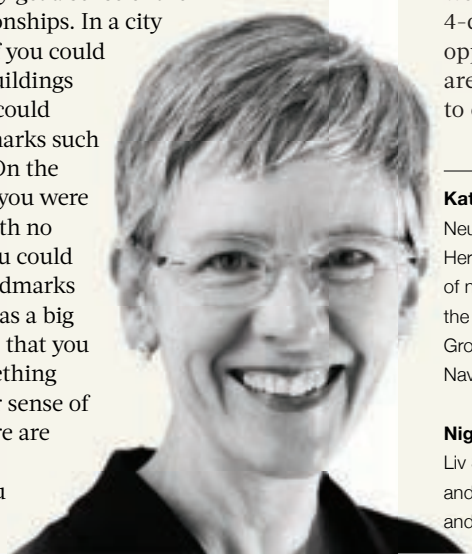
One of the things that's confusing about navigating through streets with tall buildings is that because you can't see past your immediate surroundings you don't really get a sense of the broader relationships. In a city like London, if you could see through buildings using AR you could identify landmarks such as the Shard. On the other hand, if you were in a suburb with no landmarks, you could create fake landmarks yourself, such as a big monument, so that you then had something to anchor your sense of direction. There are all sorts of fun things that you could do.

I prefer technology to work with my own cognition rather than acting as an alternative to it

Can Virtual Reality help enhance our navigation skills?

Yes, I think VR is going to be a really useful tool, partly for just studying people, trying out architectural designs or trying to understand what information people use. I've started to get interested in using VR myself to look at things like how people process the symmetry of buildings. I think it offers the opportunity to be useful in other ways also. For instance, we know that the brain's spatial map organises information well in our own heads, so people will often use a spatial strategy to remember things. We're best at remembering things that happened in particular places, so if you're trying to teach a history student something, you might create an environment such as a virtual museum.

You could play around with worlds that aren't possible, such as flying through space or creating a 4-dimensional world. I've been thinking about that and whether we could make a mental map of a 4-dimensional world if we had the opportunity to explore one. There are some exciting opportunities to come.



Kate Jeffery is a Professor of Behavioural Neuroscience at University College London. Her area of special interest is the neuroscience of navigation – visit jefferylab.com. Kate chairs the Cognition and Navigation Special Interest Group (CogNav) of the Royal Institute of Navigation – see cognavrin.org.uk.

Nigel Scard is a Human Factors Specialist at Liv Systems. He has an interest in neuroscience and its potential application for human factors and is a member of the CogNav group.

Turning speech

Speech recognition systems have been around almost as long as QWERTY keyboards. They've been incredibly successful for some but also have their limitations for many, as **Nigel Heaton** explains

I was fortunate enough to work on a speech recognition system that was at the leading edge of the technology in the late 1990s. It was a long-term project with News International where they had implemented an astonishing speech recognition system capable of accuracies of 100% that illustrated all that's interesting and challenging about speech input.

The demand from newspapers at that time was to take football reports from matches that finished between 4.45 and 5pm. These reports were subject to sub-editor and, in some cases, editorial review prior to being sent to the printer for setting. The time of the earliest first print run was around 8pm, which was generally *News of the World*, hot off the press and ready for sale in the West End at pub closing time of 11pm.

To meet these tight timescales, correspondents and reporters were stationed at all the main grounds and interesting matches. They composed their thoughts as the match progressed and at the final whistle, they quickly found a phone (often in a phone box as this was before mobile phones were common) and called in their report. The first part of the report may have been well-thought out and written, the second was straight off the top of their head, based on notes and player names.

The reports were typed up by the marvellous copytakers who were truly astonishing people. They could type at pretty much spoken English speed, mostly in excess of 100 words per minute, which is around 500 key depressions per minute or 30,000 key depressions per hour. Not only could they keep up with the speech but they could also edit out the repetitions, hesitations and deviations, spotting non sequiturs and, if I'm being honest, taking what sometimes appeared as drivel and producing written gold.

Unsurprisingly, some copytakers experienced a range of musculoskeletal disorders (MSDs). We worked with them over a long period exploring lots of solutions (my colleague Andy Baird, now of Derby University, was heavily involved in the project). This included using the Maltron keyboard, which seemed to have some effect, until we looked at the data and discovered a fully trained copytaker was struggling to get speeds of over 20 words per minute and was working for such short periods as to be unable to do the job, so their exposure to potential hazards was virtually zero but their employability was massively compromised.

Most people do not articulate well; they stop and start, they um and er, they repeat. Also, they're not skilled at organising speech that's suitable for the written word so we need an intelligent intermediary. That's not to say that there were not some incredibly skilled dictators (in the speech sense). The copytakers had strong views on who they preferred and who was a nightmare and might jeopardise the all-important deadline and sometimes did, with reports rolling over to the second edition. The copytakers were paid a premium for the job they did and it was a substantial amount at the time.

From the earliest Dictaphone, the technology was expensive and typically, they were used by senior executives who were almost exclusively male. Touch typists were female, in a job that was 'suitable' for an (unmarried) woman. Over the next 50 years, with the exception of the UK Police Force, typing was a woman's job and taking dictation (the speech recognition bit) was what the very best typists were able to do. This stereotype cascaded into design. Typists chairs had small seat pans, no arms and relatively aggressive back support. Supervisors' chairs were typists' chairs with arms and managers' chairs had extensive seat pans, back supports and were typically covered in leather (or faux leather).

Throughout all of this, we trained very few people in how to dictate nor did we train many to type. We did not see much rise in MSDs either, as typists were very active as their role included a lot of movement, swapping paper, dealing with ribbons etc., plus as soon as they married, they were sacked, hugely reducing their exposure.

IMAGE: SHUTTERSTOCK

into text

This did start to change in the 50s and 60s (not so much in the UK, more in the USA) as the benefits of interacting directly with a keyboard and screen started to emerge. This led researchers to begin the quest for computer-based speech recognition with all the challenges it brought with it in interpreting accents and different phraseology.

In the mid-80s I was despatched on a study tour of speech recognition to the USA. To that end, I spent time with Janet Baker of Dragon, the IBM team at the Thomas J Watson Research Center, the HP team at Palo Alto and many others. This is where we learned that speech input was not going to be central to the UK's administrative Government's plans any time soon.

The Dragon team used a very clever statistical model to support their recognition software, whilst IBM relied on brute force, its access to the world's largest computerised library (their own), and lots of clever people. Other companies had other approaches but the reality was that all of them relied on people talking out loud to computers and it turned out that most people weren't that keen. A keyboard offers you a really smart and discreet way of interacting with your thoughts, shouting at a computer less so.

Most people do not articulate well; they stop and start, they um and er, they repeat

Sure, there are tasks where speech input can be very effective. Hands-busy, eyes-busy tasks may be suitable for speech input and restricted bandwidth, restricted choice tasks are also good but rarely popular with end users. The problem of narrow, deep menus using less than 100% accurate speech recognition may be familiar to anyone who uses the phone to try to get through an automated system of options just to talk to a real person who could help them.

Nigel Heaton is a founder and director of Human Applications Ltd.

What we've learned is, I think, very interesting. Speech input is constraining, much more so than typing. We can only use speech input in certain locations (it's very difficult in an open plan office, for example). By some freak of nature or design, many of us can use keyboards at the same speed as we think. We don't feel as weird typing our thoughts as opposed to saying them. Anyone who watched the Oscar-winning *Darkest Hour* will see Winston Churchill using a smart speech recognition system, perfectly illustrating some of the problems.

Overall, let's ensure as many people learn to touch type as possible and we use speech input following proper analysis of the task, the user requirements and the correct allocation of function, rather than using it as a technology (because we can) or as an incredibly frustrating design solution that offers few, if any, benefits to the end user. ●

Preparing for the unpredictable

For many of us, finding ourselves in an unpredictable and potentially hazardous environment can be a distressing experience but for helicopter search and rescue crews it's a daily operational reality. Besides the specialist technical expertise necessary, what other skills can prepare you for such scenarios? Research by **Oliver Hamlet** and **Amy Irwin** aims to find out

A typical search and rescue (SAR) crew is made up of two pilots, a winch-paramedic who attends to a casualty, and a winch-operator who coordinates hoisting procedures from the aircraft. Responding across land, coastal and maritime environments, SAR is, by its very nature, a dynamic and high-risk undertaking. Crews must react to a variety of scenarios such as rescuing stranded hill walkers, attending to ships in distress, undertaking searches from the air and anything in-between, all whilst maintaining a mandated air readiness posture. Tasks often require crews to gather information en route, and they can be met with any manner of unforeseen, or else unavoidable, challenges. From inclement weather to inaccessible locations to erroneous task information, the paradox of being prepared for the unpredictable is an essential part of the SAR role where one misstep could mean catastrophe for the crew, the casualty and the aircraft.

To aid in the preparation of flight crews for their roles, Crew Resource Management (CRM) training aims to provide crew members with enhanced non-technical skills; the social and cognitive skills that complement the technical skills they utilise in their environment. Conventionally, CRM courses offered within aviation cover a broad non-technical skills syllabus with the same training offered regardless of role or mission type. The key question explored by our research was whether a generic non-technical skills framework adequately encapsulated the behaviours utilised by SAR crews. Could a reactive rescue team differ from those whose operations focus upon more routine undertakings? Our analyses suggest the answer may lie in 'cognitive readiness'.

Described in relation to military operations in early the 2000s, the concept of cognitive readiness denotes the mental preparation an individual needs to establish and sustain competent performance in complex and changeable environments. Research into the skill has expanded in the time since but no exact consensus yet exists on its mechanisms with multiple proposed frameworks outlining often contradictory and substantially overlapping components. Despite disagreement on the intricacies, general consensus in the literature is focused upon

IMAGE: ISTOCK

aspects such as metacognition, adaptable problem-solving and emotion control.

Since 2016, through the use of critical incident analyses, interviews and focus groups, we've been provided with illuminating examples of how SAR crew use these elements of cognitive readiness in practice. Focusing on reported instances of cognitive readiness behaviours, we divided the skill into distinct elements reflected within the data, each with theoretical underpinning: adaptability, preparedness, problem solving and resilience.

Preparedness

In a responsive role, being ready to act ensures that any task is initiated from the best possible stance. In the UK, SAR crews maintain a 15-minute daytime and 45-minute night time air readiness posture, though typically crews will launch as soon as they possibly can. Preparedness is mental readiness; the mindset necessary to react. This mindset is facilitated by actions such as ensuring equipment is organised and making sure the aircraft is ready for tasks, keeping up to date on certain procedures such as winching approaches, and memorising or reviewing emergency checklists. Preparedness could also be facilitated by establishing contingency plans prior to action.

Adaptability

A consequence of having incomplete task information is that you can't plan ahead with absolute certainty. Remaining flexible to changes in target location, available resources and unforeseen challenges such as inclement weather or equipment malfunction is the precursor to allowing problem solving to take over and facilitates effective resilience. Literature surrounding adaptability related to cognitive readiness is particularly murky; some research prefixes elements with 'adaptative', others prefer adaptability as a standalone category.

We looked for how crews might remain agile and open to quick uptake of new tasks and the alteration of current actions. This includes recognising new information which might fundamentally change the task, reacting swiftly to changes in the environment, and even being able to cease actions which were ineffective or no longer appropriate.

Problem solving

Problems exist when no immediate solution is available, leaving the problem solver

SAR teams can be met with any manner of unforeseen, or else unavoidable, challenges

to adapt in order to find an appropriate course of action. A broader process than decision making, problem solving is creative, involving incremental trial and error, and rests upon the ability to analyse a situation so as to determine the actions and use the resources necessary to move forward.

In our analyses, displays of problem solving were common and linked to the unique aspects of many SAR undertakings. While crews may recognise cues and patterns from the environment no two tasks will be completely the same, with a vast mix of variables presenting a unique challenge for crews to attend to on each occasion. Crew members described incidents where radio communications were lost and had to be relayed through other aircraft as intermediaries, flying at walking pace through low level cloud to reach target locations, and in one instance, undertaking maintenance to faulty landing gear during flight to allow it to lower for a safe landing.

Resilience

It's recognised within aviation that a sudden shock and consequent 'startle' response can have drastic consequences, particularly within rescue scenarios where every second counts. Crews told us about the importance of managing responses to emotional and highly distressing situations, highlighting that within an emergency response role, resilience is critical in both the long and short term. Grittiness and determination were cited as making the difference in mission accomplishment when faced with high-intensity scenarios.

The research literature separates resilience into two main categories: strategic and tactical. Strategic resilience is primarily concerned with prior-to-task actions and appeared more akin to preparedness than the tactical resilience we recognised across a range of critical incidents. Tactical resilience, by comparison, is ensuring you remain effective in the moment. Our findings highlighted that this form of resilience could be aided by actions such as the shedding of unnecessary gear between tasks, employing stressor coping strategies such as focusing on breathing patterns, taking breaks between tasks, and frequently through interpersonal interactions, checking in with one another, offering support and even using humour to diffuse tense situations.

Looking to the future

Despite a lack of consensus on exactly what underpins cognitive readiness, there's value in taking a broader observational approach. If we can identify the behaviours that make the difference at the sharp end, then we can better detect the instances in which performance may become compromised, which is critical. Recognising high-level performance allows us to understand what should be aimed for and aids in the development of better training interventions, though of course, observation is only a starting point. The next step is measurement beyond direct observation. The world of physiological biomarkers holds promise for quantitatively assessing and measuring cognitive readiness and would lend a separate degree of validity if agreement can be reached on exactly which markers to measure. If research focuses on developing these methods of observation and measurement, then we can fine-tune training interventions. Maybe then being prepared for the unpredictable won't be quite as paradoxical as at first it seems.

Oliver Hamlet is a human factors/psychology PhD researcher from the University of Aberdeen's Applied Psychology and Human Factors Group. His recent work has involved the development of training and assessment tools for helicopter search and rescue and offshore transport crews (HeliNOTS).

Dr Amy Irwin is an applied psychology lecturer at the University of Aberdeen, and leads the Applied Psychology and Human Factors Group. She is currently supervising five applied PhD projects across multiple industries including agriculture, aviation and energy.

Further reading

Hamlet, O E D, Irwin, A, & McGregor, M (2020). Is it all about the mission? Comparing non-technical skills across offshore transport and search and rescue helicopter pilots. *The International Journal of Aerospace Psychology*, 30(3-4), 215-235.

How to write procedures

Good procedures support reliable performance in complex operating tasks critical to safety and asset integrity. The application of human factors principles can improve the usability and acceptability of procedures to support human performance in such tasks. Here, **Antonio Javier Gaspar Marichal** explains more and provides useful guidance

Rule-based performance involves the conscious effort of recalling information about procedural steps stored in our memory. Procedures assist in recall and aid operator decision making during the execution of complex tasks. Similarly, when we're fatigued or under stress, well-designed, readily available procedures will support the achievement of task goals. Procedures are not problem-free though.

Primarily, problems stem from neglecting people's needs, preferences, and physical and cognitive abilities when procedures are developed. The implications of this are under- or over-specified rule sets that slow work down.

Procedures that have been validated via an interactive design process will reflect the reality of work more accurately and support worker decisions and performance. They are also more likely to be 'owned' and followed by workers. This article provides practical advice on how consideration of human factors contributes to developing procedures that will support human performance.

What is a procedure?

A procedure is a communication tool that describes the most efficient and safer way of completing a task. Often, they include a combination of written instructions, checklists and flowcharts.

When is a procedure necessary?

As a general rule, if a task is safety-critical, a procedure will be a requirement. A safety-critical task is a task where poor human factors could cause or contribute to a major accident or fail to reduce the effects of one. These tasks require flawless performance.

Tasks such as plant start-ups and shutdowns are examples where procedures are must haves. Maintenance tasks on key systems and processes such as fire suppression systems and shift handovers are good candidates too. See the Health & Safety Executive's audit tool at www.hse.gov.uk/humanfactors/topics/procedures-audit-tool.pdf.

How do procedures support safe performance?

Fit for purpose procedures support human performance in several ways:

- Reducing memory workload which, in turn, increases our capacity to deal with unexpected events.
- Ensuring critical steps to safety and quality are carried out.
- Standardising 'good practices', so improving collective learning.
- Minimising the likelihood of 'rule-based' and 'knowledge-based' error types.
- Providing everyone with the same level of information about the task.

It's important to note that safety cannot rely upon procedures alone. Organisations must have other systems in place to control risks, that act as defences and safeguards. Therefore, procedures complement other barriers and controls, not substitute them. ●

Designing procedures people will actually use

A procedure can fail if it's badly presented to the end user. Success hinges on capturing the tacit knowledge of those doing the job. Follow this step-by-step approach to design procedures that are relevant, workable and accepted by the workforce.

1 Identify needs

Is the task critical to ensure safety and performance? Analysis of accident records and requesting the views of workers will provide insights into operational issues and help develop a list of tasks likely to require a procedure.

2 Decide the level of procedural support

How thorough does the procedure need to be? What degree of flexibility should it have? Consideration should be given to:

- Task complexity. Situational factors such as plant, people involved, the consequence of errors, communication channels and multi-tasking are factors that increase task complexity. The more complex the task is, the more it will benefit from a procedure.
- Human-machine interaction. A high degree of interaction with critical equipment or processes will generally require detailed procedures.
- Task demands. Tasks that place high cognitive load or high demands on memory or are subject to interruptions or performed concurrently or intermittently with other tasks will require accurate procedures.

Table of techniques and their main application

Technique	Main application
Brainstorming	To elicit views in workshops and focus groups
Task analysis	Using a walk-through talk-through of the task with the operators
Delphi technique	To elicit views or collect the judgment from subject matter experts
Bowtie analysis	To analyse and describe risk controls
Fishbone diagram	To analyse sources of risk
Classification taxonomies	To identify risk or controls
Interviews	To elicit views using structured, semi-structured, ono-to-one interviews

3 Understand hazards and risks

The aim is to foresee what and how things could go wrong. The technique used to generate a list of safety-critical tasks should fit the operational context (that is, complexity, criticality, industry sector), the resources available and the expertise of those involved, (see table above).

All techniques have strengths and weaknesses so it's good practice to use more than one technique so that the limitations of one can be offset by the strong points of the others. For example, the insights provided by interviews help put a bowtie analysis into context and further refine it. Most hazard identification and risk analysis techniques are carried out with teams. This participative and multidisciplinary approach ensures that findings and recommendations are geared to the right audience and operational context. The spin-off effect is the workforce ownership of the process.

Good procedures reflect the reality of work accurately and support worker decisions and performance

4 Create user friendly procedures.

Aesthetics matters; the more visually appealing a procedure is, the greater the likelihood it will be used. The procedure needs to be relevant, concise and workable. Things to consider at this stage are:

Decide on the format

How workers interact with the procedure should determine its shape and format:

- Will it be accessed via electronic devices? Include interaction to enable the user to view the whole document on a small screen.
- Will it be printed off and taken to the location of the task? This works best if it includes visual aids such as pictures and flowcharts.

Decide on the structure

Typically, procedures have the following sections:

- Purpose. It answers the question: why is this procedure necessary and what is its goal?
- A list of all the hazards people are likely to be exposed to.
- Precautions and controls to prevent hazard realisation.
- Tools, equipment and protective gear necessary for the task.
- Pre-conditions to be met before the task begins.
- Steps to complete the task.
- Document control.
- In the case of a permit to work: the time it's valid for.
- Reviewer and approver's signatures.
- Reasons it can be withdrawn.

Less is more. Focus on must have information

- Keep the number of steps to the bare minimum.
- Don't let a single step straddle two pages.
- Avoid overkill. Don't expand unnecessarily on individual steps.
- Avoid cross-referencing other procedures. It should stand alone.

Use plain language

- Use terms that everyone can understand.
- Define acronyms in full. If there are many, include them in a glossary.
- Keep sentences short and simple with less than 15 words per sentence and no more than three syllables per word.
- Use lists, sequential numbering or bullet points.
- Add one action per step to avoid ambiguity.
- Use active verbs and active voice.

Make it inclusive

- Use a consistent font type and size, for example Arial, size 11 or larger, 1.5 line spacing.
- Use smart heading and subheadings to structure chunks of text.

→

- Use BLOCK CAPITALS and *italics* with caution. They can make sentences harder to read.
- Use background contrast conventions to improve readability. Avoid green on red, red on blue combinations. Black on white and black on yellow are easier on the eye.
- Use eye-catching symbols and colours to draw attention to critical steps.
- Use visual aids instead of text wherever possible.
- Get it proof-read by someone else.
- Aim for Flesch-Kincaid readability scores of 60-70 (see **www.webfx.com/tools/read-able/flesch-kincaid.html**)

5 Test it out before roll-out

Request feedback from end users, from both experienced and novice operators and run as many iterations as necessary until everyone is comfortable with it. Test the procedure in a 'real-life' or simulated environment. Do workers use it as intended? If not, establish what needs to be changed to make it work.

6 Train the workforce

Identify training needs, training material, the facilitator and the means of delivery, for example, will it be classroom-based, on-site, used in a task briefing? Consider use of visuals and relevant scenarios. Collect feedback at the end of the session and at several intervals afterwards and act on the feedback at the review stage.

7 Launch it

Emailing a copy of the procedure is not enough. This is where the benefits of having involved key people in the previous stages pays off. It makes implementation smoother but there are still a few things to consider:

- Location of the procedure; make it accessible and readily available to people.
- Give it a logical, intuitive name.
- Maintain effective version control. It's not unusual for people to save copies on their personal computers which, over time, become uncontrolled and outdated. Document control software systems such as SharePoint can help here.
- Laminate hard copies for ease of cleaning.

Be generous. If the procedure works well, share it with others in your industry.

8 Continuously improve

Nothing stays still. Review the procedure regularly; how often will depend on your specific circumstances and the criticality of the task the procedure supports. Some indicators suggesting you need to review the procedure before the next review date are:

- Complaints raised by staff about its workability, relevance and usability.
- Changes to the task context such as hardware, software or the environment it's used in.
- Findings of incident investigations that cite the procedure.

Antonio Javier Gaspar Marichal is the Environmental, Health & Safety (EHS) Manager at Dematic, supporting the EHS requirements of client installation projects across the UK and Northern Europe.

Further reading

Guidance on human factors safety-critical task analysis (2nd Ed). Energy Institute

James Reason (1997). Managing the risk of organisational accidents.

Guidance to help design effective and usable work procedures for the healthcare sector. CIEHF. https://bit.ly/WorkProceduresDesignGuidance

Guido C Carim Jr. et al. (2016). Using a procedure doesn't mean following it: A cognitive systems approach to how a cockpit manages emergencies. http://dx.doi.org/10.1016/j.ssci.2016.06.008

Reliability and usability of procedures. HSE (Core topic 4).

Improving compliance with safety procedures. Reducing industrial violations. HSE 1995

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A new 'normal' in defence human factors?

Even before Covid-19 locked us down and forced a new way of working, it hasn't always been easy to arrange face-to-face meetings to investigate human computer interface design. So, having to carry out trials remotely, **Ed Oates** turned to crowdsourcing, with encouraging results

Working in UK defence, I've experienced restrictions in access to subject matter experts due to their operational deployments, routine embarkations, travel budget limitations and just the physical distances in moving people from one location to another. Typically, a small number of senior operators from the equipment end-user organisation will be allocated to support human-computer interface (HCI) development at the manufacturer's human factors laboratory or development test site. The problem comes when they're unable to attend but Covid-19 has made that 'normal', so what's the new way of working?

This was one of the issues I wanted to address in my PhD thesis: "Crowdsourcing with Serious Games for Defence Procurement", where 'crowdsourcing' – the technique of mass voluntary involvement across the internet/intranet - was used for HCI design innovation, prototyping and testing.

In this case, a 'Serious Game' means a 'game with a business purpose', so if a popular computer game like Minesweeper had a close relationship to real world mine-sweeping in the Royal Navy, then it may have a business use in training naval personnel. Unfortunately, the game of Minesweeper has an HCI, simulated environment and a set of rules that doesn't match the reality of mine-sweeping, but what if a game were to be made that did emulate reality and allowed defence equipment to be previewed in a web browser within the context of a military task? This was the first part of the research to be addressed.

A web browser game was built to host an emulation of an in-service HCI, together with a representative synthetic environment and players were asked to complete a military maritime search task. The game's HCI, representing a mission system, brought together the controls, functions and displays within the Merlin Mk2 helicopter: tactical symbols, radar, camera and electronic support measures for detecting ships' radars. The game was then offered to all-comers with access to the Ministry of Defence (MOD) intranet to play and provide design ideas.

I presented the ongoing research at the CIEHF's conference in Birmingham in 2018 and had some practical advice from experts in mission system interface design, like Jo Davies (see her article "Creating the cockpit", *The Ergonomist*, Nov-Dec 2020). Now the thesis

Serious Game emulation of the tactical display

has been completed and accepted by Cranfield University, I wanted to see how it connected with other work in defence HCI design.

One of the findings was that design ideas, though all coming from within MOD, came from both inside and outside the equipment end-user organisation which widened the diversity of ideas. The usual situation, where a small number of subject matter experts are consulted, may have been able to come up with all the design ideas given enough time but those involved in crowdsourcing know that most of the smartest people work for someone else and go out to find them.

The concept of crowdsourcing innovation includes the transfer of ideas from one domain to another and some of those who played the game had experience in acoustic data processing and were able to offer their favourite controls and displays for use in the electromagnetic spectrum. Acoustic analysis looks at frequencies, pulses and bearing rate-change, which readily translated into the electronic support measures displays. Some other players had completed exchange tours with different defence systems and other nations' defence equipment and were able to offer innovative design ideas for inclusion in the game. As the web browser game was the medium supporting the design process, it was relatively straightforward to encode the new design ideas and let the players/users decide what worked for them.

Another finding was the benefit in avoiding meetings. Nick Gkikas ("Cutting-edge cockpit design", *The Ergonomist*, 567, Sep-Oct 2018) and Suzy Broadbent in her YouTube presentation (www.youtube.com/watch?v=6BXdJsHonWA) indicate that the human factors of meetings may over-ride the human factors of interface design, skewing an engineering process away from its objective ends. In contrast, playing an online game removed the opinion or group-think element of meetings. This crowdsourcing construct of the research retained users' independent perspectives so that suggested design components were not subjected to peer assessment until they were built into the game, and even then their use was only recorded in the game's log files and assessed against task-based criteria of 'effectiveness' and 'efficiency'.

As the main theme of the research was crowdsourcing, the final stage included an aggregation mechanism which sifted the game log files to indicate which set of controls and displays made a difference. With the players' in-game selections recorded in the log files and these data affected by player cognition and situational awareness, there was a lot of noise obscuring the signal of effective/efficient use of the HCI. The research followed the crowdsourcing innovation phase with a series of competitions or tests where 100 players submitted 1000 game log files and these, with careful filtering, provided a quantified rationale for which elements of the HCI might be taken forward to a fielded design.

'Making a difference' in effectiveness and efficiency was the output criterion, and those who produced the best results were not all from the senior operator group. In fact, a number of officer cadets, still in boot camp, were more successful and this is another finding of the research, that those with a history or past experience of previous HCIs may stick to 'old ways' and not make full use of the more innovative displays and controls. With defence systems sometimes taking many years to bring into service, it seems worth questioning the value of a small number of senior operators involved in the design process when they may well be retired by the time the new generation have to 'fight' the system provided for them. James Surowiecki's book, *The Wisdom of Crowds*, has a sub-title, "Why the many are smarter than the few" and offers more thoughts on crowdsourcing and where and how the technique may be applied.

Those involved in crowdsourcing know that most of the smartest people work for someone else and go out to find them

Designing and building a web browser game demands particular skill sets and the engineering task of verifying and validating what is after all, a simulation, makes further demands in any future implementation of this proposed new process. The game needs to play as a game, offering the player agency through choice of actions and a changing challenge with realistic elements of chance to engage them over multiple games. The simulation part of the game requires access to real system data and ultimately to the players' belief in the game's task. Within this research, a feedback questionnaire ran alongside the game and acted as validation of the displays and maritime tasks. As with any research, there were bumps and road-blocks along the way. For those who follow on after this research, they may well find a lack of understanding in what 'crowdsourcing' is.

There also needs to be organisational support and here the Royal Navy part-funded the research and gave support through their DARE Innovation Team. Future users of serious games for HCI design may also have to overcome defence blog moderators blocking access, or managers exclaiming that their people "don't have time to play computer games!", but whoever tries this technique, please let me know.

So, what did I find in this research that might be of use to human factors practitioners? Lack of direct access to users to help with HCI design need not be a show-stopper. In fact, a crowdsourcing construct has advantages by independently obtaining a diverse range of ideas and views while retaining an objective design process on the route to a final design.

Ed Oates worked for the Royal Navy before becoming involved in defence equipment development at Westland Helicopters and later at MOD Defence Equipment and Support. He's now a helicopter simulator instructor. Retained as a Royal Naval Reservist, Ed worked on a part-time MSc in 'Simulation and Modelling' and then a PhD, combining crowdsourcing, serious games and open-source coding. His blog is at https://bit.ly/3tWw2z4.

Understanding issues in dental work

When we think of human factors in dentistry, it's often physical issues such as awkward postures and resulting musculoskeletal disorders that spring to mind. But dental hygienist **Deborah Stratford** says we should be looking much more urgently at the psychosocial issues involved and the potential impact on patient safety

Most people experience pressures at work which can be both positive and motivating but when work demands become excessive, it can cause stress and sometimes severe psychological conditions in workers. Other significant negative organisational outputs include reduced performance and productivity, increased costs of sickness absence and staff turnover and increased accidents and error.

According to the Health & Safety Executive, in 2020 there was a significant increase in work-related stress, anxiety and depression across Great Britain affecting 828,000 workers with 17.9 million lost working days which accounted for 51% of all work-related ill health. Analysis of the impact of the Covid-19 pandemic on these statistics suggests that this was not the main driver and there would still have been a significant increase even in its absence.

Multiple changes in healthcare policies and processes have significantly affected care delivery in the last decade. This has been exacerbated by a sharp growth and reliance on information technology and an ageing patient demographic with complex comorbidities and treatment needs. Cumulative excessive work demands can lead to burnout and is associated with depersonalisation for healthcare professionals. This can have negative patient outputs such as reduced care quality and satisfaction and reduced patient safety margins.

Dental hygiene and dental therapy professions are multifaceted in the delivery of dental care in dynamic, complex, sociotechnical clinical environments. This requires high levels of patient compliance and comfort while carrying out treatments including on the gums, fillings and administering local anesthesia. Their roles also require working to prescribed time limitations by dentists, with work pace and schedules dictated by managers who often have limited clinical knowledge and a financial focus. The General Dental Council acknowledges this as a patient safety concern, particularly in corporate dental businesses with limited business strategies and a strong focus on bottom line profit.

Interestingly, a 2018 study of postgraduate dentists revealed their main perceived cause of clinical error was attributed to time pressures, closely followed by poor organisational management. A 2015 study of dental hygienists revealed that 90% felt regularly stressed at work with 67% attributing lack of management support and high workload as the main factors. There's a wealth of research into the levels of stress among dentists but there's limited research available on occupational stress in dental hygienists and therapists. At the time of writing, there appears to be little or no research that used a human factors systems approach in the analysis of this significant occupational health problem which is a symptom of deeper organisational system failures.

In June 2020, I carried out some research of my own, the purpose of which was to investigate current organisational work design in dentistry and associated levels of stress, anxiety and depression in dental hygienists and dental therapists together with its perceived impact on patient safety and quality of care.

I conducted an anonymous online survey via the Facebook page of the British Society for Dental Hygienists and Therapists. The survey comprised 14 questions created around information from the HSE Management Standards Indicator Tool which incorporates potential causes of work-related stress and the 'dirty dozen' most common human error preconditions from EUROCONTROL.

A total of 481 respondents participated in the survey and the subjective data it produced illustrated high physical and cognitive workloads of the professions. Three quarters reported often feeling overwhelmed by work demands and others said they had less autonomy than they would like over work pace or structure such as breaks (32%) or appointment scheduling (42%). Less than half (41%) felt they were given supportive feedback. Only 55% were routinely provided with essential chairside nursing support which conflicts with regulatory guidelines.

Of concern was that over 90% of respondents felt regularly overwhelmed by work demands and 49% perceived work

IMAGE: ISTOCK

pressures affected the quality and safety of care delivery. A quarter of respondents estimated they made three to four errors in a typical working week with the main causative factor attributed to time pressures (82%) followed by stress (42%), fatigue (29%) and poor communication (23%). Respondents also reported suffering with stress, anxiety and depression, and 17% experienced panic attacks. More than three quarters of respondents also reported medium to high levels of anxiety and stress when returning to work following the initial Covid-19 lockdown of general dental services from March to June 2020.

The results from this research are concerning and reveal a significant occupational health problem in dentistry that has led to attrition from the dental hygienist profession. The roles of the dental hygienist and dental therapists have high physical and cognitive demands that also require high levels of emotional labour particularly while treating nervous patients.

There are a multitude of organisational stressors including low autonomy of work pace and design with lack of support from non-clinical managers who have a myopic view of dental care delivery. This results in viewing clinical work-as-imagined rather than how work is actually done with the many adaptations and tradeoffs that clinical workers have to make on a daily basis.

On a more positive note, the lack of task variety and career progression is currently being addressed by the British Society for Dental Hygienists and Therapists who are supporting many colleagues in taking up postgraduate courses and research relevant to the field.

All this demonstrates though that much further understanding and discussion is needed in this sector. ●

The dental profession provides a multifaceted delivery of care in dynamic, complex, sociotechnical clinical environments

Deborah Stratford is a registered dental hygienist and a member of the British Society for Dental Hygienists and Therapists. She has 27 years' experience in a variety of clinical dental settings and is currently studying for a Master's in Human Factors for Patient Safety at Staffordshire University. Deborah is a committee member of the National Advisory Board for Human Factors in Dentistry which was established in 2018 and is also a member of the Mental Health Wellness in Dentistry Steering Group, addressing mental health issues in the dental team. They are currently developing a mental wellness training framework and charter to embed positive attitudes and an open and supportive culture to address mental health in dentistry.

Further reading

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Remote but real life

The Covid-19 pandemic has changed the world and forced new ways of doing business, and human factors in medical device development is no exception. One year on, **Philip Lance** and **Charlotte Redden** discuss how testing medical devices on target users in their own homes has brought challenges but also unexpected benefits

The need to develop new, and in many cases, life changing therapies has not stopped during the pandemic, and neither has the progress of developing medical devices and drug delivery combination products. Fundamental to making safe and effective medical devices and combination products is human factors testing of the user interface. Should human factors testing have to stop, it's possible that many new medical devices and combination products would be delayed from reaching those in need.

Lockdowns and social distancing could not be allowed to halt human factors testing of vital products, and through the internet, and video conferencing and collaboration platforms, human factors engineers have found new ways to continue testing. Although these platforms have been used previously in limited ways, in essence we all had to start from scratch and, through trial and error, learn new ways of operating.

Over the past year, having faced the new challenges and complexities of remote testing, we've overcome difficulties and gained some unexpected benefits. Here are some of the things we've discovered:

Using a device in real homes

A traditional usability study conducted at a viewing venue usually simulates just one home setting. Thanks to remote interviews, we've seen a spectrum of home settings such as living rooms, kitchens, bedrooms and dining rooms. It's proven to be a rich source of insights, as we were able to observe participants using a device sitting on sofas, at cluttered tables or desks, or perched on the edge of a bed. Real life distractions such as children interrupting, dogs barking, loud noises from outside and delivery drivers impatiently ringing the doorbell, only enhance the realities of actual home use. This has helped us to evaluate and understand how a device's user interface performs in a multitude of home use situations.

Removing the stress of travelling to a venue

Participants will still experience some nerves and anxieties normally seen at a traditional usability study but the comfort of a familiar environment and the removal of unknowns such as finding the venue, dealing with traffic problems or the vagaries of public transport, all help reduce the participants' stress levels, helping them to relax quickly and settle into the interview. Some participants felt so at ease when attending an interview, they turned up in pyjamas, a certain unintended indulgence many of us may have experienced while working from home in lockdown!

Whilst many participants may enjoy the benefits of being at home, they still have to perform in front of a camera, which can cause some to remain anxious and defensive. For an experienced moderator, putting such participants at ease is a normal part of the introductory phase of the interview. However, now all the participant can see of the moderator is a face on their screen. No longer being in the same physical space, non-verbal communication such as eye contact, open body language and the impact of a smile is diminished, so more time and effort may be required to put the participant at ease.

Greater flexibility in timing

At a viewing venue, the interviews have a hard stop. A parking ticket might be running out, there's a job to get back to or a train to catch. This all puts pressure on the moderator to gather the data within an allocated time. Without such concerns, we've found there's often more flexibility with participants' time. Combined with the additional contingency time we now build into the scheduling of the interview, we've found timing compromises can be avoided. Occasionally for example, a participant can be particularly slow with tasks. In such cases we've often found, rather than forcing the pace of the interview to finish on time, the participant is able and willing to continue beyond their scheduled finish.

Rescheduling is also far simpler. When a viewing venue is involved, there tends to be just one opportunity to interview the participant. However, when done virtually, we've found participants to be very accommodating when it comes to rescheduling. Participants who would typically be lost if they cancelled or didn't show up, are now just rescheduled into a vacant time slot. This flexibility has proven valuable as we've experienced a wide range of reasons for a participant to be

Real life distractions, such as dogs barking and delivery drivers impatiently ringing the doorbell, only enhance the realities of actual home use

unavailable at their allotted time, from power cuts to tropical storms. We even had a Californian participant explain they had to leave quickly due to an encroaching forest fire!

The logistics have increased

Whilst remote studies can save time for participants, they do create extra logistical demands from additional project management to preparing study materials. Ensuring each participant's study package contains all the test items before we post it demands double and triple checking. If anything has been forgotten, it may result in the interview needing to be rescheduled. There are also no guarantees that supplies will be delivered on time so advance shipping is a necessity but should supplies get damaged in transit, the increased flexibility of rescheduling participants can avoid any dropouts. One drawback is that this has taken away the option for last minute study changes in the days preceding the interviews.

Technology is a blessing and a curse

The internet has made remote interviewing possible and over the last year we've used a range of viewing platforms such as UserZoom, Miro, GoToMeeting and Microsoft Teams. Whilst some of these platforms are better than others for certain types of research, there are still some technological challenges that can interfere with the interview process such as internet connections, technical IT difficulties and camera angles.

Internet connections have been taxing. Even though we contact participants ahead of their session to conduct 'tech checks' to test their computer set up, some participants still experience a poor internet connection during their interview. Poor connections have hampered the moderator and observers' ability to see and hear what the participant was doing. To compensate for this, the moderator would have to resort to longer, sometimes more difficult, conversations with the participant to establish what they were doing.

Although we've seen participants experience various IT problems, we've been able to fix many of them by talking the participant through it. IT problems at the start of the session can be quite time consuming and occasionally made a participant feel stressed at the beginning of the interview.

Regardless of the camera used (built-in laptop cameras, entry level webcams or high-quality video equipment), they were all limited by the field of view they captured. Consequently, despite spending time with the participant to carefully set the camera so that a wide enough angle was created to fully view the participant and capture sufficient detail, some participants still managed to move out of shot.

Remote testing is challenging but it's here to stay

With the moderator not being in close proximity to the participant, remote testing has certain inherent limitations. Consequently, when the Covid-19 pandemic has passed, traditional face-to-face usability tests will return, particularly in the case of summative evaluations. However, having conducted remote testing for a year and gone through a very steep learning curve, we've found that although it's not necessarily a cheaper or quicker option than face-to-face usability studies, it has a number of distinct advantages. Consequently, remote testing will continue after Covid-19 has passed.

Dr Philip Lance and **Charlotte Redden** are medical device human factors experts at PA Consulting. Their work covers usability programmes for global pharmaceutical companies to small medical device start-ups, to help the development of a wide ranges of devices from connected wearables, invasive surgical equipment, diagnostic equipment, medical robots, to combination products, such as autoinjectors and inhalers.

PA Consulting is an innovation and transformation consultancy, employing specialists in sectors including health and life sciences. For more information, visit www.paconsulting.com

Trialling a medical device at home

IMAGE: SHUTTERSTOCK

Q&A

MEMBER PROFILE

Tina Worthy talks to **Rick Heybroek** about his career from software interfaces to aviation, rail and beyond

How did you discover ergonomics?

By accident! In the early 1970s I was Technical Publications Chief Editor for Canadair (later Bombardier) after postgrad at McGill University in Montreal, Canada. Things were different then and ergonomics as an academic discipline was in its infancy. The McGill Psych department had only recently been extracted from Philosophy by the legendary Don Hebb and his 'rat runners'. But I did discover ergonomics as software interface and embedded learning design for perceptual psych and usability issues. I didn't know there was a discipline called ergonomics, probably because Canada lagged the UK in recognition; the Ergonomics Research Society in the UK was founded in 1949, the Human Factors Association of Canada in 1968. Canadair had an early computerised publication system with two shifts of entry operators to turn the writers' work into IATA, Mil EO/CFTO and other standard industry formats. This led to endless operator questions, often very late at night. By necessity (and sleep deprivation) I became interested in the usability of computer/human interfaces (CHI) and went on

to develop interactive user help software and later, computer-based training and UI design for Philips, before moving to the UK and flight simulation.

I 'met' ergonomics in 1986 in the form of Loughborough graduate and CIEHF member Mark Brunt, my co-team leader at Rediffusion. His interests were more hardware and mine more software/cognitive, so we formed a productive partnership working largely on instructor station R&D. I found that ergonomics was one of those 'answers to questions we haven't yet asked' and it perfectly fitted my interest in the applied psychology of flight training and human error.

Who or what influenced your early career?

Aside from a mixed bag of Literature, Psychology and Philosophy at McGill, I was fortunate enough to take Robert Mager's *Criterion-Referenced Instruction* at Université de Montreal. It provided a basis for work in task/training analysis and formal instructional design. I also studied Total Quality Management and educational psychology as it applied to CHI, particularly the inspiring Seymour Papert who once said "I don't want to teach children mathematics, I want to teach children to think like mathematicians". Another major factor was the availability of microprocessors and early PCs like the Osborne 1, which introduced the joys of programming in languages such as Basic, C and Z80 Assembler. (I still have my neat GBasic version of Trivial Pursuit and two broken Osbornes.)

Once installed in the UK and working on flight simulators it was a short hop to DERA, the Defence Evaluation and Research Agency, to visit and meet inspiring scientists like Roger Green, John Chappelow and others in Sue Jensen's Workload in Aviation group. After attending my first Ergonomics Society conference and meeting people like Chris Wickens, I was a convert and applied for membership.

Ergonomics was one of those answers to questions we haven't yet asked

What route did your career take?

Not entirely random, although I'm sure there was a faster way to get from A to Z. I discovered what I wanted to do as circumstances and opportunities changed. From embedded Computer Based

Training and structured training to user software design, then developing simulator instructor stations in the late '80s. It became evident that there were radical changes afoot in flight crew training as airlines struggled to implement systems to minimise human error after a decade of high profile 'pilot error' accidents. Conventional flight crew training and certification based solely on stick and rudder skills was increasingly questioned after disasters such as the 1977 KLM/PanAm 747 crash in Tenerife, 1980 Saudia flight 163, 1985 Manchester British Airtours fire and many more. It was time for a change. This led to a Federal Aviation Administration (FAA) and Civil Aviation Authority (CAA) overhaul of training methodology and the introduction of new techniques including Crew Resource Management, Line-Oriented Flight Training, the FAA Advanced Qualification Program and later, systems safety approaches such as Safety Management System. I had the unique chance to write parts of FAA and CAA flight training standards and to start the Royal Aeronautical Society's Human Factors Group in 1989 while organising over 30 industry conferences and seminars. These allowed us to bring new research in flight safety and human factors best practice to flight and cabin crew, Air Traffic Control and other transport sectors, including speakers like Jim Reason, Dan Maurino, Mica Endsley, Bob Helmreich and Jean Paries.

What happened after that?

After seven years at Rediffusion we set up an ergonomics company, initially for rail training development for Vosper, office assessments, and NHS practitioner safety training, then full time for ScotRail to look at driver safety improvement based on aviation human factors developments including mastery learning, safety systems and organisational risk management. This lasted until rail privatisation when, for domestic reasons, I went in a different direction and spent several years in Semico working with UK chip designer 3Dlabs, then clerked for a barrister for several years, which was disturbingly like "Rumpole of the Bailey".

Ergonomics remained an active occupation, not only because of the User Interface aspects of chip design work but because of the ergonomics equivalent of the 'doctor syndrome': whenever management had a human factors problem it was delegated to the handy ergonomist, so I became the health & safety staff rep, the formal risk assessment officer, asbestos and legionella consultant and, of course, the 6-pack ergonomics directive compliance person. Once an ergonomist, always an ergonomist!

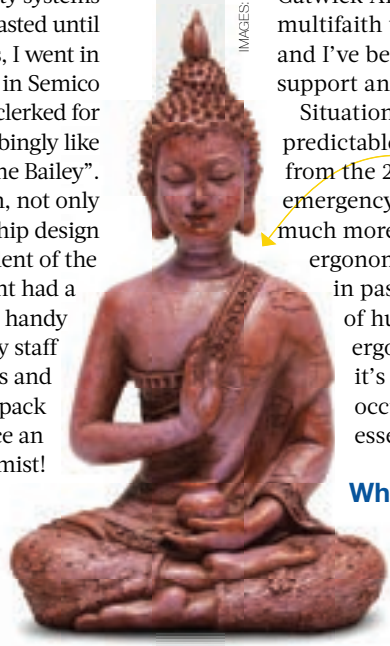
What's the most challenging project you've been involved in?

Working at ScotRail on driver training; it was axed when full privatisation killed off Training and other 'overhead' departments. But some projects continued, particularly the Confidential Rail Reporting System (CiRAS) which I developed based on a similar system in aviation (CHIRPS) but with a different structure to cope with the chronic distrust drivers had of any management involvement in incident reporting – a distrust mirrored by traction inspectors. I persuaded Professor Helen Muir from Cranfield to head the editorial board and we picked Strathclyde's Professor John Davies as Editor. The project was very successful and eventually went national and multimodal.

You've now retired from ergonomics but have a fascinating other occupation. Please tell us a bit about that.

Retirement proved boring so as a long-practicing Buddhist, I volunteered for multifaith community work, something I'd been active in previously while organising the Crawley Mela festival. When the Gatwick Airport Chaplaincy asked me to join their multifaith team in 2009 I jumped at the chance, and I've been providing services, traveller and staff support and emergency response since then.

Situations and incidents don't tend to be predictable; we've dealt with returning passengers from the 2015 Tunisian tourist attack, blizzards, emergency evacuations, trafficked teens and much more. It doesn't feel like a retirement from ergonomics though as most of what happens in pastoral care requires an understanding of human factors, particularly cognitive ergonomics. In areas such as safeguarding, it's both a way of looking at behaviour and an occupational skill set. Perhaps chaplaincy is essentially spiritual ergonomics?



IMAGES: ALAMY / SHUUTERSTOCK / ISTOCK

What advice would you have for others just starting out?

Find what you're passionate about and be totally determined to make it happen, whether it seems possible or not. ●

Obituary
JACK SANDOVER

A quiet, unassuming demeanour belied an influential pioneer of environmental ergonomics and a significant international figure who laid the foundations of our understanding of the impact of vibration on people

1934-2020

After graduating with a degree in Mechanical Engineering from King's College, London, Jack Sandover registered as a conscientious objector and for two years worked at Ravenswood School, Crowthorne, a school for children with learning disabilities. His first professional engineering job was at Rudolf Scheffuss in Germany but after breaking his neck in a road accident, he returned to the UK to work for Reed Paper Group as management trainee and, later, as project engineer.

Jack went on to have great influence in physical ergonomics, pioneering in many areas and becoming an internationally recognised researcher including in the understanding of human response to mechanical shocks, vibration and noise. In 1966, Jack was appointed Research Fellow at Loughborough University and held various appointments in the Department of Human Sciences. He completed his PhD 'Measurement of the frequency response of man exposed to vibration' in 1982 and taught many students studying ergonomics. Jack's daughter Bridget remembers him coming home from campus while they were having breakfast, after spending all night on 'the computer' which had to be booked in advance and any available slot taken.

He was course tutor for the MSc in Ergonomics for many years, much to the benefit and support of Masters students from the UK, Canada, Australia, New Zealand and beyond.

Ken Parsons, Emeritus Professor of Environmental Ergonomics says: "I have fond memories of Jack as a lecturer when I was an ergonomics undergraduate at Loughborough, and as a colleague when I joined the Department of Human Sciences in 1981. Jack was influential in my joining the Institute of Sound and Vibration Research to complete my PhD and post-doctoral research at the University of Southampton."

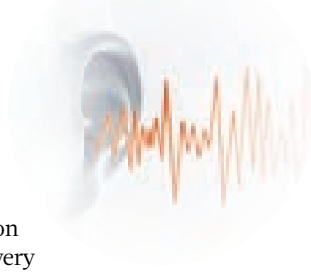
Jack's own research was an important part of the development of ISO standards related to vibration and the development of the frequency weightings that are still used today. In many respects he was ahead of his time, using techniques in their infancy which have now become well-established. For example, he used imaging techniques to measure the relative motion of spinal vertebra from archival footage illustrating intra-spinal dynamics.

Jack also took a holistic approach to solving human factors problems, such as identifying that the spinal shocks experienced by workers jumping from tractor cabs to the ground might be just as harmful as the exposure to vibration whilst driving the machine.

He put effort into research that engaged the public, including studying back pain in Formula One Grand Prix drivers in the early 1980s. Also in that period, Jack, together with Ken Parsons, John Atha and his PhD student Fred Yeadon, investigated the dangers of head impacts and boxing. This was controversial at the time and some brain injuries and deaths had occurred. British heavyweight boxer Frank Bruno came to the university with his manager Terry Lawless, and Frank punched a ballistic pendulum with accelerometers attached that Jack and others had constructed. The force and dynamic impact was equivalent to a football hitting the face at 200mph or as the sponsor, the *News of the World*, published "it really is like being hit by a (gloved) sledgehammer". The scientific aspects of the work were published in the *British Medical Journal* in 1985 under the title 'The damaging punch' - and Frank went on to become a world heavyweight champion.

Dr Sam Porter, a Senior Lecturer in Loughborough's Department of Design and Technology notes: "I worked for Jack in my first post-doctoral position from 1986-88 on a Ministry of Defence (MoD) contract researching the combined effects of noise, vibration and heat on cognitive performance. It was a perfect post for a relatively inexperienced applied psychologist. Jack was the ideal supervisor for me at the time; more inclined than others to let me get on alone, take responsibility, make one or two minor mistakes but more

Jack was ahead of his time, using techniques in their infancy which have now become well-established



importantly, learn my job. His support, when needed, was always there and his lines of communication with the MoD extremely good and very reliable. I felt very much a part of a team and after three years he sent me off into the world, equipped with all the skills required to apply for lecturing posts."

Jack spent the rest of his career working at Loughborough University but retired early from his position as Senior Lecturer and carried out private consultancy on human responses to noise and vibration. He retired fully in 1999.

From 1986, Jack's hearing deteriorated rapidly until he became totally deaf without hearing aids. After retiring, Jack remained very much invovled in the area of hearing research. He was active with the Loughborough Hard of Hearing Club, the Leslie Edwards Trust, of which he was one of the three founding trustees, and Hearing Link, as Chair of the Communications Working Group.

Jack joined the Ergonomics Society (as CIEHF was then) in 1968. He was active as a Trustee from 1995–98 and Chair of the Honours Committee and was awarded an Honorary Fellowship in 1999. He continued to take an interest in the discipline and the organisation, reading *The Ergonomist* magazine and daily email briefings.

Jack married Shirley in 1963 and together they followed their love of nature and, in particular, birdwatching. Jack's other hobbies included wood turning and genealogy. A lovely, gentle man, he passed away peacefully at his home in Loughborough in July 2020 at the age of 86. He leaves his two children Bridget and Michael, and two grandchildren. ●

Thanks to **Bridget Plimmer, Professor Neil Mansfield, Professor Ken Parsons** and **Dr Sam Porter** for their valuable contributions.

Further reading

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IMAGE: ISTOCK

Round-up CIEHF NEWS

How it works: CPD review

When CIEHF President Elect Alex Stedmon asked for comments about the Institute in the run up to the recent elections, the review process for Continual Professional Development (CPD) was a common theme. It's good practice to record your work achievements and identify areas for improvement each year. It's also a formal requirement of maintaining Chartered status.

Each January, CPD records are selected at the start of the assessment process. If your record is chosen, two of your peers will assess the record, which will have been anonymised, and provide feedback. They may accept your CPD record as it stands or request further information in which case you'll get help from their feedback. Your record would then be re-assessed and you'll be informed of the final decision. At this point, much help and encouragement would have been provided so it's rare that CPD records are deemed insufficient and Chartered status is lost.

The selection of CPD records for assessment includes pooling all those who have entered at least the required minimum number of CPD activities, excluding those who were assessed and accepted the previous year, then including all those who are not currently Chartered, →

together with 20% of the rest. This ensures that every Chartered member's CPD records are assessed in a 3-4 year cycle.

Alex says: "I've been selected twice in recent years and each time I've been given the green light without sending in further information. I know other members can feel anxious about the process but it's straightforward. Members have raised concerns about taking time out of work for maternity/paternity leave, redundancy and/or working part-time, all of which can affect our outputs and achievements. These are taken into consideration during the assessment but if you're worried about the CPD requirements, please contact us for advice. We're keen to hear from anyone who has ideas for improving the way we do things so our processes reflect the needs of our members." ●

Any questions?

We all know TV shows where you can call a friend to help out. In real life, even if we're not given the exact answer but instead we get some useful guidance, it's great to know there's someone available you can reach out to. As many of you have already experienced, our *Communities* discussion forum has built up an impressive catalogue of questions and responses that will serve not only the members who posted the original queries, but also others in the same situation.

At the moment you can find information on topics from Systems Thinking to Human Modelling Software and Ergonomics for Dogs, to name just a few. No matter what your question is, other members are very generous and supportive, and will be happy to help if they can. Many members tell me that reading the emailed daily digest summary on the topics discussed in *Communities* is their way of staying in touch with what's going on in the discipline and what people are working on and thinking about. If you haven't seen the daily digest, please check your junk folder or contact us so we can look into it for you.

Another great feature of *Communities* is the member directory. It allows you to look up and contact any other CIEHF member with a private message which will go directly to their email inbox. This way, if you've lost touch with someone you worked with or would like to connect with another member working on an interesting project, it's easy. Especially now that in-person networking is still very limited, this is an immensely valuable benefit.

So, whether you're new to the discipline and would like to draw on the experience of others, or an established human factors professional looking for other perspectives, ***Communities*** is at your disposal. Please make use of it, not only for your benefit but also for the collective benefit of our community! ●

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

IMAGE: SHUTTERSTOCK

Welcome to a new member of staff

Hi, my name's Rachel Stalker and I'm delighted to have joined the CIEHF team as an Executive Assistant. Professionally, I have over 20 years' experience at CEO, Board and Executive level across a range of sectors. By streamlining processes and forward planning, I've saved executives valuable time enabling them to concentrate on strategic/high level activities. I enjoy the processes required for effective and efficient high level business administration and support.

Active daily on LinkedIn, I follow leaders and peers within the administration sector. I'm an active member of EA/PA professional groups which helps to keep me updated with new ideas and training.

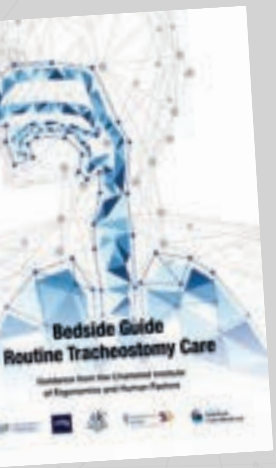
I'm also an encourager and supporter of continuous, lifelong learning and a lover of words and literature. I achieved a 2.1 English Literature BA Honours Degree with the Open University whilst undertaking a hugely demanding PA role. My future goal is to continue my studies and gain a Master's Degree.

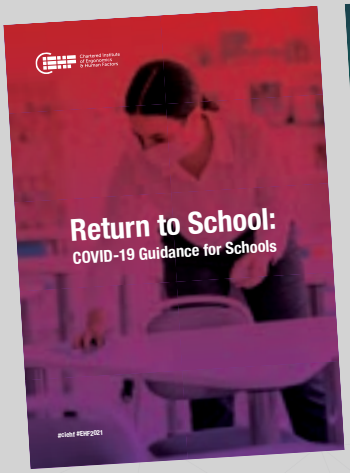
I'm really looking forward to meeting many of you so if I can help at all, please don't hesitate to ask. •

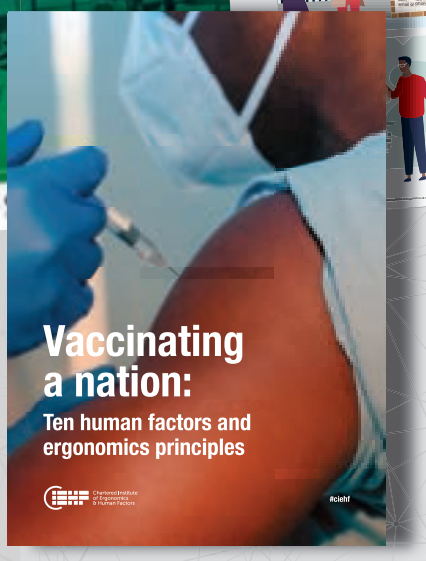
Sad news

We're sad to say that Sheila Lee, a longstanding member of the Institute, passed away in April this year. An obituary celebrating her life and achievements will be published in a future issue.

THE HUMAN FACTORS RESPONSE TO COVID-19







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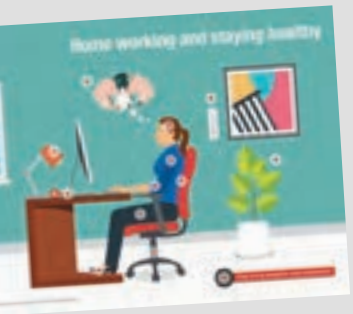
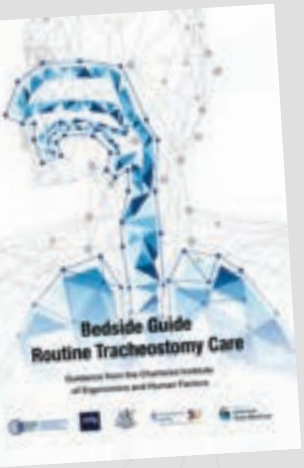
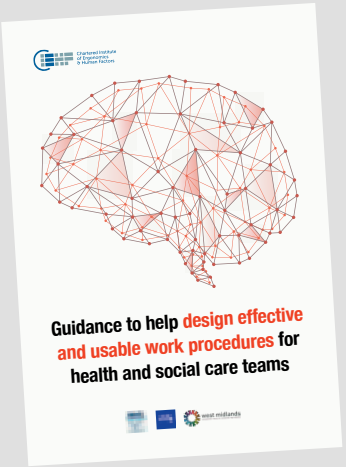
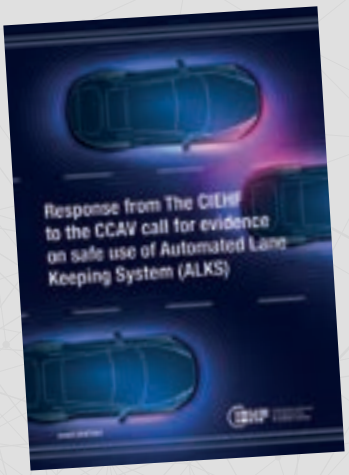
HUMAN FACTORS ADVICE AND GUIDANCE

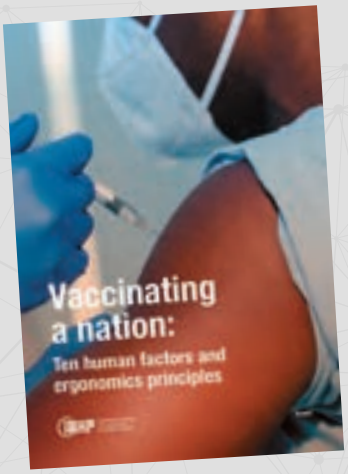
Human Factors is a science that combines physiology, psychology, engineering and technology for improving life, wellbeing and performance.











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FROM THE PRESIDENT

Success and exciting times to come

Chris Ramsden
CIEHF President

president@ergonomics.org.uk

I'm delighted to inform you that, following a complex and detailed bidding process supported by a presentation, CIEHF has been successful in winning the competition to host the 2027 IEA Triennial Congress, beating a very strong bid from Malaysia. It will be held in London on 6-8 July and will be an incredible opportunity, putting CIEHF at the very heart of global ergonomics and human factors.

I'd like to thank Noorzaman Rashid for the significant amount of work he did in response to this bid, and to acknowledge support from professional conference organisers, MCI, London and Partners and ExCel London, where the 2027 Congress will be based. In our presentation, Noorzaman ended by saying: "We can't promise you sunshine, but we can promise you excitement, inspiration and friendship to build a stronger IEA." Who could argue with a fellow Yorkshireman!

Our bid included 20 letters of support from allied professional bodies and potential sponsors including the Parliamentary & Scientific Committee, Innovate UK, BOHS, IOM, British Science Association, Chartered Society of Designers, Chartered Quality Institute and many universities and institutes.

Our proposal is to deliver a hybrid event, with more than 1500 physical attendees and 3000-plus online participants, and to make it the most inclusive and accessible Congress to date, showcasing the use of XR technologies to deliver the scientific programme, conference and associated events. This is going to be BIG!

As for this year's Congress in June, hosted online by the Association of Canadian Ergonomists, I attended many of the sessions and the experimental virtual chat rooms and 'digital discussion tables', although the sheer volume of presentations, parallel tracks and posters made navigating the Congress website somewhat of an ergonomics challenge. The Congress was a great success and the next one in August 2024 will be in the Republic of Korea.

We promise you excitement, inspiration and friendship!

FROM THE EDITOR

Demonstrating the impact of human factors

With all the attention still on the effects of the pandemic, we take a look at what homeworking means for employers, but there are still other issues of concern such as personal safety. One article looks at how technology could help in creating safer cities.

Technology is also the topic of our cover article, in which Chris Baber explains how his intriguing research into enabling better decision-making through the use of artificial intelligence could change the way we use and control drones. And Richard Bye talks us through the recent rail conference that covered a lot of ground, including the emergence of new digital technologies. We also feature Nora Balfe's focus on rail safety through her work on overspeed events.

Kim Hutton shows how important a part empathy plays in design, and none more so than in the built environment where poor understanding of people's needs can have a huge effect on everyday life.

Sarah Main explains the work of the Campaign for Science and Engineering and Richard Goorney reveals how knowledge of human factors helps him in his work as an occupational hygienist.

Sadly, we say goodbye to two of our long-standing members, Sheila Lee and Michael Goom, whose lives and work we celebrate in their obituaries.

We finish with a round-up of our recent awards which shows the breadth and depth of excellence demonstrated by members of the global human factors community.

And we look forward to a fresh new design for *The Ergonomist* in the next issue!

Tina Worthy
editor@ergonomics.org.uk
@ciehf

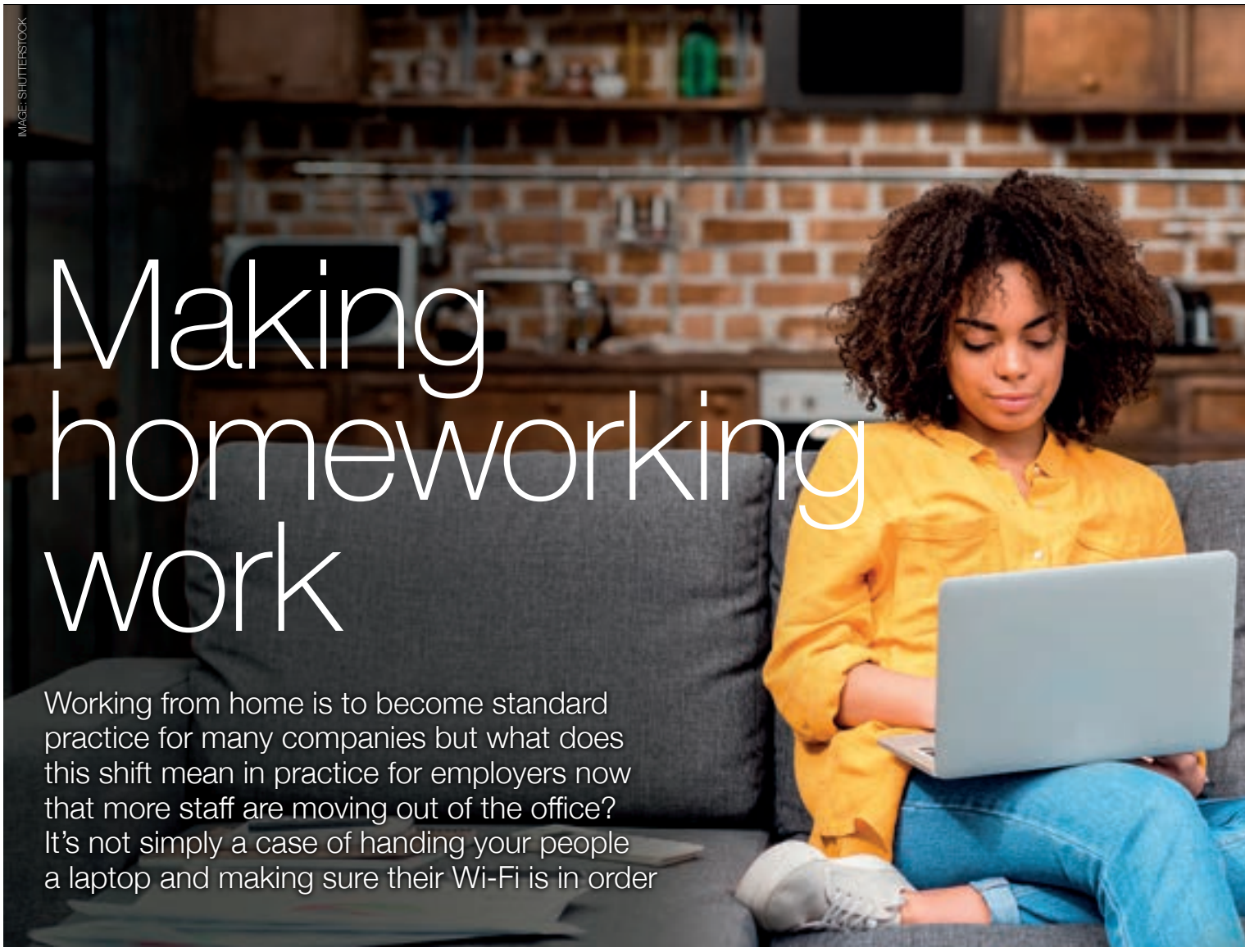


IMAGE: SHUTTERSTOCK

Making homeworking work

Working from home is to become standard practice for many companies but what does this shift mean in practice for employers now that more staff are moving out of the office? It's not simply a case of handing your people a laptop and making sure their Wi-Fi is in order

Covid-19 has turned lives, and jobs, upside down. Before the pandemic, 'working from home' was a luxury afforded to very few. Now, it's a way of life for a significant proportion of the workforce. That change presents opportunities for companies but it also presents challenges. It's a complex development that requires thoughtful handling and human factors input has an important role to play.

The rise in homeworking is not new; it's simply been supercharged by the pandemic. Even before lockdown, working mainly from home had increased 80% in 20 years to reach 5.3% of workers, according to data from the quarterly Labour Force Survey, April-June 1999-2019. What's more, during 2020, a total of 35.9% of the employed population said they did some work at home. According to the ONS's 'Homeworking hours, rewards and opportunities in the UK: 2011 to 2020', that represents an increase of 9.4% compared with the year before.

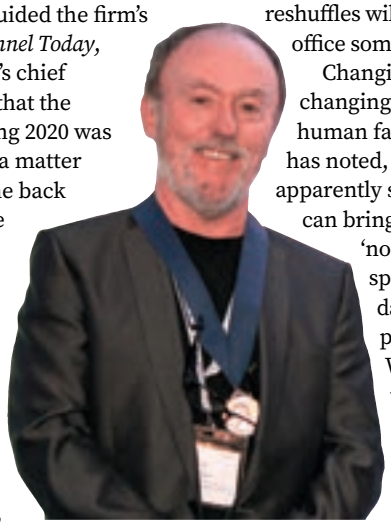
In normal circumstances, the factors that determine home working include age (older workers are more likely to be in the 'mainly work from home' category), and type of job. Homeworking is most prevalent in high-skilled professional and managerial occupations, as well as in the information and communication industries. However, there is substantial variation in the degree of homeworking across the UK. This reflects the types of industries in each region but there are unexplained regional differences that could stem from employee or employer preferences, skills or infrastructure. One factor that affects homeworking take-up across the country is broadband speed; surveys show that for most homeworking jobs the use of a computer is essential.

The increase in working from home necessitated by lockdown has prompted some companies to see this way of working as a significant part of their future. Tech firms such as Twitter and Facebook have said they will offer this option to their staff but perhaps more notably, the Nationwide Building Society has committed to giving its people the chance to work from home. These employers, and the others following suit, need to establish new norms that, among other things, maintain productivity levels and

Working from home is here to stay. Below: Ed Milnes and Bob Bridger have been looking at this issue

protect employees' health and wellbeing. In Nationwide's case, it was staff sentiment, as well as the experience of mass homeworking through lockdown, that guided the firm's decision. Quoted in *Personnel Today*, Jane Hanson, Nationwide's chief people officer, explained that the initial expectation in spring 2020 was that lockdown would last a matter of weeks. However, "By the back end of summer, it became evident this wasn't going to be ending any time soon, and at the same time, we were seeing fantastic new remote working behaviours.

"We could speak to more than 1000 leaders at once, there were more check-ins with staff, better creativity, regular feedback, more accountability and freedom, and a sense that we could still all be a 'community'."



A subsequent exercise in employee involvement where 13,000 staff were polled by Ipsos found some startling results. More than half (57%) said they'd like to continue working from home after restrictions were relaxed and 36% wanted a more blended work experience, with only 6% wanting to work in an office permanently.

While Nationwide has chosen to have a significant number of people working from home, others, such as the investment bank Goldman Sachs, have expressly ruled it out. Whatever decision is taken, it cannot be made on a whim.

Ed Milnes is co-Lead of CIEHF's Workplace Sector Group, which has increasingly been examining the implications of working from home. He said: "Ultimately, a lot of companies are going to move towards hybrid working and must wrestle with its implications. As well as considering straightforward issues such as office capacity, progressive organisations are thinking about the mix of environments in the workplace and changing the ratio of desks to meeting spaces to make the office somewhere people come to meet, rather than just a place to work. On the other hand, companies that want people to come back in will have to make concessions. Office redesigns and reshuffles will be required to make the office somewhere desirable to go."

Changing work patterns mean changing lifestyles. As consultant and human factors specialist Bob Bridger has noted, eliminating something as apparently simple as the daily commute can bring benefits and challenges. In 'normal' times, people could spend around two hours a day sitting on a commute plus eight hours in the office. Working from home means they save on that commuting time and could spend it in healthier ways, such as exercising, working in the garden or going for a walk.

Ultimately, a lot of companies are going to move towards hybrid working and must wrestle with its implications.

Equally important, though the commute can sometimes be seen as a chore, it does provide a useful barrier between work and home. It's the chance for an employee to be on their own, have their own private thoughts and listen to their own music.

Bob noted: "We must be aware of the rights of home workers to disconnect. What that means for employers is don't send emails to your employees at eight o'clock on a Friday evening. Make an agreement about when you will interact with your employees and be sensitive to their individual situations."

He also observed that being away from the office eases some pressures on staff. "In an open-plan office environment, for example, there's a great deal of emphasis on how you present yourself, react to others and resist distractions. And there can be emotional dissonance; you might have to be pleasant to someone you don't like. When you're working in the privacy of your own home a lot of those 'self control' demands will be gone."

At Nationwide, it's anticipated that permanent homeworking won't be for everyone. Many staff have said they'd like to mix work with home and Jane Hanson confirmed that approximately one-third of staff will still want some part of their week in the office. From a talent perspective, the company is equipping its leaders with additional toolkits to make sure they can manage their more remote teams efficiently, including spotting training and promotion opportunities.

Ed Milnes says that many companies are doing the right thing by consulting staff on issues such as how many days a week they'd like to commit to the office and what they think they'd need there. However, he believes organisations can go further: "Ideally, they should be taking the opportunity to ask their people how they're coping physically or mentally and giving advice on making long-term changes. Ultimately, companies need to take a human-centred approach, be willing to understand, and be flexible towards people's needs."

A smarter approach to safer cities

With technology becoming cheaper and more advanced by the day, could it hold the key to making people feel less vulnerable in urban spaces? Is there more that can be done to increase protection through surveillance, lighting and services?

The safety of cities came under the spotlight this year when the murder of Sarah Everard sparked a national conversation about the risks in our urban environments. The 33-year-old was found dead after disappearing as she walked home in South London in March, leading to an outpouring of other women sharing their experiences of feeling unsafe. One of the many questions sparked by the tragedy was how do we make our cities safer and help people feel less vulnerable?

Barry Kirby, managing director of consultancy K Sharp, sees technology and 'smart cities' as the answer to much of this problem and believes existing solutions need to be updated. "Traditional CCTV has a huge drawback in that it usually needs someone watching the right camera at the right time to do something, when normally they have a bank of screens to watch. Then they need the capability to deploy support quickly. This is difficult and rarely happens effectively," he explained.

With smart phones becoming ubiquitous, it makes sense to move to a more personal approach to safety. "There are many apps out there at the moment. The 'Hollie Guard' is a great example of one that people can use to alert friends and family that they are either going to meet someone they don't know or to an area that makes them feel uncomfortable," Barry said. "They can then check in afterwards to say they're safe and it also acts as a personal panic alarm."

The drawback to this approach is that the onus is on the individual to protect themselves. This may not always be practical and also highlights some other societal problems.

"A lot of this requires planning and coordination by the vulnerable person so they have to recognise their own vulnerability at any given instant," said Barry. "This requires a lot of behavioural change on behalf of, for want of a better expression, future victims, rather than future offenders.

"This intrinsically promotes a victim blaming culture and people may say 'why didn't you use the app?'. We need to be able to use smarter technologies to not only make more of the technologies we have, like CCTV, to recognise events that are happening, but also to stretch them further to recognise risk and be able to alert appropriate services. This could include

IMAGE: SHUTTERSTOCK

iBeacon technology, or even Apple Tags, to identify where people are walking on their own and intelligently recognise that they may be at risk. This could then lead to raising awareness with local resources such as police or PCSOs or even local security or door staff to be aware and alert."

This more joined up, process-driven approach is where human factors consultants can help. Existing agencies and solutions could be better organised to meet the human need. Barry noted: "Smart technologies need to be pushed to work inclusively for all residents and visitors and keep them safe, regardless of whether they have downloaded an app or have a certain brand of phone. The technologies do exist but there are issues around organisations and their siloes that need to be broken down and connected. This is a problem with huge potential for human factors input – from the app and technology design and development domain, right up to behaviour change, organisational engagement and collaborative working."

Iqbal Bedi, above, a consultant in 5G connectivity and smart city adviser, agrees that the whole point of creating a smart city is to benefit the people who live and work there. The joining up of existing services with new technology must always put the citizen first. "Local authority-driven smart city or place initiatives will not only improve citizen and worker environments, they'll also increase council productivity, reduce costs and improve service delivery," he said. "For example, social housing landlords are deploying sensors to detect signs of dampness and avoid the need for expensive rot works or repairs downstream. There are downstream benefits, for example, sensors can detect fuel poverty and so create real social impact but where safety is concerned, there are some really innovative solutions. Cities are deploying sensors in streetlights to reduce opportunities for crime."

As with many new systems, there are gaps in design which a human factors expert could identify. Often the human role in the technology is overlooked. "It's probably true to say that not much effort has gone into the ergonomic design of this technology," Iqbal said. "Sensors, for example, can look bulky and ugly and are typically retrofitted. This is changing gradually. I think the future of sensor technology will be to integrate sensors into new homes and into street furniture, rather than to retrofit them."

Smart technologies should be stretched to recognise risk and be able to alert appropriate services

Another human element to consider with smart cities is who monitors the data. This highlights a range of issues, from the level of training required to security clearance. The focus should always be on the safety of the citizen but decisions are often driven by cost. Sensors are currently deployed into low level complexity situations which would require a low level of intelligence to monitor environmental effects, for example, heat, humidity and movement.

"These are tasks that are currently undertaken by people," Iqbal said, "but people are over-skilled for these tasks as it doesn't need much training to undertake visual inspections. It's clear that the business case for smart cities is partly driven by replacing low level complexity tasks carried out by humans with sensors and smart city infrastructure.

"As the level of data produced by smart cities at the moment is quite low, much of the analysis and monitoring is done by people but as smart city infrastructure becomes more prevalent, the amount of data produced will become significant. The analysis of this data will be too complex a task for any human and this is where Artificial Intelligence (AI) will come in.

"For example, AI is being considered in the analysis of camera footage installed on council bin lorries to detect potholes. This can be used to dispatch council resources to patch and fix as appropriate. It would be inconceivable for people to review and analyse the hundreds of hours of CCTV produced daily, therefore using AI and clever software would be most appropriate."

As this approach is still very much in test phases, it's likely that workable models will inspire more solutions, including those that contribute to the increased safety of citizens.

Barry Kirby

A DAY IN THE LIFE OF AN...

OCCUPATIONAL HYGIENE TECHNOLOGIST

Richard Goorney

I work for an organisation that provides testing, inspection and compliance services in a range of sectors. My team provide a number of services to assist clients in monitoring, assessing and controlling human exposure to chemical, physical and biological hazards in the workplace. These include workplace exposure monitoring, noise assessments, Local Exhaust Ventilation (LEV, a system that takes dusts, mists, gases, vapour or fumes out of the air so that they can't be inhaled) assessments and lighting surveys.

When studying for my MSc in Ergonomics at Loughborough University, Occupational Hygiene was the subject of one of my lectures and delivered by a British Occupational Hygiene Society (BOHS) representative. What sold me this as a career, alongside my human factors knowledge, was that it was no office job, it would get me out and about and give me the opportunity to understand people's jobs first-hand, enabling me to make a real and immediate difference to their health.

I usually visit sites within two hours' drive of home three days per week and work from home the rest of the week. Where I attend is varied and this is one of the joys of my role because every day is different. Since working as an Occupational Hygienist, I've visited the likes of asphalt and concrete plants, nuclear power stations, train stations and bakeries. I research the site I'm visiting beforehand by reviewing the sales quote which details the work required and the reason for my visit, reviewing past reports and contacting the site representative.

Included in my standard kit is a set of personal sampling pumps which are placed on operators to assess occupational exposure to gases, vapours and fumes, such as diesel exhaust emissions, as well as total inhalable dust (like wood dust) and respirable dusts (such as crystalline silica). The pumps are worn on belts or in pockets of operators and connected by a length of tubing to a sample head that sits on their shoulder within their 'breathing zone' and captures the dust/particulate.

I have a set of dosimeters which I use to find out the direct noise exposure of an employee. They're small, wireless shoulder devices (shaped like the Apollo lunar module!) that measure noise at the operator's ear. So they measure the actual noise affecting them, wherever the operator goes and whatever the operator does throughout the working day.

I use my sound level meter when I need to know the noise level of a particular task or process, or how noisy a piece of machinery or area is. This equipment, with its black foam ball windshield on the end, is my favourite because I can obtain immediate results and involve operators by showing them the display readings and discussing their significance.

I also have a dust lamp which I use to shine a bright beam of light through an area where a particle cloud may be present. The particles diffract the light and makes it a lot easier to see the dust particles and their source. I also use other kit such as gas detection devices and smoke tubes to detect air flow current.

On an average day (though occasionally I might also work nights) when I visit a site, I usually leave home by 6.30am as operators may start their shifts early and finish shortly after lunch so this gives me maximum time with them. I also aim to monitor when operating conditions and staffing levels are considered typical of an average day so need to factor in the equipment set-up time and a site induction, if there is one.

Preparing for monitoring on site involves ensuring the equipment is calibrated and then putting the personal sampling pumps and/or dosimeters on the operators, who typically wear

Left: a site visit to a quarry. Right: sound level meter and doseBadge

This work gives me the opportunity to understand first-hand, people's jobs, enabling me to make a real and immediate difference to their health

them for about four hours. In the meantime, I identify where the main noise and dust sources are and also begin taking measurements using the sound level meter. This is usually done straight away because operators may use their equipment infrequently or processes may take place rarely in a day so they need to be captured when they happen.

I observe and chat with operators to understand their roles, equipment used and working environment. It's really useful having my human factors knowledge here too as I can get a real understanding of their work. Fundamental to my role is the 'Hierarchy of Control' when recommending control measures. For example, in brick making, defective bricks are often thrown into a metal bin generating impact noise but rather than wearing hearing protection a possible solution might be to reduce the height of the drop and applying an sound absorbent lining to the bin.

I'll also identify safety signage such as mandatory blue respiratory protective equipment (RPE) and hearing protection signs. Although not ideal, they serve as an administrative control except when there are so many signs in work areas that you get 'cluster sign blindness', whereby you're more likely to disregard the less 'visible' signs within a cluster of signs.

I'm interested in how people wear their RPE and how they are trained to use it too. For example, a powered air-purifying respirator (PAPR) is a portable battery powered respirator that filters ambient air in the user's immediate environment, directing the clean, filtered air to either the user's face or mouth via a breathing tube. But it's not uncommon to see the PAPR hanging loose, stretching the hose and making it uncomfortable to wear over time, so the operators might end up resisting using it. It's also possible their heads could be pulled backwards by the poor fit, causing tension in the neck, headaches and mild neck injuries.

Throughout the day I take pictures which act as an aide memoir when it comes to writing my report and they can also be helpful to stakeholders.

My day ends when I collect the samplers, calibrate my equipment once more and ensure the operators have completed their questionnaires. These ask about the tasks they've undertaken throughout the monitoring period, hour by hour, the RPE and hearing protection they're provided with, and whether they have worn them during monitoring. Finally, I debrief the client with my initial findings.

Once home, I package up the sample heads, complete the supporting paperwork and send these to the laboratory for testing. I usually receive the results within a couple of weeks, so I can identify if operator exposure was within the prescribed legal limits. Likewise, I upload the dosimeter and sound level meter data to my laptop, enabling analysis in combination with the information on the completed questionnaires. Then I write the report and describe the site process and hazards, background information about the site, my monitoring methods, results and recommendations.

As an Occupational Hygienist, I'm always learning and developing but one of my aims is to obtain the BOHS Certificate of Operational Competence in Occupational Hygiene which requires me to demonstrate through my education, training and experience that I'm competent to practice in this field.

Richard Goorney is an Occupational Hygiene Technologist with experience across the manufacturing, construction and transport sectors. He has an MSc in Ergonomics (Human Factors) and is a Graduate Member of CIEHF and an Associate Member of the BOHS.

Campaigning for a thriving scientific sector

As the Covid vaccination programme has so vividly illustrated, science and engineering have a vital role to play in helping meet the global challenges of the future, driving forward prosperity, health and societal benefits for all. To achieve these goals, the sector must receive the full backing and support from government, as **Professor Sarah Main**, from the Campaign for Science and Engineering, explains

The Campaign for Science and Engineering (CaSE) is the leading advocacy group for science and engineering in the UK. Its number one mission is to ensure that the entire country has the skills, funding and policies to enable science and engineering to thrive. Over recent months, we've been at the forefront of a campaign to protect the breadth and connectivity of the UK scientific ecosystem from the effects of Covid-19, so that the sector can play a leading role in the country's recovery. We're also very pleased to have seen the Chartered Institute of Ergonomics & Human Factors play a vital role during the pandemic, bringing their expertise to bear on a range of issues from PPE usability to home workspaces.

CaSE has been protecting UK science and engineering for the last 35 years. We were founded as Save British Science in 1986 by a group of scientists funding an advertisement in *The Times* as a direct message to the Thatcher government to 'Save British Science'. Since then, this small grassroots organisation has been transformed into the authoritative and resilient organisation that CaSE is today, while retaining the core spirit which kick-started the original campaign.

Since those formative years, we have shepherded UK science and engineering through economic downturns, spending cuts, election cycles and referenda, ensuring that the sector receives the support it needs and remains in robust health for the future.

Our mission is to ensure the country has the skills, funding and policies for science to thrive

We deliver independent and expert analysis on areas of broad concern from across the community, developing clear briefings and recommendations for action that help influence policymakers and governments in England, Scotland, Wales and Northern Ireland.

Our work is clustered around three main areas of funding, education and skills, and evidence in policy-making, and within these topics we also focus on specific issues and campaigns. Recent examples include our *Power of Place* report, looking at how to maximise the local economic impacts of research and development (R&D) investment as part of the Government's 'levelling-up' agenda, and working rapidly to secure a commitment from the Government on EU research funding, following concerns that the science budget would be raided to meet these obligations.

Our members lie at the very heart of what we do. As a charity, we're completely independent of government influence and are funded entirely by our membership of 115 organisations including businesses, universities, professional bodies and research charities, as well as more than 500 individual scientists and engineers. Our work is informed by consultation with this membership and their support is vital for CaSE's activities.

We are delighted to count the CIEHF among our membership and have greatly enjoyed working with them since they joined in 2016. With a specialist understanding of people and their environments, the CIEHF brings a unique knowledge-set to our membership and provides valuable insight, helping inform and guide our policy work.

Our approach of engaging with a broad range of stakeholders is one shared by the CIEHF, who themselves collaborate with professional and occupational institutes, trade bodies, research entities, and government agencies. When we speak to government, we do so with the breadth and expertise of our entire membership behind us, from the CIEHF and the National Farmers Union, to GlaxoSmithKline and Cancer Research UK. Collectively our members employ more than 336,000 people in the UK, and our industry and charity members invest £32 billion a year globally in R&D.

And 2021 is proving to be a busy year. We've already published a briefing on improving STEM (science, technology, engineering and mathematics) provision in primary and secondary education, and have launched the exciting next stage of our R&D Decade campaign aiming to transform public support for research. We're now looking ahead to influencing the Government's innovation strategy and ensuring that the uplift in R&D spending is maintained at the next Spending Review, among many other challenges and opportunities. All of these efforts are made possible by the support of organisations such as the CIEHF and we look forward to partnering with them into the future, bringing about the shared vision of a UK that can fully realise its science and engineering potential.

Professor Sarah Main is the Executive Director of the Campaign for Science and Engineering (CaSE) and represents the interests of members in high-level discussions with government ministers, parliamentary committees, chief scientific advisers and senior civil servants.

CHIEF EXECUTIVE'S PERSPECTIVE

Making a business case

Following the publication of more than 30 very successful guides, white papers and infographics last year by the CIEHF, we've been approached by Professor Andrew Thatcher, Chair of Industrial and Organisational Psychology at the University of Witwatersrand in South Africa, to become involved in a major project. The aim is to create three different publications to make the business case for ergonomics and human factors. This initiative is led by Andrew on behalf of the International Ergonomics Association.

The first publication is aimed at 'C-suite' executives and leaders working in major industries across a wide spectrum from aviation, mining and construction to pharmaceuticals.

The idea is to create short but compelling publications and perhaps supporting videos to demonstrate how our discipline and profession can contribute to business success. We're not using full case studies but short vignettes or stories that demonstrate what certain businesses have done and the impact that human factors has made. This might include the return on investment, for example, cost savings leading to more efficient and lean processes whil3 reducing risks to more inclusive design leading to increased sales or market share.

Nichola Adams and I are supporting Andrew, alongside a wide range of members providing data and information. I'm certainly hoping that the publication is useful to the broader public sector, particularly healthcare. International round table discussions were set up across a wide number of countries which has already helped to shape our thinking for this very important piece of work. In the coming months, we'll be running additional round table sessions which will help formulate the second publication on how we can best inform departmental heads and senior managers in business about the impact and value of human factors. The third publication will be aimed at organised labour and worker representative groups. CIEHF will be supporting online events for all three target groups as part of an international effort to promote human factors more widely. If you'd like to contribute or share useful information, please contact me directly or DM me on LinkedIn.

In July, Professor Sarah Sharples chaired a webinar making the links between human factors and Equality Diversity and Inclusion, EDI. Courtney Grant put together an outstanding presentation and the whole event is available on demand (https://youtu.be/yB8t53UQ0c4). Using plain language, Courtney described how using human factors techniques can contribute to addressing inclusion, an issue almost every organisation seems to be focusing on right now.

We're creating publications to make the business case for ergonomics and human factors

Sarah Sharples, a past President of CIEHF and now Chief Scientific Adviser to the Department for Transport, believes we could better make the case for human factors by linking back to EDI issues. The interest has been significant from members and as a result, Courtney's presentation is being turned into a guide for members. Chris Ramsden, President of CIEHF, will be helping to curate a session on design for individuals with disabilities and we're speaking with Professor Amanda Kirby, a specialist in neurodiversity issues.

In the meantime, Amanda Widdowson will be pulling together a report on Design for Everybody, her President's Project 2020/21 aimed at collecting more up-to-date body measurements. We hope that this initiative will influence a larger scale project to update existing data sets, so they more accurately reflect the diversity in society today.

Speaking about influencing large audiences, the CIEHF publication *Vaccinating a Nation* is now also available in Hindi, Bengali, French and Spanish. Thank you to all the members who have volunteered time to undertake this work. The guides are available to download from our website. Following more on the ground research led by Janette Edmonds, Helen Vosper, Hugh Currie and Paul Bowie, *Vaccinating a Nation* part two will be available soon. This document will present the key learning points arising from the human factors assessment of the vaccination system implemented by NHS Ayrshire and Arran.

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noorzaman rashid

A platform for rail human factors

A host of factors including emerging technologies have helped to precipitate an unprecedented demand for rail human factors research, knowledge and expertise – a demand which made the recent seventh International Rail Human Factors Conference more significant and relevant than ever, as **Richard Bye** explains

Since the first International Rail Human Factors Conference, which took place in the UK in York in 2003, the need for specialist rail human factors practitioners, academics and consultants has risen exponentially. This is due, in part, to the emergence of new digital technologies that disrupt roles and processes, as well as the growing recognition of the value delivered through human-centred design, and the competing priorities for ever higher levels of safety, capacity and resilience.

The CIEHF-supported conference went online this year. Organised by the Rail Safety and Standards Board (RSSB), in collaboration with Network Rail and the University of Nottingham, the conference provides an unrivalled forum for the discussion and advancement of ergonomics and human factors theory and practice across the growing global rail sector.

Immersive and inclusive

Online conferences exemplify the trade-off between efficiency and thoroughness, providing a fantastic opportunity for cost-effective global participation but with reduced levels of interpersonal interaction. After all, it's impossible to replicate the sights, sounds and serendipity of a conference without the cloakroom, coffee and chaos of a physical gathering. Yet, despite the limitations of the virtual world, RSSB's organising team artfully orchestrated the people, processes and technology required to create a seamless user experience that felt both immersive and inclusive – no mean feat when you're delivering to an audience whose day jobs require critical analyses of human-system interfaces!

Conference proceedings were opened by RSSB's Ann Mills. After welcoming the 180-strong audience, Ann introduced the Leading Health and Safety on Britain's Railway strategy – a framework of risk and capability areas that has human factors principles at its core. The strategy proved to be an interesting and pertinent talking point, with several of its 12 risk areas, including fatigue, workforce safety and train operations, featuring in discussions throughout the conference.

Allison McDonald, from SystemiQ in Australia, made the first keynote speech asking attendees to consider the role of human factors specialists, not only in the design of future systems but also in the design of job roles and in the training and competency interventions necessary to deliver sustainable levels of safety and performance. Allison's talk set the tone for a conference which was characterised by the need for the long-term, big picture and full lifecycle thinking that will be necessary for the discipline (and the industries it supports) to flourish in the digital-first, post-pandemic era.

The conference surfaced a rich seam of novel, insightful and impactful human factors interventions

The need for a whole system and human-centred approach, based on forward-looking scientific research and hard-won lessons of the past, was reinforced in the second keynote by Simon French and Mark Young from the Rail Accident Investigation Branch. Simon's personal account of cultural factors, cognitive biases and the forces of locally rational decision making, beautifully illustrated not only the value of human factors integration in incident investigations but also the need to draw careful conclusions from the analysis of frontline work in railway environments.

Mark cautioned against an over-reliance on modelling approaches and other methods of abstraction that, although useful, can lead an ergonomist's focus away from human performance. Stressing the importance of human performance, he highlighted that, despite the myriad efforts to bridge research and practice, we have real-world problems that science can't answer: What is too much (or too little) in terms of cognitive workload? Why do car drivers swerve around level crossing barriers? What are the predictors of effective safety-critical decision making for track workers, platform staff, control room teams and system designers? In a deliberate attempt to pose more questions

Seventh time around, and yet again, thanks to the organising committee, reviewers and participants, the conference proved to be a tremendous success. With delegates from Europe, North America, Australia, New Zealand and Asia, the conference provided a great opportunity for the international rail human factors community to meet online, share experiences and learn from one another

Huw Gibson, Head of Human Factors, RSSB

than answers, Mark presented delegates with a dual challenge – to solve complex problems at the socio-technical system level, while never forgetting about the human in human factors.

Eclectic and engaging

The conference surfaced a rich seam of novel, insightful and impactful human factors interventions with talks that showcased advances made, and lessons learned, at the interfaces between humans and machines, trains and station platforms, and members of the public and level crossings.

More than 80 speakers from countries including Japan, France, the UK, Australia and the Czech Republic brought diverse perspectives to a range of eclectic and engaging topics, with delegates joined together through the common language of human factors.

Although attendees' local contexts and environments differed, the talks demonstrated that we are all facing many of the same problems. And these are not just rail problems. Macroergonomic issues of safety culture and leadership, the maturity of human factors integration, new technology innovation, human and organisational performance, and the design of joint cognitive systems, were strong conference themes that will echo across healthcare, aviation, military, process control and other domains.

The three-day conference was brought to a close by Professor Sarah Sharples. Looking to the future while reflecting on the past, Sarah gave a thought-provoking and motivating speech, reinforcing the need to consistently deliver the right approach whilst declaring that the rail human factors community must be bold and proactive in leading technology development to make a meaningful impact.

Richard Bye is a Principal Ergonomics Specialist at Network Rail.

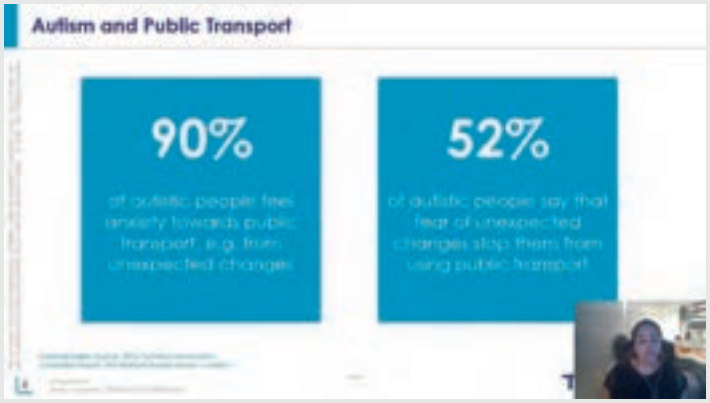
Further reading

Papers from the conference can be accessed via the Spark Rail Knowledge Hub at https://bit.ly/RailHF2021

PRESENTATION

The need to establish a socio-technical systems approach to underpin the safe, high-performance delivery of rail decarbonisation was set out by David Golightly from Newcastle University. Reducing carbon emissions as part of the GB rail network's environmental sustainability strategy, will require multi-billion-pound investments in electrification and other forms of sustainable propulsion that, as David explained, will amplify the human factors risks that are inherent in the development, construction, operation and maintenance of electrical control technology. David said these risks must be managed using significant investments in human-system integration, and put forward the need for a holistic approach that would offer advantages in reducing costs, accelerating delivery, improving safety and minimising service delay.

PRESENTATION



Hannah White from Thales presented a thematic analysis of rail travel through the eyes of people with autism. First person accounts were used to illustrate that accessibility must extend beyond the needs of wheelchair users to consider people who have hypersensitivities, motor impairments and difficulties with hazard perception. Hannah argued that the rail industry needs to reduce the unpredictability of train travel by improving the availability of information to support journey planning and providing tailored guidance for passengers during times of delay or disruption – what are inconveniences and frustrations for some, can be intolerable barriers for others. This was a powerful reminder of the necessity to improve the railway's physical, virtual and information environments for those that need it most – a reminder that we must create a railway that works better for everyone.

Hooked on helping

Good design not only makes life better for people, it can also protect them by reducing the risk of injury or harm. A handheld tool designed specifically for textile workers has transformed a daily task which had previously been leaving them suffering from hand and arm pain

Workers at the Herbert Parkinson textile factory had been plagued by pain caused by manually inserting up to 200 metal pin hooks into curtain tape every day, often pushing the hooks through thick fabric. The task involved repetitive upper limb work and everyone found the pins difficult to grip and hold, leading to reports of musculoskeletal discomfort.

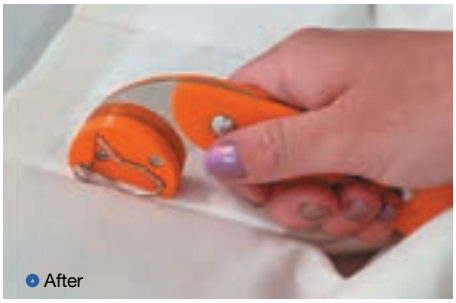
But design engineer David Atherton worked with them to create a tool that has now made their jobs simpler, easier and safer. It also saw Herbert Parkinson awarded this year's Musculoskeletal Disorders Risk Reduction Through Design Award, which is sponsored by the Health and Safety Executive (HSE) and supported by CIEHF.

One of the workers said: "Before we got the hook insertion tool, putting metal hooks into the curtains caused a lot of pain to our fingers, especially with the thicker fabrics, as it required force to push the hooks in. The tool gives more leverage, so the hooks slide in more easily, and now there's no pain in our fingers and hands."

Rachael Murray, Branch Safety Advisor at Herbert Parkinson, had been approached by colleagues about the problems they were experiencing because of the hook insertion. She was put in touch with David, who visited the site to speak to workers and developed a prototype of the device after examining their situation.

The gadget was then trialled with some of the workers to test what difference it made to them when they were inserting the hooks. David said: "I decided quite quickly that a small hand tool would be the most time and cost-effective device to use. Within three weeks I delivered a prototype for trials on the production line."

Before



After

HSE MSD Design Awards

The tool was designed to fit comfortably in the hand, meaning workers would not need to use their fingers to fit the hooks reducing the risk of musculoskeletal problems. It also led to fewer cuts and infections in the fingers of the people who used it on the production line. David added: "The tool was a great success and operators were very enthusiastic about it."

It's a brilliant example of a collaborative design approach that's reduced musculoskeletal risk, cut costs and increased comfort for all workers

After the successful trials, the tool – which is made from stainless steel, 3D printed nylon and two magnets – went into production so that everyone could use it. It's helped revolutionise daily work at the factory in Lancashire, which makes products for the John Lewis group. And as well as reducing injuries and pain, productivity has increased since the new device was introduced.

The award was announced at our online ceremony in June by Ali Wellens, Head of Health and Work Branch, Engagement and Policy Division at the HSE. She said: "This award is designed to highlight the important contribution that design changes can make to reducing the risk of musculoskeletal disorders and they give recognition to changes that have made a real impact to the lives of workers. The winning entry really impressed the judges and captured the brief by providing a simple and really effective engineering solution, which also helped with the problem of a fiddly and repetitive manual task. It's a brilliant example of a collaborative design approach that's reduced musculoskeletal risk, cut costs and increased comfort for all workers."

Inspiring interest to bring about change

The need for safe, efficient and reliable systems and methods of working has never been higher. A prime example of this is the UK's intensive vaccination programme where the requirements for safety and productivity have been uncompromising. One organisation aims to ensure human factors takes centre stage in their efforts at improvement through an innovative training scheme, as **Hatim Sachak** explains

At GlaxoSmithKline's (GSK) Barnard Castle site over the past year, understanding human factors and how to apply knowledge about human behaviour and abilities has been fundamental to Continuous Improvement. Here, Human Factors Advocates and many other staff members have developed an understanding of a broad range of topics in order to drive change and facilitate even more impactful performance improvement.

The participation of GSKs 'Early Talent' especially is key to implementing lasting change in the workplace. The Industrial Placement cohort this year has received invaluable training from Human Factors Director, Julie Avery, and Workstream Lead, Nadia Earl. The training enabled placement students to become Change Agents in the workplace who could then inspire beneficial change around them in their current roles and in any future positions.

Following these sessions, many placement students volunteered to be coached on a single speciality topic which they could then present as part of our Human Factors Programme on topics previously taught by Julie. Early Talent members from across GSK's UK sites were invited to attend. The topics included Human Reliability Assessments (HRA), Growth Mindsets, Switch Change Management and Corrective and Preventive Actions. All sessions were recorded and will be shared with the rest of GSK via the company's online learning platform.

Our continuous improvement culture gives everyone the opportunity to contribute to change

Placement student Angela Francis said: "During my placement year at GSK, I entered this programme having no experience in human factors but following sessions led by Julie, I graduated as a Change Agent! As the sessions progressed, I quickly realised how an awareness of human factors can contribute to a successful business. Following our training, I was given the opportunity to present on Switch Change Management to members of GSK's Early Talent across the country and have used my knowledge to help me implement change during my placement."

Amrit Dayanand, also a placement student, noted: "GSK's success is created by the interaction between its high-quality people and robust processes. Human factors training has given me the tools to analyse the inner workings of this relationship in my day-to-day work and beyond, from developing the quality of our people using Growth Mindset to designing resilient processes using the Swiss Cheese Model."

Another critical part of our Continuous Improvement has been the collaboration of production team members during HRAs led by Nadia, with support from placement students. These workshops aimed to help teams of manufacturing staff have an open discussion about obstacles that they face in their daily work. Each session aimed to first clarify that applying human factors begins with a shift in mindset, where, in order to improve and move forward, it's imperative to maintain a no-blame culture and identify how to ensure activities and practices are performed correctly."

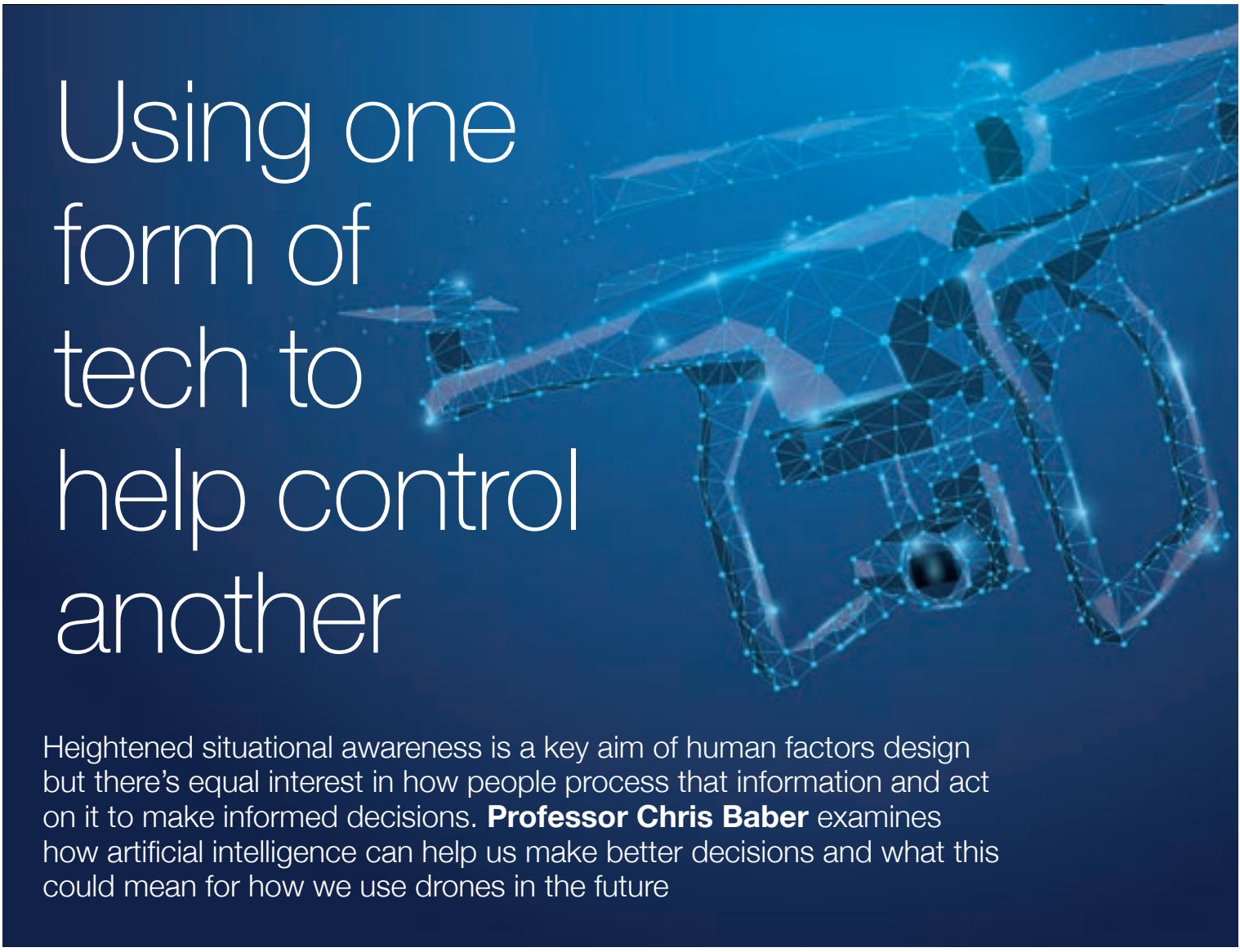
The HRAs also showed individuals how to ask the right questions about their work and environment in order to direct each team's focus towards the most pressing or easily solvable problems. Finally, at the end of each workshop, production teams gained an understanding of how to spot 'Human Error Traps' and whether or not people are set up for success. Exercises like HRAs support the development of our Continuous Improvement culture where everyone is given the opportunity to contribute to change. As the Barnard Castle site continues to embrace and celebrate change, face challenges and overcome obstacles, understanding core human factors topics will be crucial to developing long-term success.

Hatim Sachak was a Reliability Engineering IP at GSK and has now finished his placement and returned to his studies.

Further reading

See a previous article about GSK's industrial placement programme 'Encouraging Early Talent' in *The Ergonomist*, issue 581, Jan-Feb 2021

Using one form of tech to help control another



Heightened situational awareness is a key aim of human factors design but there's equal interest in how people process that information and act on it to make informed decisions. **Professor Chris Baber** examines how artificial intelligence can help us make better decisions and what this could mean for how we use drones in the future

When people think of the capability of drones in the future, they generally imagine them to be totally autonomous but there will still need to be a human who takes responsibility for the drone's behaviour. That means there will always be a need for a human operator in the loop to define waypoints and intervene if the drone activity is unacceptable. This is fine for a single drone but it provides a challenge when many drones have to be monitored in real time and managed in an increasingly crowded airspace. In the near future, this could be a reality for a range of activities from warfare to delivering mail.

How can human decision-making be supported by artificial intelligence (AI) and contribute to human-machine teams? For our research on the challenges of managing threats in a crowded airspace from multiple uninhabited aerial systems (UASs or drones), we designed a video game for computer students to pit their wits against a range of hostile, neutral and friendly drone activity. Players had three ways of managing the scenario: manually with full 'air picture' display; a 'management by consent' option which included a computer-generated 'decision support' aid but without an 'air picture' display; and a hybrid 'management by consent' option with a decision support aid and 'air picture' display.

Having oversight of multiple autonomous or semi-autonomous systems will be a challenge for the future, so what we were looking at were ways of cueing the human operator so that they would know when to pay attention to a particular area, either because of the behaviour of a drone or due to some other situation. Rather than being 'in the loop', the human manager is 'over the loop' and poised to take control if required.

The results of the three scenarios were interesting. With the manual system, players were slightly 'trigger happy', logging the highest number of hits but also the highest number of 'false alarms', hitting neutral and friendly drones as well as causing other collateral damage. This raised questions concerning the difference between awareness of the situation and awareness of decisions.

The 'management by consent' polygon-only warning system scenario led to better 'rules of engagement' performance (in terms of minimising collateral damage), even though users were

IMAGE: SHUTTERSTOCK

uncomfortable that it provided limited situational awareness as there was no air picture available. The lack of air picture also hampered the player's ability to respond quickly.

In the 'management by consent' hybrid polygon and air picture scenario, the likelihood of hitting drones in the protected zones increased and the decision support helped to limit the false alarms.

Polygon displays have been used in human factors since the 1980s and have worked particularly well in helicopter cockpits because they provide detailed information in a very simple format. However, we found that the players using the management by consent polygons were safer in their decisions but slower in their reactions. This ties in with previous studies we've done on people's mental workload and their sense of situation awareness. We found that just using those polygon displays by themselves gave them a much higher workload and much lower situation awareness because people are trying to second guess what the polygon displays are telling them and slowing their reactions.

However, in the scenario where the player uses both polygons and the dynamic air picture display they also make safer but slower decisions because their attention is divided between the moving drones in the air picture and the changing information on the polygons. It shows there's a trade-off in the decision making between the decision you choose and the consequences you're prepared to accept as a result of that decision. In the drone game, the manual players often chose to 'disable' a hostile drone as quickly as possible but accepted the collateral damage of it being a 'friendly' or it falling on a property.

Having oversight of multiple autonomous or semi-autonomous systems will be a challenge for the future

In a military setting, this would be covered by the rules of engagement but the difficulty at the moment is that the rules of engagement always assume a human is completely in charge. When we start introducing semi-autonomous weapons, then there's still a responsibility for the human to be completely in charge but that becomes problematic when these systems start to make complex decisions or when they behave very quickly.

That's why we not only need a human 'over the loop' but also a better understanding of the policy for drone management and that policy will define the constraints in terms of what's not acceptable behaviour. However, that's a challenge as that policy may have to be updated in real time to deal with an unexpected situation, and should it be delivered to all drones or a limited number which are near the area of issue?

This research is part of a series of studies for an Anglo-French military consortium to look at human-machine learning, and we're working on a follow-up project looking at mission planning using a forest fire scenario. We've built a demonstrator that allows you to compare your proposed course of action with the options generated by the AI. We use a Bayesian Belief Network, which describes the joint probability distribution for a set of variables, to generate alternative courses of action and the AI demonstrates both the cost and likely success of an action you've proposed with all of the options that the computer has developed. If the AI proposals are likely to be more successful or lower cost, then you might need to see whether your original plan needs changing.

It's about human-machine teaming and scanning all of the possible decisions that could be made, helping to inform the human in their planning and raising decision awareness.

THE DRONE GAME

The Drone Game was built around a simulated air defence task for a single player to protect 'celebrity' houses in a Los Angeles-style suburb from being overflown by paparazzi drones. Each house had a protected area, designated by shading on the map, and if a 'hostile' drone came within this area it could be 'depowered' by activating a beacon. However, if a drone was depowered outside the protected areas it could cause collateral damage to other houses. The drones were colour coded red, yellow, blue or green to reflect their threat level: hostile, unknown, neutral and friendly respectively.

With up to 15 drones crossing the air space at a time, the aim was to monitor the dynamic air picture and ensure the hostile drones were neutralised before they overflew the celebrity house, while allowing the other non-hostile drones to continue unmolested.

The game was given to MSc Computer Science students at the University of Birmingham and 66 usable sets of results were analysed for performance in terms of hits, false alarms, collateral damage and reaction times using three different drone control platforms.

Professor Chris Baber is Chair of Pervasive and Ubiquitous Computing at the University of Birmingham.

Further reading

Baber, C & Morar N, 'Manual control verses management by consent in managing multiple threats', Contemporary Ergonomics & Human Factors 2021, presented at the CIEHF Ergonomics & Human Factors Conference in April 2021. See https://bit.ly/3xAVNYm

Recognising ergonomics excellence

This year's CIEHF awards were announced and presented in an online ceremony that demonstrated the very best in research and practice. Here's some of the highlights.

Sharing the journey

BP's human factors programme isn't just helping their own employees – it's being rolled out across the oil and gas industry

When BP's Human Performance Team realised the difference that human factors could make to the oil and gas industry, they didn't want to keep it to themselves. The company had launched an 18-month programme to help their staff reduce risk at sites around the world and soon saw how valuable it was. They shared the resource with others in the industry via the CIEHF and the Energy Institute as the Learning Pathway for the Energy Sector so more organisations could harness the benefits of human factors thinking. And their global effort to integrate human factors methods into the sector helped them secure this year's CIEHF President's Award.

Sandra Adkins, Safety Culture, Human Performance and Safety Science Manager at BP, described how the pathway was the result of a journey that had begun around ten years ago. She said: "Through understanding some of our incidents, we know that

integrating human factors methods into our management system would enhance our performance. We created a suite of human factors tools that could be used by non-specialists in areas like incident investigation, task analysis and risk assessment. But we knew that to make our human performance strategy work, we needed local capability that could create fit-for-purpose solutions for their region's needs. The human performance programme was launched and the company now has more than 50 people around the world on it."

Sandra described the team's achievements as a "truly global effort" and paid tribute to all the people who had worked on the project over the years. Raising a glass to the winners, CIEHF President Chris Ramsden said: "This is awarded for the team's technical expertise and industry influence over a long period."

Also highly commended for the President's Award were NHS Education for Scotland and Relaesa, the Latin American Network of Ergonomics and Human Factors in Health Systems.

Getting off to the right start

The winner of this year's New Ergonomist of the Year Award made a difference from the moment she started at BAE Systems

You don't need to have had a long career to make an impact, as the winner of this year's Young Ergonomist award proves. Lucy Crabb, a graduate human factors engineer at BAE Systems, was nominated for being "confident, conscientious and wise beyond her years" after immediately establishing herself as an asset to the company. She developed guidelines that are now being used on two different programmes

Lucy Crabb

including the Tempest Future Cockpit programme.

Announcing the award, CIEHF immediate Past President Amanda Widdowson said: "It's a hugely complex area that needs the acquisition and retention of significant amounts of information. This has meant Lucy has had to create good working relationships with many people from multiple disciplines and the guidelines she developed are already being applied.

"She's presented the philosophy to many different stakeholders across the business, from fellow human factors engineers to senior managers and capability leads. It's a very well-deserved award."

A lifetime of inspiration

The outstanding careers of defence expert Laird Evans and neuroergonomics pioneer Professor Raja Parasuraman saw them honoured for their major contributions to human factors

Our Lifetime Achievement Awards celebrate your human factors heroes and recognise the individuals who have changed people's lives for the better throughout their careers. The two prizes shine a spotlight on people who have made a real difference in our discipline, and this year was no exception.

Laird Evans of BAE Systems was named the winner of the Lifetime Achievement Award for Practical Application, while Professor Raja Parasuraman was posthumously given the Lifetime Achievement Award for Academic Research.

Laird's long and distinguished career stretches over more than 40 years with a focus on the defence industry. He's played a leading role in human factors integration in the sector and has supported the design and development of some of the UK's most advanced defence systems. Laird joined British Aerospace in 1980 after completing a BSc in psychology and an MSc in applied psychology. He was a member of the Sowerby Research Centre which became the Advanced Technology Centre (ATC) following the merger that led to the formation of BAE Systems. Laird was appointed head of the ATC's 30-strong human factors team in 2012 then worked as a freelance consultant for two years after its closure in 2015 before joining MOD Defence Equipment Support.

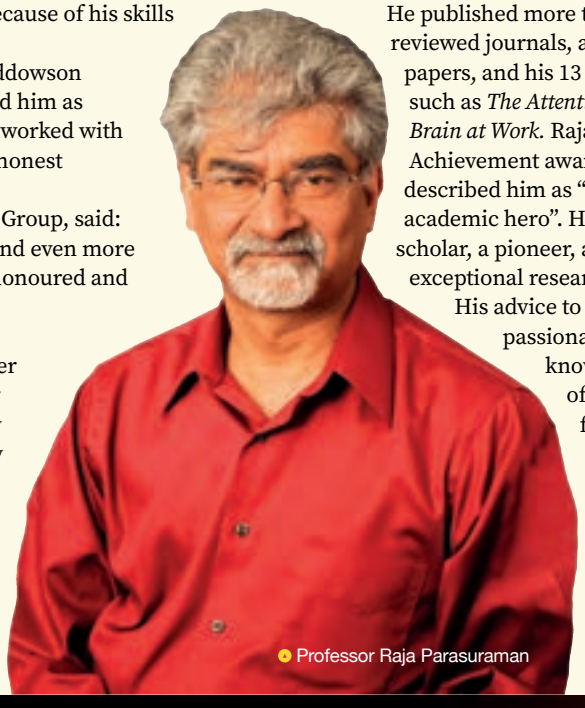
During his career, he's worked on early missile simulators, underwater vehicles and research sponsored by the European Space Agency. But as well as his knowledge, experience and expertise, Laird was also nominated because of his skills as a leader.

Announcing the award, Amanda Widdowson said one of his colleagues had described him as "possibly the best manager I have ever worked with – methodical, meticulous, inscrutably honest but kind, compassionate and fair".

Laird, who leads our Defence Sector Group, said: "I was flabbergasted to be nominated and even more flabbergasted to have won. I feel very honoured and humbled and extremely grateful."

Laird Evans

Professor Raja Parasuraman, the winner of the Lifetime Achievement Award for Academic Research, sadly passed away in 2015 aged 64 but his work and legacy still continue to inspire academics and practitioners. His career started in the 1970s after he graduated from Imperial College London with a degree in electrical engineering and gained a PhD at Aston University. Raja's early work included vigilance and human automation performance benefits and costs but he later moved into what was then a new field that he called neuroergonomics. His pioneering studies, bringing together his interests in human factors and neuroscience, led to the establishment of the topic as a new scientific field and Raja is now regarded as the 'father of neuroergonomics'.



Professor Raja Parasuraman

He published more than 400 scientific articles in peer reviewed journals, as well as hundreds of conference papers, and his 13 books included influential titles such as *The Attentive Brain and Neuroergonomics: The Brain at Work.* Raja was nominated for the Lifetime Achievement award by Professor Hasan Ayaz, who described him as "my collaborator, mentor and academic hero". He added: "Raja was an incredible scholar, a pioneer, a visionary and thought leader, an exceptional researcher and extraordinary person.

His advice to young researchers was to be passionate in order to develop theory and knowledge which can guide the design of technologies and environments for people. His legacy, the field of neuroergonomics, will live on in countless faculties and in the students he's advised and continues to inspire."

Announcing the award, Amanda Widdowson said: "Raja is much missed but we celebrate his life and his achievements."

Something to shout about

Explaining exactly what human factors is and how it helps can sometimes be a tricky task, but not for the joint winners of this year's CIEHF Outstanding Communications Award.

The award was shared by Martin Anderson, founder of the Human Factors 101 website, and the Healthcare Safety Investigation Branch (HSIB).

Martin set up his site in 2016 as a starting point for people new to the discipline. It now draws readers from more than 140 countries and is available in multiple languages. He joined the online awards ceremony from Australia – where it was 1.30am – after the winners were announced by CIEHF's Dr Ian Randle. Ian said: "The great choice of relevant topics and accessible presentation makes this website very valuable to the human factors community."

Martin added: "The website takes quite a bit of work so it's really good when people send me feedback to say that they find it useful. Thank you to everyone who supports the site – they keep me motivated to keep writing."

HSIB was honoured for its investigation into understanding and managing the risks linked to the transmission of Covid-19 in hospitals.

The team recognised the importance of being able to communicate their findings in an accessible and visual way and used a series of methods, such as a heat map of a typical ward, to make sure their message was clear and easy to understand. They also developed a tool which would help staff across all levels identify transmission risks and what steps could be taken in mitigation.

Presenting the award, Ian said: "Their national investigation reports helped drive improvements in patient safety through clear messaging and illustrations."

Suzy Broadbent's work with BAE Systems and Barry Kirby's Human Factors 1202 podcast were also highly commended for the Communication Award.

Support in a crisis

Our volunteers are vital to our work and this year's winner has been crucial in creating guidance to help navigate the pandemic and beyond

The CIEHF's wide range of work wouldn't be possible without the dedicated team of volunteers who share their time and expertise with us. Their generosity makes choosing the winner of the Volunteer of the Year Award an almost impossible task, especially after the extra demands of the last 18 months.

The Institute's Chief Operating Officer, Tina Worthy, thanked everyone who has supported our work before announcing Helen Vosper as the winner of this year's prize.

Helen, a Chartered Human Factors Specialist, senior lecturer at Robert Gordon University and a Principal Fellow of the Higher Education Academy, has played a pivotal role in creating guidance documents, particularly during the pandemic. These include the 2018 white paper *Human Factors in Health and Social Care* and Covid-19 advice on ventilator design and tracheostomy care and procedures.

She was also one of the authors of the *Coping with Complexity* toolkit for early career pharmacists, which explains how human factors can be used to support clinical decision making.

As well as contributing to guidance documents, Helen is part of several groups and is co-chair of one of our most active Regional Networks. She is a prominent member of the Pharmaceutical Sector Group and last year was elected to the Institute's Professional Affairs Board where she is leading the initiative for the Learning Pathways. She's also an assessor for CPD and membership applications.


Helen Vosper

CIEHF Chief Executive Dr Noorzaman Rashid paid tribute to the number of sectors Helen has helped with her expertise. He told her: "Your contribution stands out not just because of the time and the energy you've given but also because of the breadth of topics you're involved with. This reflects your dexterity, intellect and energy to want to make a difference in more than one space."

Further details

To watch the replay of the ceremony on-demand, see https://youtu.be/5InZY8986L0

Chartered Institute of Ergonomics & Human Factors

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- Short paper format (2 pages)
- Committee review
- Deadline: 14 January 2022

How will you be involved?

For all details go to:
conference.ergonomics.org.uk

#ehf2022

Best Paper Awards

This year's best journal paper awards highlighted the breadth and variety of research being carried out in ergonomics and human factors today.

Free tool for risk management

The Applied Ergonomics Journal Best Paper was awarded for a fascinating research project that resulted in a useful free tool for practitioners.

The need has never been greater to create sustainable working conditions and one area in need of attention is the risk management processes targeting a reduction in musculoskeletal disorders (MSDs). According to the International Labour Organisation, they constitute 40% of the global compensation costs of occupational and work-related injuries and diseases.

Linda Rose and her colleagues developed the RAMP Package - Risk Assessment and Management tool for manual handling Proactively. The package aims to facilitate the application of the RAMP tool to manage MSD risks and consists of a freely available tool, a website and training courses for MSD risk management. It supports the whole risk management process from checklists that enable data collection and analysis to a novel results visualisation sheet and an action module for managing identified MSD risks. It's already been disseminated to 86 countries in the first 26 months, with many users in low-and-middle-income countries.

The RAMP tool and training materials were developed using a participative iterative methodology involving researchers and practitioners. The RAMP Package has been designed to meet organisations' needs for an accessible, comprehensive risk assessment and management tool and is available to download for free via KTH Royal Institute of Technology's website at www.ramp.proj.kth.se.

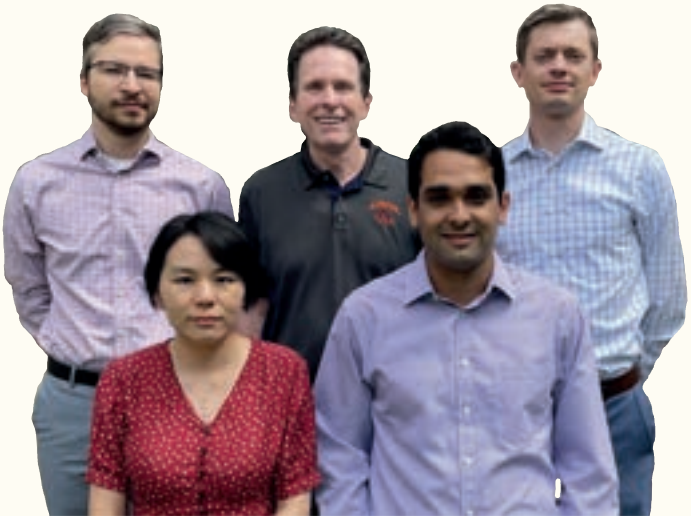
As the researchers say: "With the freely accessible RAMP Package available worldwide, ergonomists and others wanting to reduce MSDs can download, learn how to use and implement RAMP for risk management regardless of financial means and higher education."

For all details of this research and information about the tool, see:
L M Rose, J Eklund et al, The RAMP package for MSD risk management in manual handling – A freely accessible tool, with website and training courses. Applied Ergonomics, Volume 86, 2020, 103101, https://doi.org/10.1016/j.apergo.2020.103101

The complexities of job rotation

Unusually, the Ergonomics Journal Best Paper Award has been jointly awarded to two groups of researchers. One group looked into job rotation.

One tactic to try to reduce occupational exposure to musculoskeletal risk is job rotation but careful consideration must be put into its introduction if it's to be effective. Amir Mehdizadeh and his colleagues examined a novel framework that looked



into the effectiveness of a job rotation scheme, starting with a literature review. They followed with the Fatigue-Failure Theory for evaluating musculoskeletal disorder (MSD) risk and Illustrated their conclusions with a case study based on injury data.

The paper states that "a significant proportion of the existing literature is based on a linear dependency between risk and exposure. As will be clear from our analysis, if such an assumption is made, a rotation can indeed be expected to be effective at reducing the effect of MSD injuries."

But the researchers noted that more recently studies suggest that "a nonlinear dependency may be more accurate, in which case a rotation scheme would be predicted to increase the overall injury risk."

Amir and his colleagues say their results suggest that "the effect of job rotation is highly dependent on the composition of the job pool, and inclusion of jobs with higher risk results in a drastic decrease in the effectiveness of rotation for reducing overall worker risk. The study highlights that in cases when high-risk jobs are present, job redesign of those high risk tasks should be the primary focus of intervention efforts rather than job rotation."

The researchers point out that they did not look to design a practical rotation schedule but studied the potential of rotation in principle which meant they weren't constrained by practicalities that usually have to be taken into account.

The researchers note that MSD risk reduction is just one of a number of reasons for job rotation, others include multiskilling and reducing boredom. Whilst they didn't take these aspects into account, they say their findings suggest that "MSD risk reduction may not be achievable based on rotation alone (and, in some cases, may lead to an increase in pooled risk to the rotation cohort), and hence all other benefits must be weighed against the effect on MSD risk".

For details of this research, see:

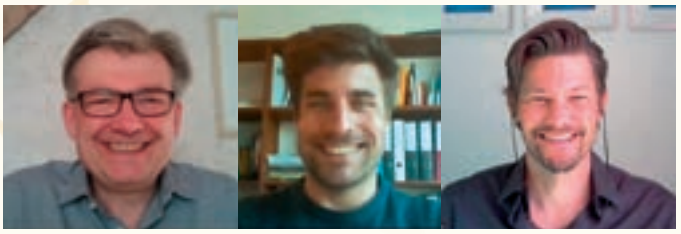
A Mehdizadeh, A Vinel et al (2020), Job rotation and work-related musculoskeletal disorders: a fatigue-failure perspective, Ergonomics, 63:4, 461-476, https://doi.org/10.1080/00140139.2020.1717644

Usability, UX or accessibility?

The other winners of the Ergonomics Journal Best Paper Award tackled the tricky issue of the use of similarly termed concepts.

Confusion can arise between similar terms in any discipline, and Juergen Sauer and colleagues looked into the concepts of usability, user experience and accessibility. They looked at their meanings and their relationship to each other, which included an analysis of the definitions, methods and typical outcome measures employed.

The researchers say: "While



the concepts may be typically used in specific contexts (such as for usability of everyday products, user experience in software development and accessibility in housing), we would expect that more significant progress would be made in the field if a more holistic view of the three concepts were adopted by clarifying the mutual benefits in designing user-centred products."

The researchers state that they wanted to offer some form of integration between the three concepts which might help to advance the field, avoiding debate over which of them is "most convincing". They hope that integration will cause less confusion within scientific communities and among practitioners.

The researchers argue that the terms should continue to be used despite some concerns in the literature about their utility. Interestingly, the paper proposes the term 'interaction experience' (IX) as a higher-level concept which encompasses both user experience and usability and incorporates the important ideas conveyed by accessibility.

Noting that they are introducing another term into an already crowded area, the researchers say: "…in this case we firmly believe that such a new concept is necessary for two reasons. First, it could alleviate the problem of the excessive use of the fuzzy and ill-defined UX concept. Second, it may reconcile the opposing views surrounding the definitions of usability and UX. …Whilst IX as a general term cannot be measured …its constituting elements (accessibility, efficiency, user satisfaction, emotion, etc.) can be measured by making use of established instruments and methods."

Juergen and colleagues note that "…for practitioners such a clear distinction would be helpful because it draws their attention to the wide range of aspects that need to be addressed, including satisfaction, emotion and aesthetics". They suggest using spider charts as a way to report the results of evaluating artefacts with regard to usability, user experience and accessibility which, they say, may help practitioners interpret the characteristics of a device at a glance.

For the full argument, see:

J Sauer, A Sonderegger & S Schmutz (2020), Usability, user experience and accessibility: towards an integrative model, Ergonomics, 63:10, 1207-1220 https://doi.org/10.1080/00140139.2020.1774080

Further information

To find links to all the awards information and full papers, go to www.ergonomics.org.uk > Awards & Accreditation > Awards

Designing with empathy

According to a recent Family Resources Survey, there are more than 14 million people living with some form of disability in the UK alone. Experiencing just a few of the issues faced by those with disabilities can lead to more inclusive design and the creation of better buildings, according to research by **Kim Hutton**

Kim Hutton vividly remembers the day she checked into a hotel to be told that it was nearly full. "The only room we have available is an accessible one," the receptionist told her. "Is that a problem?" Kim was, she recalls, taken aback by the question. "I asked why it would be an issue for me. It must have been the stigma associated with the grab rails and the wet room." The incident focused her thoughts on the importance of design and how vital it was to make aesthetics so universally appealing that adapted rooms and other facilities were not seen as special designs at all.

Now, as a highly experienced neuro-physiotherapist and the founder of the training and research consultancy Human Connections, she's taken this agenda forward in a drive to make the built environment as inclusive as possible. Kim has written a paper, following her Master's degree in Human Factors at Loughborough University, examining how 'empathic modelling' can positively influence the empathy that architects have and how it informs their inclusive design thinking. She discussed her work during her presentation at the recent CIEHF Ergonomics & Human Factors Conference in April 2021.

Kim's background is fascinating. A chartered physiotherapist, she also specialised in paediatrics and worked for many years at London's Great Ormond Street Hospital. She also carried out neurological training, discovering the brain had a huge capacity for positive change following injury. Her university work concentrates on human factors. "It's a discipline where you bring science, engineering and humans together," she says. "My whole career has focused on how people can be the best they can be and how they interact with their environment. I thought my medical background would align well within the field of human factors."

She has a particular interest in breaking down exclusion barriers. "We need to understand our differences and our similarities. I firmly believe that we've become very tribal. Everybody thinks that you are either able-bodied or disabled. That's not the case – disability is a continuum. You can be permanently disabled, temporarily disabled – for instance, coming back from a skiing holiday with a plaster cast on – or situationally disabled, such as when you have a child on one arm and you're doing everything one-handed. There are also times when people can become disabled purely through the environment they are operating in. Over the years I've seen a lot of patients facing barriers that were completely avoidable."

As part of her MSc studies, Kim decided to explore what architects knew about inclusive design. She quickly discovered that in many instances, they didn't receive any mandatory training, instead it was an optional module. "Yet they are the people building the world we live in. I wanted to let them spend time exploring the built environment in wheelchairs and let them experience what it felt like and the barriers they might encounter but it wasn't possible due to the pandemic restrictions."

Instead she designed what she terms an 'empathy toolkit', including special glasses from the University of Cambridge and arthritis gloves she created herself. Eight architects from one practice were invited to take part in the study. None of them were known to Kim so there was

IMAGE: SHUTTERSTOCK

Mimicking can stimulate that neural pathway and research suggests we may create a new neural map

no personal relationship that could have influenced the outcome.

The toolkit was designed to simulate loss of some visual ability, as well as loss of hand dexterity. Those taking part then performed common activities of daily living, as well as two design tasks. "I included tasks such as pouring cold water into a cup – though in real life of course, it could have been hot – as well as taking pills, writing a letter, filling in a form, looking at the packaging of a microwave meal and reading a medication leaflet."

Participants' empathy levels were measured before and after they undertook the tasks to see if the intervention made a difference. They were also interviewed afterwards to see what insights they had gained into their own design thinking. Due to the pandemic, the exercises were carried out remotely but the results, Kim says, were fascinating. "This was an online experiment with all the materials posted to those taking part. As I wasn't in control of the participants' individual environments I had to simplify the tasks to control the risks."

She created a fictional persona – a character called Brian, a 63-year-old male working in a design office who was becoming frustrated at always having to wear spectacles and who was developing arthritic hands. Using a validated scale, participants were asked if they could put themselves in his shoes. When the scores came in, she was amazed. The lowest increase in empathy was more than 13% and the highest nearly 75%. The average rise in motivation to help others was close to 40%.

"It was the simple things that really impacted participants. For instance, they couldn't take the little silver cover off the toothpaste tube and they couldn't read the correct dosage of paracetamol they should take. They also couldn't read the instructions to put a ready meal into the microwave and when asked to remove the packaging on a pad of yellow sticky notes, they found that they couldn't find the edges to open it. They were shocked that the simulated level of capability loss made them feel frustrated, angry and tired. They felt that they had lost their independence."

Participants knew that they could revert to 'normal' but the experience really made them think. "They were aware that they could take the glasses and the gloves off but that someone with a disability lived with their issues all the time. The experience did make them say that they would design 'with the senses' going forward."

With this particular study completed, what happens next? Kim says that it's encouraging that this research indicated that empathy can be influenced and can be enhanced through mimicking. "If we mimic something, we can stimulate that neural pathway and research suggests we may create a new neural map. Children are natural empaths. For example, if one baby sees another baby crying, he or she will want to go over and soothe it. But I think that as adults we need to reconnect with those emotions and keep our empathic pathways open. If we can learn through 'walking in other people's shoes', we gain insight and by doing that we become less judgmental.

"I found a lot of the comments that came through in the study were insightful, such as, 'I realised I normally work as an architect designing a building for the width and the access of a wheelchair but not for the person sitting in it'."

The exercise, Kim adds, also helped those who took part relate back to personal experience. "They may have had a grandmother who couldn't see and they said they knew now why she was so frustrated. They were also talking about how they would design in future with less glare and more colour contrast – simple things they can do in terms of design rather than retrofitting, which is really expensive."

Will it help them to change as architects? "Yes – in fact they already have. They've changed designs locally. And that really has been music to my ears."

Further reading

Hutton K & Maguire M, 'How 'Empathetic modelling' positively influences Architects' empathy, informing their Inclusive Design-Thinking', Contemporary Ergonomics & Human Factors 2021, presented at the CIEHF Ergonomics & Human Factors Conference in April 2021. See https://bit.ly/3i0jHpk

Keeping rail research on track

Unlike road driving, train safety at higher speeds has more to do with the physics at the interface between the wheel and the rail than the driver's skill. Overspeed events, where trains exceed their permitted speed, pose a significant threat to safety and are the subject of research by human factors rail specialist, **Nora Balfe**

The CIEHF's *Human Factors in Barrier Management* white paper was key to the project by Irish Rail to analyse the risk from trains exceeding their permitted speed on the national rail network. The consequences in such a situation range from passenger discomfort at the lower end of the scale to derailment, multiple fatalities, infrastructure damage and significant financial loss at the upper end.

Nora Balfe, a human factors specialist with Irish Rail, together with Ken Byrne from Trinity College Dublin and independent human factors consultant and lead author of the white paper, Ron McLeod, examined the risk using the bowtie analysis method, with a structure inspired by the approach in the paper. Nora discussed the team's experience at the Institute's recent Ergonomics & Human Factors Conference.

Irish Rail traditionally monitors overspeed trends on the network using handheld radar guns. But data is increasingly being collected via automatic detection of overspeeds through monitoring systems that are both train-borne and trackside. Thanks to this information, there's an increased desire to better understand the associated risks and how they are controlled.

In recent years, Irish Rail has recorded multiple but decreasing number of overspeeds: ten in 2017, eight in 2018, nine in 2019 and four in 2020. Internal safety investigations have generally identified train driver performance as a causal factor.

Currently, the Irish railway network does not have widespread automated support to help drivers avoid or recover from overspeeds. Therefore the need to evaluate the controls currently in place and how these could be improved was identified. A bowtie analysis was chosen as the best form to do this. "It was new for us, and was a steep learning curve," Nora said.

"Initially we were attracted to the approach by the more accessible visual output compared to traditional risk assessment methods, and this was a real benefit, but so too was the clear linking of barriers to threats, and degradation factors to controls. I also like the way human error is treated as a degradation factor rather than threat in the bowtie. The outputs, particularly the barrier management plan, have been more beneficial than a traditional risk assessment which could just sit on a shelf once it's complete."

Irish Rail was also keen to avoid issues that can limit the quality of bowtie analysis, for example, treating human error as a threat, allowing the analysis to be dictated by the functionality available in commercially available software tools and focusing on drawing bowtie diagrams before giving adequate consideration to the nature

and characteristics of the risks and controls involved. A working group was put together with expertise from across the organisation. This included train drivers, driver competence managers and operational managers; civil engineering, responsible for designing, building and maintaining the track infrastructure; safety managers, responsible for implementing and auditing rules and procedures; and, of course, human factors specialists.

The analysis was initiated and planned to be carried out in early 2020, based on face-to-face training and workshops held on Irish Rail premises. Restrictions imposed by the Covid-19 crisis however, required the approach to be re-planned such that it could be carried out remotely. This process was obviously unusual and so offered the opportunity to learn from new ways of working and potentially make changes for future studies.

"The main challenge posed by Covid-19 was of course that we couldn't run the workshops live," explained Nora. "This meant that the work that might have been done in a two-day workshop was instead spread over shorter Microsoft Teams meetings over five weeks. There were all the usual challenges with doing something like this remotely, for example, it was hard to gauge how much the working group was following the ideas, and some people are more willing to contribute in that environment.

"We overcame these issues by having multiple shorter meetings and breaking the work down in a structured way. People were asked to do 'homework' and contribute it in advance of the main meetings."

The analysis used worksheets to capture, document and evaluate information generated at each stage before drawing bowtie diagrams. The definitions of control types defined in the white paper were adopted including barriers, key safeguards and safeguards. Full barriers were required to satisfy the six quality criteria in the paper: "Having clear ownership, being traceable to the HSE management system, and being specific, independent, effective and capable of being assured."

The results of the analysis were represented in two formats, an Excel workbook containing the full analysis in tabular format and a series of hierarchically organised bowtie diagrams showing progressively more detail. Bowtie diagrams provide a visual representation of the risk space, and how it's controlled, in a way that's easier to understand than a textual or tabular representation. Because different users of the analysis need different perspectives on the risk, diagrams were presented at three levels of detail. The first was an 'at-a-glance' summary of the entire risk space on a single page. The second consisted of expanded diagrams of each of the threat and consequence lines, showing the degradation factors and the number of safeguards protecting each control. The third included diagrams showing the safeguards protecting each of the controls against degradation.

Nora Balfe

The analysis produced a comprehensive picture of the threats that must be managed, the consequences that could result, and the controls, both in existence and under development, that must be managed to control the risk of overspeed events.

A real benefit of the bowtie approach was the clear linking of barriers to threats and degradation factors to controls

Several of the concerns with the treatment of human factors in bowtie analysis documented in the white paper arose during the analysis. For example, the working group was initially keen to capture human error as a threat (reflecting the tendency of investigation reports to identify the immediate cause of an overspeed event as human error). This was overcome with the help of Ron McLeod as facilitator and the group became convinced of the contradiction of designating the human elements, (predominantly the train driver in this case), as both a threat and a control for overspeeds.

The clear guidance from the paper was judged to provide a valuable structure, so much so that by the third meeting, the working group was confident in identifying controls and degradation factors for inclusion in the final bowtie.

"The entire analysis was structured around the approach in the white paper," Nora said. "It was a great reference source for those working on the project and it gave confidence that we were following a recognised method for constructing a bowtie."

Further reading

Balfe N, Byrne K & McLeod R, 'Applying barrier analysis to overspeed events in rail operations', Contemporary Ergonomics & Human Factors 2021, presented at the CIEHF Ergonomics & Human Factors Conference in April 2021. See https://bit.ly/3hzgKgJ

Download your copy of *Human Factors in Barrier Management* for free at www.ergonomics.org.uk > Resources > Publications > Barrier Management

Obituary

MICHAEL GOOM

1948 - 2021

A jovial, highly-skilled engineer whose research, practical application and achievements helped human factors to become an integral part of defence projects

In 1970, after graduating from Loughborough University, Michael Goom joined the Research Department of the Guided Weapons Division at the British Aircraft Corporation in Filton, Bristol (currently MBDA). He joined the then fledgling Human Factors Group who were investigating the interactions between the operator and the emerging weapon system technology.

Immediately he became a popular and reliable member of the team working on vision research in the military environment, examining the performance of aircraft optical sights and the newly arrived electro-optical systems and head-up displays. In one trial, a whole helicopter cockpit was mounted on a three-axis vibration rig to test the system in a realistic environment.

Most guided weapons systems at that time required the operator to both visually track the target whilst simultaneously issuing commands to the in-flight missile to guide it towards the target. Initial studies investigated and optimised the shape and sensitivity of the joystick commands to ensure that the operator had precision control of the missile whilst both tracking the target and being under attack. This was a recurring topic of some of Michael's work on later projects with the choice of the manual control input depending upon the position of the operator sitting, standing or lying prone when using it.

Michael made a significant contribution to the development of the Rapier anti-aircraft system that was initially developed as a static system to defend friendly troops against air attack in a presumed cold war engagement between Soviet and NATO forces on the north German plains. This was a manually tracked and guided system so considerable attention was given to design of the various visual displays and controls to ensure good performance of the operator, the avoidance of friend-on-friend fire, and therefore the whole system, whilst in the hostile environment of a battlefield.

During his early work on this project Michael was instrumental in persuading the Ministry of Defence (MOD) to incorporate the MANPRINT (Manpower and Personnel Integration) philosophy into weapons system requirements. This was to ensure that the system requirements focused on the needs and capabilities of the human operator.

Colleague Peter Michael said: "Michael's sense of humour combined with his common sense, practical approach saw us through many of the trials and tribulations of demanding experiments. He was a pleasure to work with, steady during work and always jolly when the day was done. But his greater contribution to ergonomics lay in his relationship with the everyday good engineers through to their most senior managers. A rare tact is needed, combined with a good jovial nature to tell an engineer that he had designed a scale back-to-front, or that a soldier under stress could not always remember an accurate bearing whilst scrambling back into his armoured vehicle, or lift many kilos of equipment wearing full NBCD [Nuclear Biological Chemical Defence] kit. Michael had this tact; it was a natural part of his style, never forced or insincere, just natural. Where feasible he would undertake physiological measurements to back his words by experiment, by measuring soldiers' heart rate and energy expenditure during simulated deployment trials to prove his point."

Michael was among the pioneers in making ergonomics become an integral part of the design process

Peter continues: "Michael was the all-round ergonomist, even coming up with an answer to the most difficult question "How

strong should a plug and cable be if a soldier uses it to climb onto his armoured vehicle?" In those days there were few manuals to guide you and any ergonomist would have to fly by the seat of their pants to come up with a credible, workable answer. This was Michael's strong point and he was among the pioneers in making ergonomics become an integral part of the design process, and he took these skills into mainstream engineering."

A particular challenge was that some weapons systems required more inputs than the operator could generate by using hands and eyes only. Extra input sources were needed and so attention was given to using the orientation of the operator's head as an initial system input. This was achieved using a special helmet worn by the operator to measure and define directions. This was a particular challenge on the human factors front.

A later development of the system was Tracked Rapier where the complete weapon system was mounted on the back of a tracked vehicle to give greater mobility, with the operator riding in the cab. Again the weapon system was manually controlled and had to be brought rapidly into full operation after riding over rugged terrain. Michael conducted experiments to observe the effects of the vibration exposure and operator recovery time, post-exposure.

The cab environment could be a harsh one for the operator exposed to noise, flash and vibration from the close proximity of the missile at launch, whilst also guiding the missile onto its target. Flash and noise protection was essential for operator protection. The system was also expected to work under conditions of tactical nuclear warfare with the operator in full NBCD kit and possibly exposed to the effects of nuclear flash. How long would recovery take? This was all part of the design equation; crucial questions that Michael helped to research and answer.

On a more mundane level, but equally important to the soldier, was the climate control of the cab. This was not a simple technical issue for an all-weather military vehicle but one which had to be traded off against the adverse effects of the bulky cold weather kit needed to be worn in the cramped cab. How would this affect operator effectiveness?

These examples illustrate the wide scope of Michael's work to make the weapon systems that he worked on much more operator friendly and optimised for operator effectiveness in all military environments.

In 1991, Michael identified the need for a forum outside of individual contractual relationships where the MOD and its prime contractors could exchange information about the problems of integrating human factors into defence procurement, and in which they could work together to resolve them. He invited major defence contractors and the MOD to an inaugural meeting, where it was agreed to set up what was to become the MOD-Industry HFI Working Group, with Michael as chair.

Around this time, John Harrison was proposing an innovative layout for a new ship's Operations Room, on which Michael worked and remembers: "Mike's group had invested in the JACK anthropometric modelling tool and worked with us to help visualise key events like watch handover. We were pushing the technology to its limits and Mike's practical approach helped us to produce useful results. Mike was the supreme pragmatist, always seeking to bring abstract ideas down to earth and to turn vague questions into practical things that could be done. He was also one of those people you could easily get on with – a valuable asset in a cross-disciplinary area like human factors."

Michael joined the Ergonomics Society (as the CIEHF was then) in 1972 and deservedly became a Fellow in 1995. Seven years later, in 2002, Michael was awarded the Institute's William Floyd Award for his outstanding contribution to human factors, for which he was very proud.

Outside of work, Michael was keen on woodworking and model engineering, he was a volunteer at Westonbirt Arboretum and an enthusiastic bell ringer. His model engineering talents can be seen in his written report into how he built a trebuchet (a medieval mechanical rock thrower) in 2016: see page 12 of his local engineers' society newsletter: https://bit.ly/MGtrebuchet. Last year, Michael used his 3D printer to make face masks for NHS workers, using his skills as an engineer to help the cause.

He died peacefully at home in April aged 72 and leaves his wife, Barbara, their two children and three grandchildren with happy memories of a brilliant, fun-loving and gentle man.

Thanks to **Peter Michael, Trevor Chambers, Richard Cook, Paul Bonnel** and **John Harrison** for their valuable contributions.

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Phil Burt is an experienced physiotherapist and bike fitter, having spent 12 years as the Head of Physiotherapy at British Cycling, and 5 years as Consultant Physiotherapist at Team Sky. After a long career supporting the world's best at three Olympic Games and seven Tours de France, Burt is now concentrating on using his expertise to help cyclists at all levels to improve their health, comfort and performance.

Joseph Giacomin, Brunel University London
Automotive Habitat Laboratory: overview of insights

Co-design challenges arising from the driving context and from the workings of human memory are discussed, as are strategies for properly embedding the human characteristics involved into the design process

Joseph Giacomin is a professor of Human Centred Design at Brunel University London. He has produced more than 120 publications including the books 'Automotive Human Centred Design Methods' and 'Thermal - seeing the world through 21st century eyes'. He is an editor of Ergonomics and the International Journal Of Vehicle Noise And Vibration.

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The conference is organised by the Chartered Institute of Ergonomics & Human Factors, and with the support of ComfDemo under the European Union Horizon 2020 Clean Sky 2 programme (No 831992)

Obituary

SHEILA LEE

1928 - 2021

A confidence and conviction to push ahead enabled much achievement as an osteopath, ergonomist, teacher and actor, despite shattering setbacks.

Sheila Lee was born in 1928 in Kenilworth, Warwickshire. After school and a brief period in the accounts department of the Rover Car Company, Sheila decided to follow her dream and go into the theatre. She played in repertory work at many theatres sometimes with big names, among them Lawrence Olivier. As her career developed, she became an early actor on live television and also moved into films. She played opposite Michael Crawford in *The Checkered Flag* and, in *Village of The Damned*, opposite George Sanders.

While still in the theatre, Sheila met her future husband, Robert, and they were married in 1967. The arrival of children, two sons, meant that Sheila's acting career was put on hold while she focused on family life. But this idyll was cruelly cut short in 1971 when Robert passed away while riding a horse in Richmond Park.

At that moment, Sheila demonstrated her true strength, courage and resilience. Although her life was shattered, she had to find a way to support her family. Within months she had a job as the drama teacher at St Anthony's school in Hampstead. She wrote plays for the children and was a popular teacher. She also founded the Hampstead Players, an amateur group, and directed many plays performed at Hampstead Parish Church.

Sheila also turned to a new path – osteopathy. At the time, osteopathy was still struggling for legitimacy, possibly as a result of the Profumo Affair. Sheila became a leading light at the British School of Osteopathy (BSO, now the University College of Osteopathy) and was instrumental in pushing for the legislation that fully legitimised the profession, taking it from the side-lines to mainstream medical practice. There are endless stories of Sheila curing problems that her patients had lived with for years. She truly was a very talented osteopath. She also discovered she loved teaching university students and she enriched her osteopathy classes with case studies from her professional practice. It was the beginning of her recognition that the causes of injuries needed to be addressed, else the injuries would just recur. So began her interest in ergonomics.

In 1982, Sheila visited a pub in Cricklewood to hear a live jazz band playing. Prominent in the band was Dr Stephen Pheasant who, it turned out, was a lecturer in anatomy at the Royal Free Medical School and a practising ergonomist. As an osteopath, Sheila had a very good knowledge of and interest in anatomy and was curious about ergonomics. The two met at the interval and so began Sheila's second major relationship and love. She and Steve were very much on an intellectual plane and were to remain together until his untimely death in 1996. They developed teaching and instructional material together, both for osteopathy students at BSO and for ergonomics students at UCL. Many of those students will remember learning from Sheila about exercise and movement to prevent work stress and injury. Her particular interest was in musculoskeletal injuries related to work; she lectured extensively on the subject and had articles published in a number of journals. In addition, Sheila collaborated with Steve in writing a tract entitled *How Not To Have Back Pain*, and she contributed to a section for his book, *Ergonomics, Work and Health*.

After Steve's death, once again Sheila's indomitable spirit shone through. She became a Consultant Ergonomist and carried on Steve's ergonomics work, taking part in 80 legal cases, giving expert opinions in writing and on occasion, in court. She initiated the founding of the Stephen Pheasant Ergonomics Library at the BSO, and she founded the Stephen Pheasant Memorial Fund to preserve and continue his intellectual contributions to the ergonomics community for the benefit of students in their ergonomic studies. Reflecting Steve's passion for broadening understanding of the role of ergonomics in everyday life, the aim of the Fund is to promote the science of ergonomics and its impact on people's health and wellbeing. Sheila recruited a team of Trustees who share her professional focus and who continue to administer the Charitable Trust today. Her son Tom has now joined as a Trustee to continue her good work in this area.

Sheila was instrumental in pushing for legislation that fully legitimised osteopathy

Sheila passed away on 5th February 2021. She is survived by her two sons, Tom and David, and five grandchildren.

Thanks to the trustees of the **Stephen Pheasant Memorial Fund** for providing this information.

Further reading

https://spmf.ergonomics.org.uk/fund.shtml

Supporting children's home study

The CIEHF has published a new short guide intended to help parents and carers support children of all ages in studying from home. It gives advice about encouraging the development of good habits into adulthood through improved posture, movement and exercise, awareness of ergonomics, comfortable furniture and environment, and responsible use of technology.

The guide, *Healthy and Happy Home Learning: A guide to children's ergonomics* is available to download now from the Institute's website or from **https://bit.ly/ChildrensHomeWorking**

A sad goodbye

Long-standing member Hugh David, always a great supporter of our conferences and whose interest was mainly in air traffic control, has sadly passed away. An obituary will be published in the next issue.

Countdown to a fresh new look

We're very excited to announce that we have a new publisher for *The Ergonomist*! After five years with Redactive, we're moving to Connect, our communications partner for the past two years, who have won the competitive bid for the work. Not only does it mean we can look forward to a closer relationship with Connect's great team, but *The Ergonomist* will get an exciting new design!

The benefits don't stop there. Contributors will not only see their work more engagingly and creatively published in the magazine but also, where appropriate, in a variety of ways across a number of different communication channels.

Packaged up in the deal is access to Connect's commercial expertise so advertisers can look forward to some great deals in *The Ergonomist* and across other channels, enabling them to reach a wider and more diverse audience.

We'll be revealing the new design later in the year in our move with the next issue to a thicker magazine.

In the meantime, we'll keep you up to date with all the latest news and information through our monthly eNewsletter, *Think*, our member emails and of course, our social media channels.

A great way to spend an hour

Do you sometimes feel like you're the only one facing human factors challenges where you work? Or having trouble finding support (or even an open ear!) for the implementation of change? Then come and find out from a chat with other members that you're not alone.

Hour-long Regional Network 'meet-ups' started out during the pandemic as a substitute for in-person member events but have now developed a life of their own. So far we've had nearly 30 of these online via Zoom this year and have covered a lot of ground, from agriculture, car parks and historic buildings to undergraduate studies and military clothing, to name just a few. All in a friendly and very helpful atmosphere where everyone can speak up, share their experience or ask questions.

If you haven't attended a meet-up yet or would like to give a short talk on a topic that fascinates (or puzzles) you, please feel free to contact me or your Network leader. You can see an overview of the Regions and upcoming meet-ups on our website (Get involved>Regional Networks). Members are invited to talk for 5-10 minutes and start a discussion. This allows others to learn from other sectors, see what worked or didn't work and see issues from another perspective. Many members have said it's a great way to spend an hour.

Scheduling international meet-ups is not so straightforward, but we're keen to expand the Networks so if you're based outside the UK and would like to get involved, please get in touch.

If the time difference or other commitments make it difficult for you to join in, please remember that you can always connect with other members in our online discussion forum, Communities. It thrives on sharing and helping each other, and by asking a question in the forum you'll help others to get answers too. Did you know that many of the great topics for our webinars and publications were first discussed in the Open Forum? If you have any thoughts on which topic should be covered next, don't be shy – start a discussion!

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

TOWERGATE INSURANCE
PROFESSIONAL LIABILITY

Our policy for members of an association provides a variety of cover in one product, so there's no need for you to purchase a portfolio of different policies to ensure you are protected against various possibilities.

Professional Liability insurance

We understand that things don't always go to plan, no matter how diligent you are, and it's also important to remember that you don't have to have done anything wrong, all it takes is for someone to allege that you have and you may need to defend yourself.

If you ever find yourself in this situation, without an extended Professional Liability policy in place you could be faced with paying substantial damages and having to fund expensive legal fees yourself. Our insurance protects you against the expense and worry associated with legal action taken against you.

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Legal Expenses - this gives you access to a Free 24/7 Legal Helpline, Pre-Hearing Representation and Fitness to Practice Hearing Defence, and cover to pursue and defend your legal rights arising from Contract Disputes or HMRC Tax Investigations.

Markel Law Hub - to compliment the legal advice line, you have access to the Markel Law Hub, an online resource of expert legal and business guides, templates and content, provided by Markel Law LLP.

Main Exclusions*

- Deliberate or reckless acts
- Legal costs and expenses incurred without or prior to our consent
- Liabilities that should be more specifically insured elsewhere for example Employers' Liability

*Other exclusions apply, please contact us for details.

Cyber Liability insurance

With cyber-attacks becoming ever more widespread and sophisticated, you need to be sure you've got the right protection. What would you do if your business suffered a data breach? Have you got cover for reinstating data? If you're subject to a regulatory investigation, are your costs covered?

A number of factors in the day to day running of your business can contribute to data breach – such as lost paper records and ransomware attacks to name but two.

Cyber Liability insurance can give you protection against cyber security risks:

- Data recovery in the event of a security breach
- Dedicated cyber security advice against the latest digital threats
- Protection against the theft of your intellectual property in the event of a cyber-attack

Health & Safety

Towergate are always on the look-out for services which complement the professional liability policies we provide to you. We have teamed up with our partner, Ellis Whittam, to provide you with unlimited access to a free Health & Safety and Employment Law/HR portal where you can find up-to-date advice and resources, including Risk Assessment tools to help you understand how well your business complies with your legal obligations.

For the **Risk Assessment Template**, visit https://www.towergateinsurance.co.uk/media/6859002/towergate-insurance-risk-assessment-template-working-in-other-peoples-homes.docx

The risk assessments will provide an insight of your current Covid compliance levels and highlight any gaps or areas requiring additional measures. Ellis Whittam are available to discuss pragmatic solutions and are offering you a free online consultation, co-ordinated via ourselves.

Why we partner with Ellis Whittam

Towergate enjoys a longstanding, trusted relationship with Health & Safety, Employment Law and HR specialists Ellis Whittam, who help the sectors reduce operational risk. They are highly qualified dedicated advisers who help protect client's wellbeing and safety while providing organisational peace of mind.

Towergate have a team of in-house specialist advisers who understand that every customer has different needs and concerns. Speak to our team on **01438 735 251** or email **new.pro.liability@towergate.co.uk**

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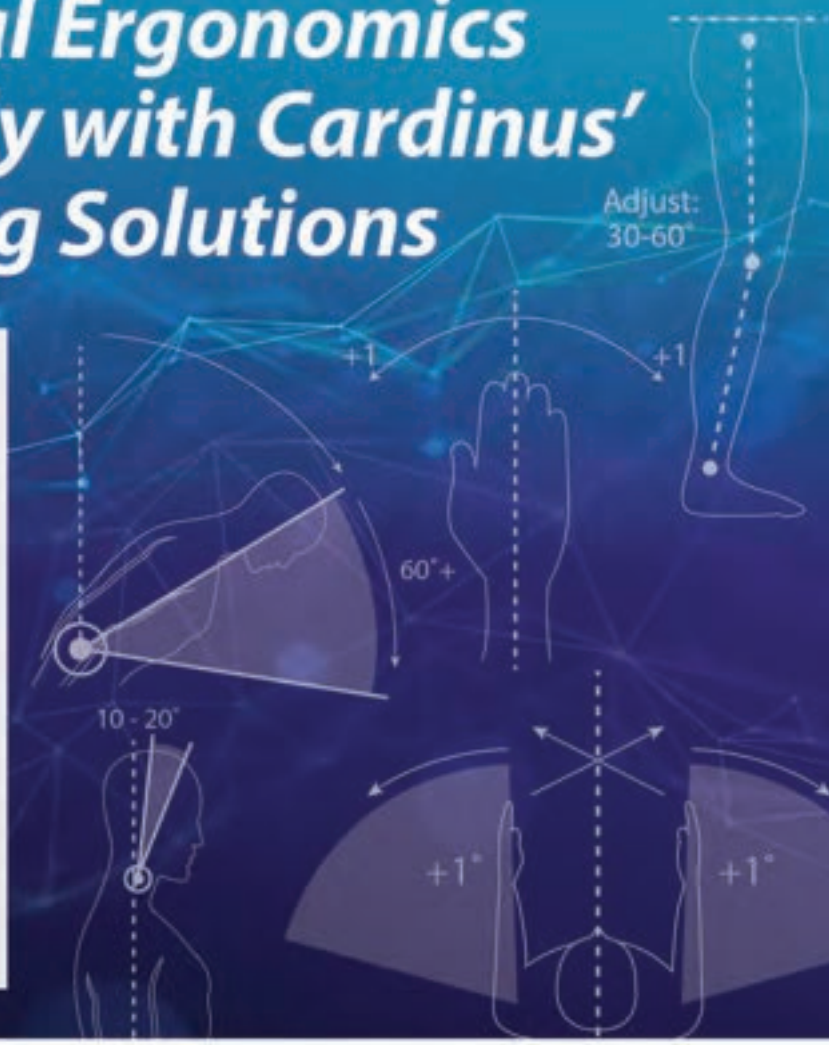

Bring home, office, lab and industrial ergonomics together in one programme.

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THE Ergonomist
ergonomics.org.uk
Bringing human factors to life
No. 586 December 2021

Climate of change

How we can help businesses embrace the green revolution

CRA
RISK & SAFETY CONSULTANCY

Vacancies

Senior and Principal Human Factors Consultants

Company	**Corporate Risk Associates Limited (CRA)**
Location	**Ideally South-East or North-West England based staff**
Terms	**Permanent, full-time**
Remuneration	**Highly competitive salary and comprehensive benefits package**

CRA is an integrated Risk, Safety, Security and Human Factors consultancy and has provided a range of services to Critical National Infrastructure based clients for over 20 years. Since 2020 we have been part of the Assystem Group, a global provider of engineering, digitisation and Systems Engineering services to the pharmaceutical, transport, civil, regulatory, power and renewables sectors.

We are seeking to employ Senior and Principal Consultants on a permanent basis to work with our expanding Human and Organisational Factors team, joining CRA during an exciting phase of growth.

As part of the wider Assystem Group, you will have the opportunity to work on a wide range of projects in the safety critical domains.

Primarily working in the civil nuclear and defence industries with opportunities to support the development of capability into other safety critical sectors. New build and energy transition projects provide long term opportunities.

This role requires a highly motivated individual who will excel at technical work and support business development activities with both new and existing clients.

You will be passionate about strong client engagement and interaction based on our core values of Quality, Leadership and Integrity.

In addition to flexible working options (home and CRA offices), you will be willing to take advantage of opportunities to work with our clients on-site within the UK and internationally.

You will be part of a growing and progressive team that offers excellent flexibility and will encourage your professional development and consolidate your career prospects.

Essential Requirements

Degree qualified (Bachelors, Masters, Doctorate) in Ergonomics, Human Factors or Occupational Psychology.

Chartered Member of CIEHF (or eligible to achieve).

Demonstrable experience in the successful application of Human Factors methods in high-hazard sectors.

Strong technical and commercial Project Management skills, preferably with experience in a dynamic consultancy environment.

Ability to provide effective mentoring and technical oversight to early-careers consultants.

High level of IT proficiency, computer literacy, MS Office Suite.

Ability to think intuitively and creatively.

Strong inter-personal skills with demonstrable ability to work within multi-disciplinary teams.

Excellent report writing and presentation skills.

Commercial awareness and ability to persuade and negotiate.

Ability to achieve necessary UK security clearance.

Willingness to travel within UK and overseas.

Desirable Requirements

Experience in consultancy environment.

Experience of business development including identification and development of prospects and proposal writing.

Experience of Human Factors integration in large multi-disciplinary engineering projects.

Experience in the application of human error analysis techniques within high-hazard industries.

Knowledge of safety case principles and their application within regulated industries.

Experience within the defence and civil nuclear sectors.

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For a confidential discussion regarding this opportunity, please contact James Amende
email jamende@crarisk.com | phone +44 7852 826291

CRA
RISK & SAFETY CONSULTANCY

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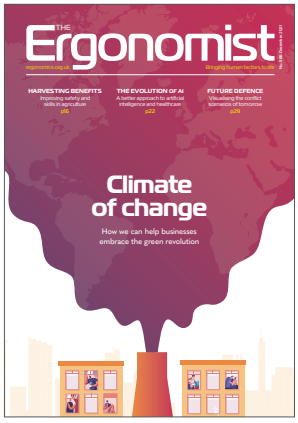


COVER IMAGE: Shutterstock

Briefings

CIEHF AGM

Chartered Institute of Ergonomics & Human Factors

NOTICE OF ANNUAL GENERAL MEETING

The CIEHF's AGM will take place at **17:15 on Monday 11 April 2022** by webinar for the following purposes:

- To receive the minutes of the 2021 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
- Council Members (trustees)
- Professional Affairs Board Members

Nominations are sought from Technical Members for the following position:

- Technical Member Representative on Council (trustee)

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 **25 February 2022**.

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 **11 February 2022**. The current General Regulations can be found at **www.ergonomics.org.uk > About us > CIEHF Documents**

RESEARCH ROUND-UP

Pain, pilots and the problem of PPE

The effect of activities such as walking or assembly line work that involve upper body movement are explored in new research revealed in the journal *Ergonomics*. It's the first time a single study has explored how these tasks affect back pain, spinal angles and balance in older women.

Researchers discoverd participants experienced more back pain and greater upper-spine flexion following 30 minutes of walking and standing with trunk rotation. But there was no impact on balance, suggesting there wasn't an increased risk of suffering a fall. Read the research at **bit.ly/upper_body_tasks**

A study into the effect of real-time auditory feedback and dynamic workloads of the performance of remote pilots has also been published in *Ergonomics*. It found auditory feedback improved decision-making under low and moderate workloads, but reduced it under high workloads. These results could help practitioners looking at sensory deprived working environments. To read the full study, visit **bit.ly/auditory_feedback_pilots**

The problems of poorly fitting personal protective equipment (PPE) are revealed in *Applied Ergonomics* in a study which surveyed 248 healthcare workers. It's thought to be the largest targeted survey of its kind and more than 55 per cent reported being hampered in their role because of the equipment. There were also significant sex difference, with less than a third of women felt safe in their roles during the pandemic compared to more than half of men. Read the full study at **bit.ly/PPE_fit**

Members can enjoy free journal access by logging into our website and visiting **My CIEHF > Research**.

Pharma manufacturing in the spotlight

Eager to realise valuable business, quality and safety performance at similar levels of improvement to that of the energy and aviation sectors, pharmaceutical companies are adopting human performance within their operations. But the industry context and regulatory environment has proven the adoption of human performance principles and practices to be challenging and complex.

To discuss this and give perspectives on human performance adoption value, successes and challenges, the CIEHF's Pharmaceutical Sector Group's manufacturing sub-group gathered online at the end of October for an engaging webinar. Amy Wilson from Biogen, John Wilkes from AstraZeneca, Cliff Berry from Takeda and Jim Morris from NSF shared their experiences. Talks and discussion focused on the human-centred approach to work, integration into existing systems, how we need more expertise, wider sharing of best practice and collating a common vocabulary. There was also discussion about 'getting out of our own way' - how status quo thinking and a desire for quick fixes limits progress.

To watch the webinar recording on-demand, visit **https://youtu.be/K5bimykwuD0**. If you'd like to know more about the Pharma Sector Group, please email us at **ciehf@ergonomics.org.uk**

"The new year promises many new challenges and opportunities for our profession and I truly believe that 'our time has come'. "

Chris Ramsden p6>

CONFERENCE 2022

How will you be involved at EHF2022?

There's still time to submit a short paper for the Ergonomics and Human Factors 2022 conference.

The annual event brings together professionals from around the world to share insight and ideas and learn about the latest research and thinking in our discipline.

The 2022 conference in April will be a mix of online and in-person events and we'd love to hear about your work and your views.

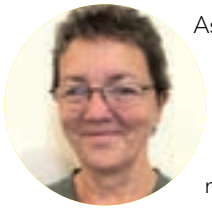
Short papers can highlight the application and impact of human factors and ergonomics, shine a spotlight on a short case study or maybe reveal early results or work in progress.

The two-page submissions can be sent using the downloadable template available on our website – **conference.ergonomics.org.uk** – and the deadline is 14 January 2022.

It's a great way to get feedback, advance your career and showcase your work to potential collaborators. Don't worry if you've never submitted a paper before – please just get in touch with us with any questions at **conference@ergonomics.org.uk**

FROM THE EDITOR

A transformative year



As you'll have seen by now, *The Ergonomist* has undergone a transformation and now has a bright new look and feel! We've changed publishers and are now delighted to be working with Connect, who also design many of our other publications. With more pages and a larger variety of content, we hope you'll enjoy this issue and, as always, we welcome any feedback.

With COP26 just finished, the spotlight is now firmly on how governments and organisations will respond to the increasing demand for urgent action to counteract the escalation of global warming. Can ergonomics make an impact? Can its principles, tools and techniques be used to make a difference? In our cover article, Barry Kirby explains how 'climate ergonomics' can help businesses adapt and embed sustainability into their processes and practice. Murray Sinclair argues in his article that "as a profession dedicated to humanity's interaction with the world, we have a duty to respond".

Julie Rainey helps us embrace the idea of bringing the outside in and living closer to nature through biophilic design. For those who time is spent outside, wide-ranging research into the work of farmers reveals insights into attitude, motivation and behaviour in one of the UK's most dangerous occupations.

In defence, we look at the emerging technology in human-machine interfaces and how they'll change the nature of conflict. And the use of artificial intelligence in healthcare is explained in an introduction to our latest White Paper.

A sincere thank you to everyone who has contributed to *The Ergonomist* in what continues to be a challenging year due to the pandemic. We've published a huge range of articles, guidance and thought-pieces on a variety of topics to showcase the incredible breadth of this discipline. I encourage all of you to use this magazine next year to share your work and thoughts with others – just contact me with your ideas!

Wishing you all a happy, healthy and peaceful new year.

Tina Worthy
Editor
editor@ergonomics.org.uk

PRESIDENT'S PIECE

Challenges and opportunities

I'm tempted to say that we're emerging from the pandemic but it would appear that there's still a long way to go and we can expect further developments over Christmas and into the early part of the new year.

This means that the CIEHF's Healthcare Sector Group is being kept busy, not only providing the valuable guidance for healthcare systems and commissioners, but also updating earlier publications which have proved to be so valuable. Our work is recognised on a global scale and many of our publications have been translated into different languages and support international work.

As we approach the end of the year we can reflect upon many successes for the CIEHF, not only in publishing multiple white papers and thought leadership pieces, but also planning for the future with our successful bid to host IEA2027, the International Ergonomics Association's triennial conference. This is a tremendous achievement and a triumph for our Chief Executive Noorzaman Rashid who lead the work. It's also been gratifying to see his work recognised with national and international prizes, including the Best Association Leadership award at the UK Association Excellence Awards.

"Our work is recognised on a global scale and many of our publications have been translated into different languages and support international work."

However, I'm truly humbled by the commitment and tremendous support that we receive from the teams of volunteers who so generously give their time and skills to support the CIEHF in creating such an amazing body of work over the past year, often at very short notice. This involvement has supported the great work done by Tina, Iris, Ian, Amanda and Rachel at CIEHF Central and the dedication and commitment of our Sector and Special Interest Groups, task groups, Executive, Council and Professional Affairs Board.

Internationally we have seen the 'relaunch' of the Federation of European Ergonomics Societies following an administrative move from Strasbourg to Brussels with the CIEHF being recognised as one of the three founder members. Our continued involvement with the IEA and support for emerging human factors communities and organisations further strengthens the CIEHF's position as a global leader.

The new year promises many new challenges and opportunities for our profession and I truly believe that 'our time has come'. We end the year seeing the CIEHF on a sound financial footing with a growing membership and more active international engagement. I look forward to sharing with you the many new and exciting developments coming in the new year.

Many thanks to all of you for your continued support and for your work in making the CIEHF truly world class. May you have a very merry Christmas and a very happy and peaceful new year and above all, stay safe. I hope to see many more of you in person in 2022. ■

Our publications play an important role

Chris Ramsden
CIEHF President
president@ergonomics.org.uk

"Some of our other emerging priorities for 2022 include creating more links with international members."
Dr Noorzaman Rashid p8>

INTERVIEW

Robot intimacy?

An interview with Dan Chen

In an effort to prevent the spread of Covid-19, many hospitals, emergency departments and long-term care facilities barred family and friends from visiting coronavirus patients. Communication technologies such as iPads and telepresence robots have allowed patients to communicate with their loved ones, while social robots have been used to help combat loneliness for those in isolation.

Seven years before the Covid-19 pandemic began, designer and engineer Dan Kun-yi Chen created the 'Last Moment Robot' as an interactive art piece. The robot is a small, white, sleek machine designed to comfort users through its gentle caress and reassuring voice.

With Covid-19 and the growing trend of using robots in healthcare and caregiving, dying alongside a robot may be closer to reality than ever before. Although the Last Moment Robot was originally designed to be art, it raises questions about the meaning of intimacy and how our image of dying might change with technology. Mira Gruber, a human factors and cognitive psychology PhD student at the University of Central Florida, and Holly Yanacek, Assistant Professor of German at James Madison University, spoke to Chen to talk about his robot and its relevance during Covid.

What was your inspiration for your work on the Last Moment Robot?

For death, there is this ideal image of you surrounded by your loved ones. You have this mental model of how people should die. It's almost like a script that's being performed over and over again; it feels almost robotic. That's how I formed the idea of the Last Moment Robot. I was also thinking, what can

we replace humans with? As you can see with automated phone answering machines and self-checkouts, human labour is being replaced by machines. Can we replace humans in more extreme ways? What is the moment that we need someone the most? This moment is probably death. It's the most desperate situation in which we need human intimacy and connection. Can we replace humans with robots, even at this moment?

How did people react when they visited the exhibit?

In the first installation of the Last Moment Robot, I guided the participant into a room with fluorescent lights and a hospital bed alone, creating this intimate moment with the robot. The installation echoes the emotions of being alone and having that robot there actually gives them some sense of comfort. Even though they know it's not real, they project some sort of emotion onto the robot. The robot creates engagement, so it feels like someone is caring for them or even just paying attention to them. Once you get that physical pressure, when something is pressing on your arm, there's something psychological and chemical happening.

Most people come away with this sense of, "Wow, this is a little bit different than I expected".

What are your thoughts on the Last Moment Robot now that dying alone has become a real possibility during the Covid-19 pandemic?

Whether people use this kind of robot or not, I think having access to this tool is critical. Before Covid-19, I thought this type of robot shouldn't be produced, as it facilitates people being alone. But the way I designed the device, I'm not trying to make people think it's a real human. I purposefully designed the robot like a medical device so users can understand that they are projecting human emotion onto this device. If it can ease their emotional state, why not?

I also think the need for it is more prominent in the nursing community. The burnout rate for nurses was pretty high already and with Covid-19, the rates are even higher. There are stories of nurses who don't have time to hold people's hands in ten different rooms, so they had to let them die by themselves. Nurses don't have the time and mental energy to watch one person die and then go to another room and do it again. In situations like this, is something better than nothing?

What do you think your robots reveal about changes in the relationship between humans and machines in our very technological world?

I think humans are becoming more machine-like. We are imposing structures like key performance indicators, performance reviews, and ratings; everything has a metric. At the same time, machines are becoming more human-like because of AI and user experience design. It's almost like a reversal.

Watch the robot at **https://youtu.be/T8PNzA2S6EY**

CHIEF EXECUTIVE'S PERSPECTIVE

Another great year

I'm delighted to report that as we approach the end of my second full year as Chief Executive of the CIEHF we have matched the performance of last year and achieved even more in specific areas this year.

By the end of December 2021, we will have published and been involved in around 30 publications, guides, infographics and white papers. All of these have contributed to building our brand and presence in the UK and internationally. These publications, combined with an online programme of masterclasses, professional development sessions and practice-led sessions, have contributed to helping to recruit more than 300 new members this year.

As we move forward, we will look to complement these guides with higher quality research through white papers and, increasingly, we'll ensure that we share the impact of human factors, making a stronger case for our discipline. Please contact me directly if you're interested in developing a paper for publication.

Earlier this year, Courtney Grant and Sarah Sharples delivered a session focused on inclusion. Their presentation has been made into a guide that will be published soon on how human factors can enhance the delivery of equality, diversity and inclusion. For the first time this year, volunteers have helped to translate some of our publications into French, Spanish, Persian, Hindi and Bengali. This was hugely useful for our *Vaccinating a Nation* guidance, which sets out ten principles to support systems thinking when establishing a vaccination programme.

"As we move forward, we'll ensure that we share the impact of human factors, making a stronger case for our discipline"

Our Membership Manager, Iris Mynott, has been supporting our Regional Networks with online meet-up sessions. These have proved to be an extremely valuable channel for sharing ideas and building professional connections. If you'd like to give a talk about what you do to your Regional Network, please email Iris.

As we approach 2022 we can look forward to our first major in-person event, the EHF2022 Live conference to be held in Birmingham on 25-26 April. It will feature engaging discussions and a wide range of industry speakers, together with the Institute Lecture and Broadbent Lecture. I'll be honest, I really can't wait! Ahead of this on 11-12 April, we'll be holding EHF2022 Online where we'll hear talks on a variety of topics in research and practice.

In 2022 we'll also see the launch of our new membership database and website and a new learning management system, all helping to modernise how we communicate and deliver support for our members.

Barbara Haward will be leading an important review in 2022 of membership structures, which will help us to clarify our member grades and recruit more people who want to achieve Chartered status. Part of this exercise is also about bringing the domain of UX closer to the CIEHF.

Some of our other emerging priorities for 2022 include creating more links with international members and making a stronger contribution through our members to the International Ergonomics Association (IEA).

A new appointment of a Head of Learning and Development will contribute significantly to rolling out our programme of Learning Pathways and in helping us to identify more university courses we can encourage

REGIONAL NETWORKS AND THEIR LEADERS

- **Scotland:** Helen Vosper
- **Northern Ireland & Republic of Ireland:** Julie Rainey
- **North West & North West Wales:** John Lovegrove
- **North East England:** David Golightly
- **Midlands:** Fran Ives
- **Beds, Bucks & Herts:** Chris Avis and Zuzana Chin
- **South West & South Wales:** Joe Cook
- **London & South East:** Andy Buttery
- **Southern England:** Jo Davies

to apply for our accreditation. I'm in early discussions with members about creating some 'affinity groups' for women, BAME and LGBQT+ members. If you're interested in being involved, please contact me directly.

I'd like to take the opportunity to congratulate Laird Evans and Steve Harmer, co-chairs of our Defence Sector Group, for winning the IEA Human Factors and Ergonomics Prize this year for the group's contribution to the defence industry. Also to Patrick Waterson for winning the IEA/ Elsevier John Wilson Award which recognises major contributions to applied ergonomics in actual design of work, systems, technologies and environment leading to improvements in system performance.

I was delighted to win the Associations Excellence Award for Leadership this year and a HIROC-sponsored award at IEA2021 for my talk on Patient Safety. This honour should really be shared with Sue Hignett and our Healthcare Sector Group led by Paul Bowie, Mark Sujan and Chris Ramsden.

Last but not least, I'm pleased to announce that our President Elect, Alex Stedmon, has been awarded a Royal Academy of Engineering Visiting Professor role at Cardiff University. This is a three-year post, focusing on Future Human Systems: Experience-led Engineering, specialising in aspects of transport, security and symbiotic engineering. Alex will be working closely with colleagues in the Centre for Artificial Intelligence, Robotics and Human-Machine Systems and Human Factors Excellence. ■

Noorzaman Rashid
Chief Executive
noorzaman.rashid@ergonomics.org.uk

OUR YEAR IN NUMBERS

↑29%
Increase from 2020 in online seminars, masterclasses and professional skills events held

348
New members

36
Publications and infographics produced

7354
Registrations for online events

198
Accreditations awarded to individuals and organisations

26.2k
Downloads of publications

On the right track

Suganth Kumar reveals how the human factors team at Alstom is making a difference in the rail sector

Building of rolling stock in the city of Derby started in 1839, and at the Litchurch Lane Carriage and Wagon works in 1876. The historic site is now owned by Alstom following the acquisition of Bombardier Transportation in January 2021. The combined business is the UK's largest private sector rail transportation group, responsible for supporting around two thirds of the UK's rail fleet. It's also halfway through delivery of the UK's largest new rolling stock fleet: the 2660-car AVENTRA fleet.

Alstom has an established engineering and design process that's applied to every project. Human factors and ergonomics activities are designed to integrate into the engineering life cycle such that it adds most value at the right stage of each project. The current human factors team is a global team with a breadth and depth of experience ranging from human factors assurance of rolling stock and control centres to maintenance depots.

The team is organised into a core competency network with a group of experts in defined human factors topic areas. Their main focus is to sustain and develop expertise through active networking.

The human factors methods applied at Alstom have evolved over the years to consider new human factors research findings, advances in technology, learnings from previous projects and the realities of project implementation. Traditionally, human factors activities were focused on the passenger and the train crew, however the last decade has seen the scope widened to consider all users of the railway system, including the manufacturing crew, the maintainers, signallers as well as emergency services personnel. The ambition of the team is to provide an adaptive physical and cognitive environment for all users of the railway system.

One of the key approaches to realise this ambition involves the use of latest technologies. Virtual reality has been used to perform human factors assessments of the manufacturing crew, train crew as well as maintenance crew activities. The assessments cover a variety of tasks from signal spotting by the train driver to a maintainer removing a panel on the train roof. More recently, virtual reality has been used to engage with the customer and demonstrate design proposals, such as in a UK new build project where immersive virtual reality technology was used with a 3D IC.IDO Powerwall.

Technologies such as Heads Up Display (HUD) have been implemented by Alstom to present information to the driver in their line of sight. HUD is expected to minimise the need for the driver to lower their head to capture the information from the in-cab displays. Real time human factors testing was performed on a fleet of trams in Nice, France, to evaluate the impact of the HUD on driver safety performance and satisfaction.

Present human factors assessments are very much reliant on the availability of accurate 3D computer aided design (CAD) models to perform digital human modelling analysis. However, accurate 3D CAD models are sometimes not easily available, especially for retrofit rolling stock projects. To tackle this challenge, Alstom has used 3D scanning technology on the existing rolling stock to create new 3D CAD models which can be subjected to digital human modelling analysis. In addition to these complex technologies relatively simple solutions have also been used to facilitate routine human factors activities. Online platforms such as Microsoft Teams for end user testing and using a ruler embedded app to take measurements using a mobile phone camera are examples of such simple yet practical human factors applications.

Tram with HUD in operation in Nice, France

The core competency network ensures that learning points from different projects across regions are shared and integrated into the Alstom human factors activities. The return on experience process drives this agenda by going back to the customer after the product is delivered to obtain feedback. The Alstom Derby site is a key link in this return on experience process with a legacy of human factors assurance of over two decades. This places Alstom in full traction mode to deliver the benefit of human factors to all users of the railway system. ■

Suganth Kumar is a Human Factors Engineer at Alstom and a Graduate Member of the CIEHF.

Are you part of a human factors team that's making a difference? Get in touch with us at **editor@ergonomics.org.uk**

Taking climate action from the extreme to the mainstream

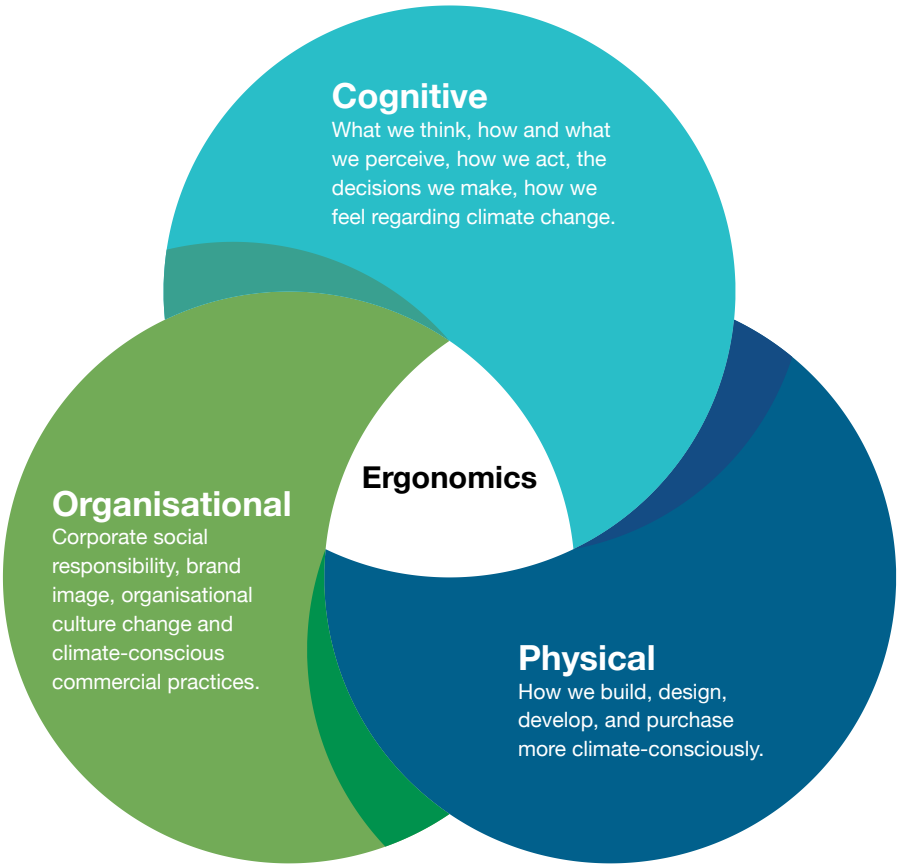
COP26 turned the world's attention towards climate change and the stark warnings about what could lie ahead for our planet. **Barry Kirby** explains why climate ergonomics could play a significant role in not only addressing the causes of the problem but also helping us adapt to a changed environment of the future

Climate change is the greatest human challenge faced today. It's unequivocal that human influence has warmed Earth's atmosphere, oceans and land.

Today's lifestyles and overuse of resources means that our planet's average temperature continues to rise, leading to environmental disasters such as the destruction of eco-systems, flash floods, fires, and droughts. As climate change is human accelerated, then logic would suggest that the solution should be human focused. To reduce the negative impact that humans have on our planet, substantial changes must be made to behaviour. Even if it is too late to restrict climate change, we as humans will still have to deal with the changing environment of the future.

Scientists from a range of disciplines are putting forward the notion that humans must change their ways if climate change is to be contained.

Many people have been calling for change, but there is a strong belief that this change is to be done by governments or big business as these organisations are able to make the most impact. Anyone calling for this type of change, on a personal basis, may struggle as they may not know where to begin, may not be able to afford to make more sustainable choices or may act radically or extreme when calling for action. Many businesses struggle >



Climate ergonomics operates within three main areas

to take the first step, especially when there are a numerous pressing business concerns such as paying staff, producing deliverables or performing work for a client. Fundamentally, many people recognise they need and want to do something, but simply do not know how or where to start.

Inspired by Professor Sarah Sharples in her CIEHF Institute Lecture in 2021, as well as the research paper I co-authored with Professor Paul Lewis and Sam Lewis about air pollution and behaviour change, I had a 'eureka' moment, realising that human factors and ergonomics could make a significant difference. As our field lies at the intersection of psychology, engineering and design, we can use 'systems thinking' approaches to make actionable and measurable change.

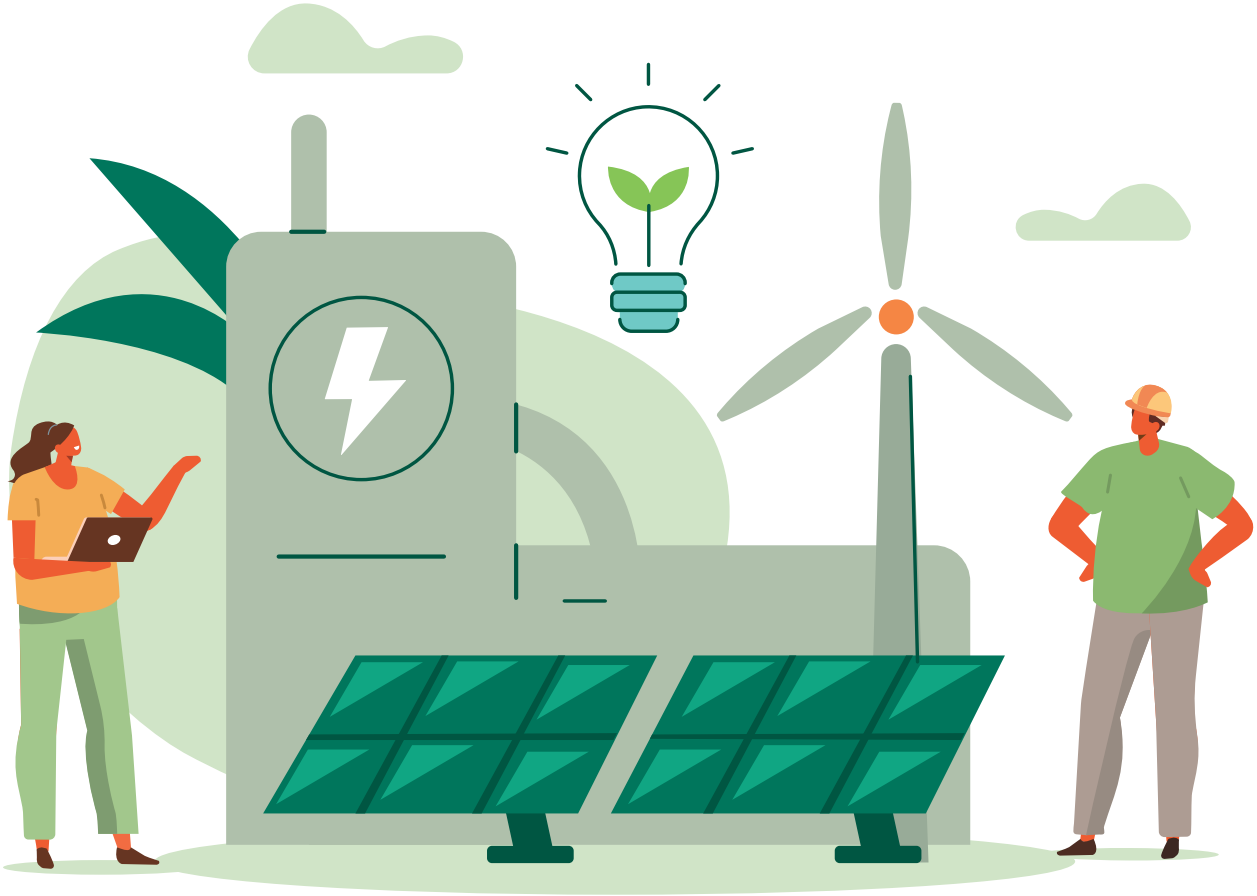
As such, human factors professionals have a unique perspective and approach to implementing and encouraging behaviour change and sustainable design. We are that discipline that encompasses the physical, the cognitive and the organisational. In many projects, we are the glue that holds multidisciplinary teams together. So surely this could be applied to the climate crisis because the problem is the same: there is a lot of great work out there but it's being done in silos. It needs to be brought out into the open, it needs a framework of delivery, it needs to be accessible, and best practice needs to be shared. In short, people need guidance. Not deep convoluted guidance, just a simple process to follow.

To that end, we started a conversation. We started many conversations. These included round table events, webinars, discussions with businesses large and small, with activists and pessimists, and with fellow human factors practitioners. We discussed what interventions into the climate change work are already happening today? What can be done? Where can we have the biggest impact? Why is it not being done already? What are the blockers?

The basics came down to four main points: the positioning of ergonomics, culture, social inequality and the application of methods and tools. Practising what we were preaching, we evaluated where would we have the biggest impact in the shortest period (especially given the COP26 activity) and we determined that business is the area of the highest impact and so we have focused on that for this initial guide, with a view to helping businesses plan and deliver their activity.

We're proud to have produced the CIEHF guide *Climate Ergonomics: Embedding sustainability into everyday business*. It brings a manageable process that an organisation of any size can use as a handrail for their

The new guide *Climate Ergonomics: Embedding sustainability in everday business*



sustainability journey. That journey starts with defining the organisation and understanding what's within the scope for assessment, be it a small micro business, a multinational organisation, or a department within a business. It encourages reflection on the level of influence of the person leading the effort within the organisation, exploring whether they have the right resources and mandate to do what needs to be done. Then it's about understanding what change could be made and evaluating the impact and costs to the business. No business can do everything at once, so there must be an understanding about which changes could bring the most impact for the right cost. Then we're into change management; picking a realistic number of changes to achieve, developing a timeframe, agreeing what 'good' looks like and then running with it.

We've been keen not to reinvent the wheel. This process is people focused. It needs understanding that behaviour change takes time, that we need to lead teams and organisations through it, making achievable targets, showing success, communicating it through the organisation and encouraging more of the same. The longer term aims of this endeavour into developing climate ergonomics is to define how we think of the environment and the sustainability of projects in our everyday working, and in the products and services that we interact with. In addition, it aims to stimulate research and development into sustainability and climate-based ergonomics. It's been highlighted that we have five years to make a real difference in the sustainability of our futures, therefore we need to do something rather than just talk about it. This guide will help industry to take the first step in encouraging behaviour change, to aid organisations in starting their climate conscious journey.

"As our field lies at the intersection of psychology, engineering and design, we can use systems thinking approaches to make actionable and measurable change."

The process must be a living process and we need to share best practice, so read the guide, talk about it, make it part of your everyday work, feed back how it can be improved to make it more accessible, start that conversation, make that first step. ■

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Barry Kirby is the managing director of human factors consultancy K Sharp

Embracing the green revolution

While human factors is well placed to help find solutions to issues surrounding climate change, how will the drive for more sustainability affect human factors practitioners and our discipline? **Murray Sinclair** takes a look at this important question

Unless we're able to create sustainable communities, the future for humanity and the world is bleak. As a profession dedicated to humanity's interaction with the world, we have a duty to respond.

Firstly, there has been the wide-spread adoption by nations of the UN's Sustainable Development Goals, with measurable progress in many countries around the globe.

Secondly, the domain of finance and banking is moving towards the adoption of environment, societal and governance (ESG) investments, with many big organisations adopting ESG policies – even the oil majors are moving in this direction.

The finance industry has noticed that investments in firms that have adopted ESG principles, while few in number, have produced better returns than the rest.

Furthermore, the EU independently has ratified the Sustainability Financial Disclosure Regulation which came into effect last year (EU-Sustainability-20 2020). So, Big Finance is on the move. What are the implications for human factors?

Well, consider the way these regulations are being expressed. There are three 'Scopes' that must show progress by organisations making use of bank loans or other financial instruments. In the words of the US Environment Protection Agency (EPA), regarding their own operations, these are:

SCOPE 1 GHG [greenhouse gas] emissions are direct emissions from sources that are owned or controlled by the Agency. This includes on-site fossil fuel combustion and fleet fuel consumption.

SCOPE 2 GHG emissions are indirect emissions from sources that are owned or controlled by the Agency. This includes emissions that result from the generation of electricity, heat or steam that are purchased by the Agency from a utility provider.

SCOPE 3 GHG emissions are from sources not owned or directly controlled by EPA but related to Agency activities. This includes employee travel and commuting, also includes those emissions associated with contracted solid waste disposal and wastewater treatment. Some Scope 3 emissions can also result from transportation and distribution losses associated with purchased electricity.

This means that, in the near term, progress can be delivered by incremental improvement exercises, tweaking the existing processes.

But this is not sustainable; within three years or so the supplier must carry out an overhaul of the processes, else fail.

Fairly swiftly, manufacturing organisations will have to embrace recycling; a circular economy is far more energy-efficient than a linear economy, implying changes to supply chains and the characteristics of the products that pass through them.

"One of the most useful outcomes of human factors interventions will be in the area of user experience"

Industry 4.0 technologies for better control of these processes, featuring huge amounts of real-time data, model-based control (for example the 'digital twin' concept) and control by changing model parameters, rather than physical interaction.

There is clearly a significant change implied in the nature of jobs; many more will be computer-intermediated ('digitalised'), implying job losses, displacements and reconfigurations.

Leaving aside the economic implications of these, there will be a massive requirement for retraining and re-acculturation for the new environment. Since digitalisation means 'humans-in-the-loop' become 'humans-on-the-loop', these humans must change from Operators to Resilient Operators, to deal with the flags, fails and collapses to which 'never-fail' software is prone. The requirement and scope for human factors knowledge and expertise appears endless, as long as we are properly prepared for this new environment (how do you train Operators to understand the 'margins of manoeuvre' that keep processes running?).

These changes will spread to other domains such as transport, agriculture, health and so on, especially if engineered components are involved. Inevitably, there will be implications for health and safety legislation and practice, due to the adoption of new materials and processes but also due to the greater integration caused by the circular economy; if we consider customer protection, who is the customer? Where does liability end?

There are bigger problems, mainly of co-ordination. In the UK, we're moving towards an electric-hydrogen energy provision economy and considerable behind-the-scenes work has gone on to deliver both of these sources.

But co-ordination is lacking downstream from this provision, for example, who's going to provide the household hydrogen boilers, when, and at what cost? What necessary legislation, incentives and safety standards will be needed? Who will deliver this new economy, with what training? Human factors practitioners, armed with a systems perspective, could be of great help here.

Evidently, the human factors profession must prepare for these changes. There is time, but not much. Are our curricula appropriate for this new human factors working environment? Are our practitioners pivoting towards these new demands? We should be aware of General Custer's Last Thought: "If help is on its way, it's going to be a bit late."

And what of the people who will be caught up in this wave of change? We're simple folk, living in our communities and going about our daily affairs, relying heavily not just on our own skills and knowledge in the workplace but on the skills of countless others in the networks providing the infrastructure that enables us to work and live, now faced with massive change. It seems that one of the most useful outcomes of human factors interventions by our consultancies will be in the area of user experience, in bringing these changes and the knowledge demands implied by them down to the level where the vast majority of us can cope and feel we are in charge, not just cogs in the inconsiderate machine. ■

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Murray Sinclair is a Visiting Professor at Loughborough University

AGRICULTURE

Planting the seeds of safety

Agriculture can be a dangerous industry, with thousands injured every year. But research into non-technical skills could help offer insights into why the sector is so risky and improve outcomes for workers, as **Jill Poots** and **Ilinca-Ruxandra Tone** explain

For anyone enjoying the UK TV series *Clarkson's Farm*, like we have been recently, you may have realised that farming isn't all rolling hills, cruising in combine harvesters and petting sheep. It only took one episode for Jeremy Clarkson to liken farming apparatus to 'a medieval fairground', whilst simultaneously featuring two men with missing digits and broken limbs in the background. While entertaining, this dark humour raises the profile of a shockingly dangerous industry. The programme highlights that the risk of fatality in agriculture is "twenty times higher than in all the other industries combined," as supported by Health and Safety Executive statistics.

Last year in Great Britain, 41 agricultural workers were killed at work, the majority by farm vehicles or animals. Additionally, there were 12,000 non-fatal injuries in agriculture, forestry and fishing, with potentially many others going unreported. Despite a slight downward trend in injuries and fatalities, agriculture remains the most dangerous industry in the UK.

Prompted by these worrying statistics, the University of Aberdeen Non-technical Skills in Agriculture (NTSAg) group, led by Senior Lecturer Dr Amy Irwin, has been dedicated to researching how human factors, particularly non-technical skills (NTS), may offer insights into this phenomenon and improve outcomes for farmers.

NTS are the cognitive (including situation awareness, task management and decision-making), social (including leadership, teamwork and communication) and personal resource skills (including stress and fatigue management) which are important for safe and effective task performance.

Conversely, failures in NTS have contributed to many dramatic accidents

"Farmers reported using non-technical skills daily and felt they may influence workplace safety and performance"

in recent history such as Piper Alpha, an oil platform in the North Sea that suffered a fatal series of explosions in July 1988. Despite having been studied extensively in other high-risk industries, such as aviation and healthcare, researchers from NTSAg were the first to recognise the importance of these skills in agriculture. Over the past six years, several studies have been conducted by the research team utilising various methods including interviews and questionnaires, the findings of which have built our current understanding and have generated various practical tools supporting farmer safety.

An initial study was conducted to identify the categories of NTS typically used in agriculture. Through interviews featuring the critical incident technique, farmers shared their thoughts and actions related to both positive and negative farming experiences. The findings revealed what farmers considered the top hazards in the industry – namely machinery, livestock and slurry – and confirmed the occupation's status as hazardous and stressful. More importantly, farmers reported the use of NTS daily and felt that these skills may influence their workplace safety and performance. Situation awareness (informally defined as 'knowing what's going on'), decision-making and task management were useful skills for both teams and lone

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Research results in valuable advice

The research project has led to the creation of a series of resources and safety leaflets with advice and guidance on managing risk.

Topics include communication, managing the risks of fatigue, mental health and dealing with livestock.

There's also a guide explaining the similarities between agriculture and the aviation industry – a sector where human factors expertise plays a key role.

Situation Awareness: Agriculture & Aviation examines the common concerns of farmers and pilots, such as working in high-tech and high-risk situations with conditions which can quickly change.

It explains the role of situation awareness in both professions and highlights the potential lapses that can occur.

Another guidance leaflet focuses on decision-making and the links between farmers and firefighters. It gives examples of when being able to make quick decisions under pressure helped prevent serious damage and points to studies which have shown that both frequently use their past experience to make decisions.

Other resources offered on the project's website include a pocket guide to farmer safety critical skills, a situation awareness checklist for operating tractors and a tractor safety app.

To find out more, go to **https://research.abdn.ac.uk/nts-farming/**

Research UPDATE

Research into the effects of whole-body vibration – which can be caused by agricultural equipment including tractors and other farm machinery – features in a recent issue of the journal *Ergonomics*. The study looked at its impact on fatigued back muscles, finding it resulted in "delayed muscle contraction, high overall muscle activation and increased perceived discomfort" which can all increase the risk of injury. **To read the full article, visit bit.ly/whole_body_vibration**

> workers. Additionally, teamwork and leadership were identified as useful NTS for those farmers working in teams. As a result of this exploratory study, NTS were found to be relevant in agriculture, similar to other hazardous industries.

Building on this knowledge, farm workers were surveyed in a second study to investigate factors contributing to NTS attitudes and behaviours. Attitudes towards safety climate, compliance and motivation revealed a significant association with farmers' NTS. Additionally, individual factors such as personality traits like conscientiousness and neuroticism, as well as environmental conditions such as concerns over cost and equipment, predicted NTS attitudes. All in all, the study highlighted factors which can inform NTS engagement and training initiatives.

More specific scenario-based work followed, focusing on how farmers approach risks related to two main sources of injury and fatality: tractors and cattle. In the first of the two studies, farmers were asked to assess risks from various categories in the context of tractor scenarios and indicate whether they would proceed with the tasks and why. Findings revealed that not all risks within a category were considered equal; farmers reported they would not proceed working with a missing Power Take-Off shaft but didn't view missing seatbelts as risky. Many farmers evaluated risk in terms of financial loss or equipment damage, as opposed to risk to safety, suggesting safety messages may be more impactful when they relate to economic aspects rather than personal safety.

In the second scenario-based study, risks were presented in the context of cattle handling vignettes involving lone working. In addition to the questions in the first study, participants were also asked to describe their risk management strategies. Stress and fatigue were not perceived as dangerous, compared to other categories of risks. Again, risk was considered in the light of broader aspects, including animal welfare and duty to complete the task, suggesting potential solutions related to risk framing. Participants reported the use of cognitive NTS decision making, situation awareness and task management when managing risks in the above scenarios,

41

AGRICULTURAL WORKERS were killed at work in Britain last year, the majority by farm vehicles or animals

12,000

NON-FATAL INJURIES in agriculture, forestry and fishing

47% OF FARMERS stated that productivity was their focus rather than safety

confirming the applicability of these skills when handling livestock alone.

Additional studies have also been conducted on situation awareness (SA), due to a lack of research evaluating requirements, error types and influencing factors in agricultural operators for this particular skill. The first study explored SA for tractor operators. Elements required to maintain SA spanned the machinery system, ranging from an awareness of inside the cab to the apparatus hooked on the back. SA errors most frequently occurred when the information was not observed, usually due to individual performance limitations and task-based pressures such as fatigue, compromised physical health, rushing, distraction or stress. When asked about the safety context on their farms, 47% of farmers stated that productivity was their focus rather than safety, most commonly due to time pressure and financial difficulties. The second study confirmed the negative impact of stress and fatigue on SA in the context of critical incidents reported by farmers. Taken together, these findings emphasised the importance of SA for safe and efficient work practice in farming whilst also suggesting potential barriers for maintaining good SA.

Based on this body of research, NTSAg has produced a series of information leaflets, an e-learning course in collaboration with Lantra Scotland, and a range of free tools for farmers, including a pocket guide covering NTS and a tractor SA checklist with an accompanying app. More recently, the team has developed FLINTS, a behavioural marker system designed to support the training and assessment of farmer NTS. The group used their research findings to generate a list of NTS and associated elements and conducted a series of discussion and review groups with farmers, farm safety professionals and key farming organisations to produce observable behaviours for each element. The team has also recently developed the first CRM-type training programme in agriculture in collaboration with KURA Human Factors, aimed at enhancing NTS.

"A great deal of work has been carried out by NTSAg to understand the involvement of human factors in agricultural safety"

A great deal of work has been carried out by NTSAg to understand the involvement of human factors in agricultural safety, identifying NTS as crucial for farmers' safety and performance, and highlighting the role of various influencing factors such as stress and fatigue. The demographic and qualitative data captures large differences in farms around the UK and Ireland; while some are small, family-run with one or two workers, others are large enterprises, meaning organisational culture and safety climate along with priorities and risks may differ from farm to farm. It's important to include farmers' voices in this research, and while this can be challenging due to remoteness, online studies have proved successful in yielding larger and varied samples. Agricultural shows and rural organisations, for example young farmers organisations, remain useful vehicles for recruiting participants and promoting safety messages resulting from research studies. Irrespective of these challenges and differences, the ultimate goal remains unchanged: reducing injuries and fatalities in agriculture. Farmers are important to our society for a myriad of reasons, including the food supply chain and the protection of the iconic British countryside. Therefore, it's crucial to conduct further research in order to learn how to improve their safety.

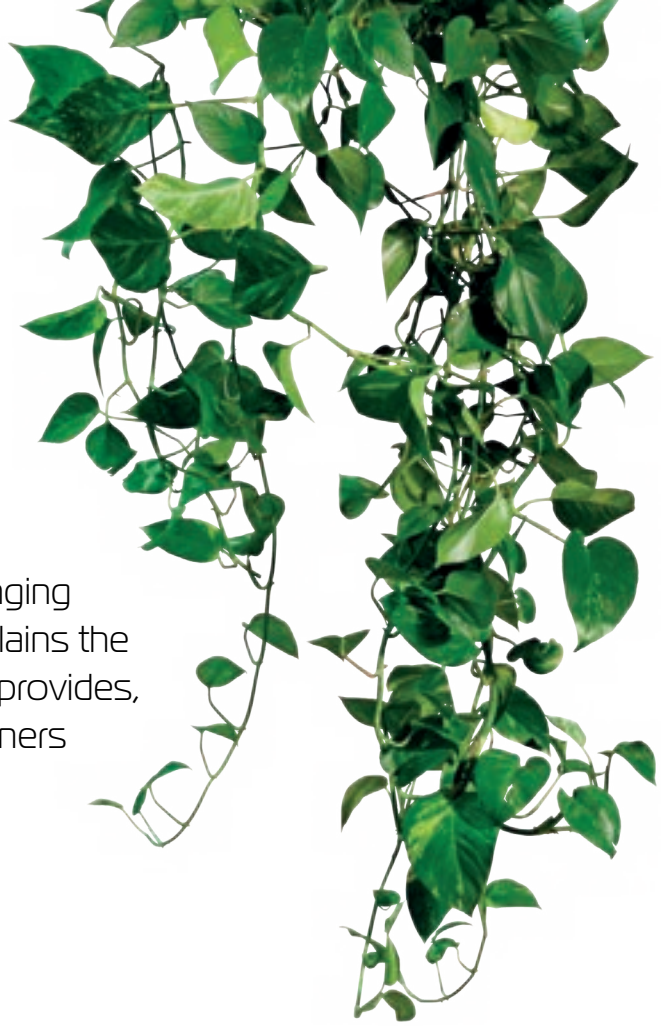
Safety in agriculture is a top priority

Jill Poots, below left, is a PhD researcher in the Psychology Applied to Safety and Health lab at Leeds Beckett University, UK, investigating human factors in telemedicine. She's an associate member of the University of Aberdeen's Applied Safety and Human Factors group where she assisted with research in agriculture, sparked by her experience of growing up on a dairy farm in Northern Ireland.

Ilinca-Ruxandra Tone is a PhD researcher and a member of the Applied Psychology and Human Factors and Non-technical Skills in Agriculture groups within the School of Psychology at the University of Aberdeen, UK. Her research focuses on non-technical skills, particularly situation awareness, and contributing personal factors such as stress and fatigue in agriculture.

To find out more, visit https://research.abdn.ac.uk/nts-farming/

Nature and nurture



Biophilic design can improve environments by bringing more of the natural world inside. **Julie Rainey** explains the principles behind this approach and the benefits it provides, and why it's so relevant to human factors practitioners

Biophilic design has received increasing attention as a design philosophy in recent years. It is a lesser-known human-centric design principle and of particular interest to human factors professionals, architects and designers interested in indoor environments. The pandemic has put the spotlight on how much time we spend indoors as well as the benefits to our mental and physiological wellbeing of being outdoors.

What is biophilic design?

Biophilia is an inherent need for humans to interact with nature. The study of biophilia has evolved from within the fields of environmental and evolutional psychology, sociology, biology and physiology and has now been adapted to the fields of neuroscience, endocrinology and architecture.

Nature and biophilia is one of the most researched areas of environmental psychology; there is a vast amount of evidence. In particular, biophilic design is being considered by sustainability professionals, designers and beyond. Whatever the science, it all relates back to the desire for a (re)connection with nature and natural systems.

Biophilic design is an extension of biophilia and incorporates natural materials, natural light, vegetation, nature views and other experiences of the natural world into the modern built environment. It integrates elements of nature into architecture and urban planning projects. It goes far beyond adding a simple plant to your desk.

Biophilic design is used within the building environment and interior design sectors to increase occupant connectivity to the natural environment through direct and indirect nature, and space and place

WHAT IS BIOPHILIC DESIGN?

- A human-centred design approach
- Used in building and urban community design
- Harnesses power of nature to make our built environment healthier and happier
- Creates spaces that respond to our innate human needs
- Encourages an emotional attachment to particular settings and places
- Introduces nature direct and indirectly to our indoor spaces
- Creates inspirational and restorative spaces that connect occupants to their indoor surroundings
- Considers how a space makes you feel and in doing so supports the activity of the place
- A new area of sustainability that focuses on health and wellbeing
- Scientific, evidence-based design involving psychology, biology, physiology, neuroscience, endocrinology and architecture
- Promotes positive interactions between people and nature that encourage an expanded sense of relationship and responsibility for human and natural communities

conditions. It's based on 15 principles or 'patterns of design', including visual and non-visual connections with nature, dynamic and diffuse lighting, biomorphic form and patterns, material connections with nature, mystery, refuge and awe.

Why should human factors professionals be interested in biophilic design?

As human factors professionals we are aiming to create the sort of environments that:

- are physically, physiologically and mentally healthy
- improve cognitive function, leading to creativity, reduced error, improved concentration and performance
- improve productivity
- lower levels of absenteeism (which has an impact on cost and manpower)
- lower employee turnover, improve employee retention, creating environments that enhance social connections.

It may be of surprise that these are compatible and in tune with biophilic design. As human factors professionals we consider the individual, task, processes and environment. Quite often though, there is more emphasis placed on the first three and less so on environment and that's why it's worth taking an interest in biophilic design.

Bringing the outside inside can provide many benefits

What does a biophilic design concept involve?

Biophilic design 'tools' include indoor gardens, vertical plant or moss walls, air-purifying plants, aromatherapy, soundscapes, lighting strategies, interior design, views of nature, use of natural materials, colours and fabrics, and access to open space.

Water features and biodiversity can also be highly beneficial. Even photographs of nature are shown to have significant mood and productivity benefits.

Biophilic design has been proven to improve our cognitive function and performance and increase creativity, productivity and social connectiveness, as well as having restorative and calming benefits.

It's relevant and beneficial in our office workplaces, healthcare, educational, hospitality, home settings and even manufacturing. It's also been seen to reduce crime and even increase perceived sales values in retail units.

Some of the other reasons professionals are interested in biophilic design are to attract the best people, increase the value of real estate, increase company kudos, improve recovery rates in healthcare settings and improve learning outcomes in schools.

Biophilic design also promotes sustainability by creating more awareness about nature, the need to protect it and the benefits of the creative use of nature. It balances sustainability initiatives by factoring in people as much as the planet. In urban planning, nature can educate, strengthen and connect communities.

The pandemic has highlighted the importance of healthy indoor environments and this has been a springboard for biophilic design.

Air quality in particular is an area that has had a lot of focus and so the addition of incorporating greenery such as plants and, more increasingly, green walls as successful ways to improve the indoor air we breathe has given biophilic design an opportunity to take the conversation further and showcase its full scope and benefits. ■

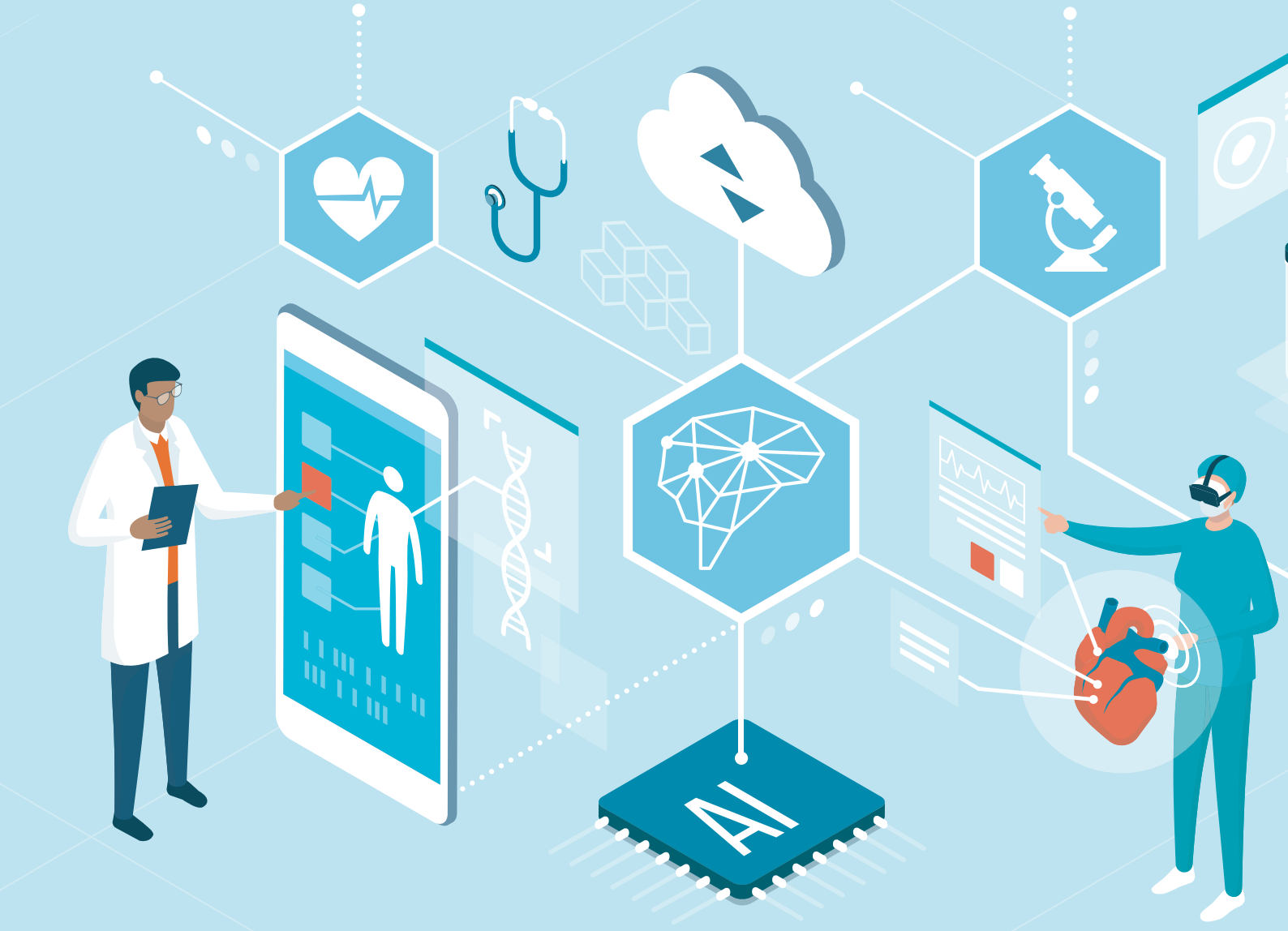
Research UPDATE

Indoor plants can be as effective as guided meditation in helping psychological recovery from fatigue, new research has found. A study in the journal *Ergonomics* examined the effectiveness of both methods after participants carried out a vigilance task. When they spent a rest break with a plant, their level of distress significantly decreased. Read more at **bit.ly/plant_recovery**

Julie Rainey is an Ergonomics & Human Factors Consultant and Director of Ergo & Wellbeing Ltd

Finding a healthier approach to AI

The authors of the CIEHF's white paper on artificial intelligence and healthcare explain what the new guidance is about, the principles behind it and why the systems perspective at its heart is so important for the evolution of AI



The design, implementation and operation of safe and effective artificial intelligence (AI) is a complex and pressing issue across safety-critical domains. In healthcare in particular, there is increasing interest in the use of AI, with many such systems currently under development or already in operation. It's critical that human factors and ergonomics principles are used to support this evolution.

In September 2021, we launched the new CIEHF white paper *Human Factors and Ergonomics in Healthcare AI* at the Patient Safety Congress in Manchester. It argues that we need to move from a technology-centric focus, which is concerned predominantly with the performance and accuracy of AI in isolation, towards a systems perspective, which allows us to understand how we can integrate AI meaningfully and safely into processes and systems.

In the literature, this narrow focus on AI is often expressed in the conclusions of papers, where the performance of the AI is compared with that of people on a narrow and well-defined task, such as the identification of breast cancer from mammograms. Quite often this is then picked up in the news and amplified in headlines that suggest that, for example, AI outperforms doctors or that AI makes radiologists obsolete. However, such claims are likely to be overly optimistic because most studies of AI in healthcare to date are retrospective and undertaken by the developers of the technology, and so we don't really understand yet what happens when we start using AI in real-world settings.

The few examples of independent prospective evaluation usually provide a more detailed and realistic picture of the effects of introducing AI into actual systems – and the results highlight the importance of considering wider systems aspects and socio-environmental factors. For example, a retrospective study of an AI tool designed to support ambulance service call handlers in recognising cardiac arrest calls found that the AI was able to recognise cardiac arrest more often and quicker than the call handlers. However, a prospective evaluation was unable to replicate these findings and concluded that there was no improvement in performance of the joint system of call handlers and AI.

"As AI systems become more advanced, the role of human factors in healthcare AI will become more critical"

The eight human factors principles described in the guidance represent topics both old and new. Some of the principles, such as optimising situation awareness and workload, have featured in the literature on automation for decades, and valuable lessons can be transferred to the design and use of AI. Others, such as the role of explanation and trust, the impact on relationships, and ethical issues are, arguably, topics that have become increasingly important with the use of AI.

Moving forward, as AI systems become more advanced the role of human factors in healthcare AI design, implementation and operation will only become more critical. Fully autonomous >

TECHNOLOGY (AI)FOCUS

- Data quality
- Algorithm accuracy
- "Human vs Machine" performance
- Bias in data

SYSTEMS PERSPECTIVE

- Situation awareness
- Workload
- Automation bias
- Explanation and trust
- Human-AI teaming
- Training
- Relationships
- Ethical issues

AI systems loom large on the horizon and there are concerns regarding how we can work with, manage and control such systems once they are introduced. Again, the need for a systems perspective is critical to ensure that advanced AI optimise rather than hinder patient safety.

In the white paper, we discuss the importance of understanding and assessing the distributed situation awareness (DSA) requirements of the joint human-AI healthcare sociotechnical system. Advanced healthcare AI technologies will possess their own unique situation awareness (SA) requirements and will need to share and exchange SA with human healthcare workers. Human healthcare workers will need to understand what the AI system is doing, what it's aware of, and why it has made certain decisions. Given the critical role of SA in optimal performance, considering and proactively modelling DSA during the design of healthcare AI is an important requirement.

Systems human factors can also be used to help design the controls required to ensure that advanced healthcare AI systems operate safely. Our work suggests that three forms of control are required.

The first set includes controls which are enacted during design and development activities to ensure that designers create safe healthcare AI systems (for example, AI design standards and regulation for AI designers).

The second set includes internal controls that are built into AI systems to prevent dysfunctional behaviours that might threaten patient safety, including morals, ethics and decision rules.

The third and final set includes controls for the broader sociotechnical healthcare systems in which the AI will operate. For example, in the case of advanced autonomous healthcare technologies, the healthcare system itself would require new laws, rules and regulations, standards and codes of practice, and testing and certification processes. The care providers that use the AI will require new policies and procedures, risk assessments and risk controls, training programs, supervisory arrangements, emergency procedures and so on.

A key message of the white paper is that proactive and early human factors input is required. Systems human factors methods such as Cognitive Work Analysis (CWA), the Functional Resonance Analysis Method (FRAM), the Networked Hazard Analysis and Risks Management System (Net-HARMS), and the Systems Theoretic Accident Model and Processes (STAMP) will all be useful to help proactively design and test these controls alongside the design of healthcare AI. It's critical that we learn the lessons from other domains and don't wait until healthcare AI systems are implemented.

The white paper was developed by 30 contributors, coordinated through the CIEHF Digital Health and AI Special Interest Group. We also had input and support from national and international partners including British Standards Institution, Human Factors Everywhere Ltd, the South American Ergonomics Network (RELAESA), US-based Society for Health Care Innovation (SHCI), the charity Patient Safety Learning, Assuring Autonomy International Programme hosted by the University of York, the Irish Human Factors & Ergonomics Society, and the Australian Alliance for AI in Healthcare. This high level of engagement has enabled us to build a community of practice as part of the development of the white paper.

The white paper is a landmark contribution for the NHS, informing policy makers, decision makers and users about the principles and benefits of human factors. Human factors theory and practices, although growing in the NHS, are yet to be deeply embedded in NHS practices and thinking. Terms such as 'human factors', 'usability' and 'design standards', will be familiar to many involved in the design, procurement, implementation and evaluation of technologies in health and social care.

However, in these settings, such terms are often misused. A common example is using the word 'usability' when staff are instead describing measures of user experience and acceptance.

When people use such buzzwords to reassure themselves that these aspects are covered, without validated assurance methodologies, this has real-world consequences. The issues that human factors could have resolved or optimised will continue to affect system performance and embed potential safety hazards, ultimately impacting patients.

To address safety, NHS standards have implemented proactive safety activities. NHS standards require hazard logs and clinical safety case reports in the implementation of new digital products. The standards use terms such as 'usability' and 'design standards', and require someone with "knowledge of risk management processes".

However, there is little explicit guidance on the definition, standards and evaluation of these activities, nor what qualifications and experience is needed to complete, act on and approve outputs from such activities.

The white paper arms readers with a taste of human factors and its practical application in health and care AI. It also underscores the value of human factors in improving staff experience and the efficacy, productivity and safety of health and care systems.

To ensure suitable and effective application of human factors concepts and approaches, ideally human factors experts (Chartered Members) would work as part of project teams but these roles are not widespread in the NHS. Until there's a requirement to consider human factors assessments in NHS design, procurement and evaluation decisions, there will be little pressure on the market to improve these aspects of their products and for the NHS to employ experts in this field. Schemes like the NHS AI Award (which funds the development of novel AI technologies for the NHS) could further force the adoption of human factors optimised AI systems by requiring evidence of human factors assessments and improvements.

The use of AI in healthcare is still in its infancy, and the potential for radical transformation in the way healthcare is accessed and provided is enormous. The white paper aims to raise awareness of human factors among stakeholders but it's only the beginning of what needs to be a journey to support patients, healthcare providers, regulators and technology developers in taking the next steps. ■

Human factors and ergonomics principles for AI in healthcare

- Situation awareness
- Workload
- Automation bias
- Explanation and trust
- Relationships between staff and patients
- Human-AI teaming
- Training
- Ethical issues

Mark Sujan (pictured below left) is founder of Human Factors Everywhere Ltd, and a visiting academic at the University of Oxford. He chairs the CIEHF Digital Health & AI Special Interest Group.

Rachel Pool has worked in safety roles across the NHS and is currently NHS England Safety Analyst for the national Covid-19 vaccination programme.

Paul Salmon is a Professor of Human Factors and is the Director of the Centre for Human Factors and Sociotechnical Systems at the University of the Sunshine Coast, in Queensland Australia.

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Chartered Institute of Ergonomics & Human Factors

Fat fighters

Cooking oil poured down household drains can create giant fatbergs that block sewers and water systems, but human factors research could help tackle the problem of these mountains of grease

Lurking in the sewer systems of our cities and towns is a growing, greasy menace with the potential to cause chaos to water systems. Boulders of congealed fat and debris called fatbergs build up when cooking oil is poured down sinks and waste such as wet wipes is flushed away. They can grow so large they block city sewer systems and have become an expensive problem, costing utility companies millions of pounds each year to clear.

In 2017, an immense fatberg weighing the same as 11 double decker buses and stretching the length of two football pitches was discovered in East London. Chunks of the monster lump later went on display in an exhibition at the Museum of London. But while work continues to remove them, human factors research has also focused on how to stop the congealed masses being created in the first place.

Nuno Santos Silva studied the interventions that could change people's behaviour to ensure they deal with waste in a way that doesn't contribute to these problems. His research has become even more timely after reports of a rise in sewer blockages over lockdown. With people spending more time at home, the amount of unflushable waste being thrown down drains increased, putting the water system under even greater stress. Nuno's research looked at whether human factors could play a part in helping to rid people of their bad habits when it comes to disposing of cooking fats.

His aim was to use a behaviour-change approach to investigate the household sociotechnical-system surrounding fatbergs. He wanted to discover the underlying reasons and motivations driving how households get rid of cooking oils and hoped the findings would help develop interventions to prevent sewer networks being blocked by fatbergs, stopping the disruption and expense they can cause.

"In 2017, an immense fatberg weighing the same as 11 double decker buses and stretching the length of two football pitches was discovered in East London"

The research, undertaken as part of Nuno's postgraduate studies at Loughborough University, used behaviour change theories and a behaviour change wheel with theoretical domains. Data was collected through surveys and interviews.

The most common behaviours when getting rid of cooking oil were either putting it down the sink or toilet, or the less harmful methods of bottling it so it could be recycled or wiping it then putting in the bin. The study found that householders were often short of suitable options provided by local waste-collectors. There was a willingness to change behaviour if the opportunity was there through interventions such as oil disposal schemes. The findings also suggested there was a feeling of 'out of sight, out of mind' when it came to getting rid of waste.

Some of the study participants were labelled "fatberg friends" as their behaviour contributed to the build-up of the oily masses. However, the study found there was no "intentional malice" in getting rid of fat down the drains and it was suggested this was done simply because it was easy. Similarly, other household oil users mistakenly believed using hot water and washing up liquid was enough to counteract the problem. The research discovered a willingness to change behaviour if the opportunity of a well-implemented intervention arose. Some trial schemes have been launched to encourage people to deal with waste fats correctly, including taking it to recycling banks at supermarkets. But the study concluded that people were still short of options for dealing with cooking oil. It called for more research addressing the problem by applying practice theory to inform better interventions aimed at changing behaviour. ■

Step into the future of defence

A new online tool is helping to visualise how humans and machines could work together in the defence sector, with a range of thought-provoking scenarios predicting what the conflicts of tomorrow might look like. Its creators explain how it works and the difference it could make

The Human Interface Horizons tool (HIH) provides an information-rich resource for visualising and exploring new and emerging human-machine interface technologies and the future defence and security operating environments in which they might be used.

The HIH was developed to raise awareness of cutting-edge and emerging human-machine interaction technologies and explore their potential uses within the context of the future defence and security operating environment. The principal audience for the tool is developers of future platforms and systems who must consider the technology trade-offs and opportunities of competing future interface technologies. The tool supports this by highlighting the wider sociotechnical challenges that defence and security are likely to face in a future operating environment with evolving technologies and job roles.

Our approach

The HIH uses multiple visually engaging tools to access information. This is intended to allow both specialists and non-specialists to explore the novel and emerging interface technologies in a manner that promotes innovation. It enables users to easily compare and contrast information about different interface types and their characteristics, and customise the presentation of that information to their own preferences and needs.

A significant feature within the tool is nine illustrated defence and security scenarios covering a variety of operating environments. Embedded within each of these future-focused scenarios are a number of novel and emerging technologies which are intended to stimulate engagement with defence audiences and support innovative thinking regarding 'the art of the possible' for how humans and machines might interact in future.

Innovating our communications

A common challenge we face as practitioners is to communicate our knowledge in engaging ways. All too often, our work culminates in lengthy technical reports that take time to both produce and read. Alternative ways to influence and interest people should always be considered and actively pursued. As practitioners, it's important that our own products reflect core principles of our discipline; that they are accessible, navigable and produce a positive user experience.

To access the Human Interface Horizons tool, go to **https://dstl.github.io/Human-Interface-Horizons/** You can read excerpts from two of the scenarios over the following pages and for the full library, visit **https://dstl.github.io/Human-Interface-Horizons/scenario-library** >

The mine warfare specialist

You open the heavy door and are immediately struck by cool darkness.

"Jack, lights on," you call into the darkness and note the way your voice gets swallowed by the room's sound-absorbing walls.

Your personal assistant hears you though and dutifully obeys. The lights come on dimly and get gradually brighter, feeding you light comfortably as your pupils adjust. You look around the room, searching for your suit on its hanger on the rail in the corner. Your name is printed across the suit's shoulders. You walk over, grab it and start pulling it on quickly. In the muted calmness of the room, it's easy for you to forget the urgency of the situation.

Once donned, you seal the magnetic strip on the front of your suit. As you stride over to the printer, tucked into its alcove in the wall, you feel the gentle stretch of the suit's clinging material.

"Jack, printer on," you say, and the printer comes to life, lights flashing and small motors spinning noisily.

"Screen on." In response, the wall mounted screen above the printer instantly turns on. It's split between two video feeds. The first is an aerial shot of a large sleek object moving slowly through water which is the same greeny-grey colour as the object itself. The second murky image appears to show the same object from below.

"Jack, can you make a model of the mine please – one tenth scale."

The print carriage starts to move rapidly back and forth, with the extruder starting to build up a model of the mine. After a few seconds the model is complete and you wait for the green light to come on, to show the object is fully set. You pick the model up and study it with interest. You don't recognise it. It looks like a streamlined cigar with a propulsion system at one end.

"Jack, do you recognise this mine?"

"No, it's not in the database," your personal assistant responds through your earpiece. "It appears to be similar to the EM-75 but it's a different shape." He then proceeds to reel off various data derived from the Unmanned Underwater Vehicle's sensors about the estimated payload and its velocity. It's big, but thankfully travelling quite slowly. Despite not recognising this mine, Jack seems pretty certain it was originally anchored and then released in response to either a command or some stimulus.

Questions are buzzing through your mind. "Okay, well I'd better go and take a look before it finds an oil tanker in the middle of the shipping lanes."

You walk over to the VR area, grab your gloves and take your lens case off the shelf, popping the case in your breast pocket. You put the thin, tight gloves on and then take the seat inside the metal control rig, stationed in the centre of the area. You place the harness belt around your waist, place your elbows into the rest pads and grip the two familiar levers.

With one last breath out, you take the lens case out of your breast pocket and open it. One at a time, you take out each lens on the tip of your index finger and place one in each eye. Temporarily blind, you blink furiously as light streams into your eyes through the lenses. You focus hard on the world that now appears to surround you, stifling the urge to hold your breath and thrash around in the underwater seascape.

Above you, you can see a slightly blurred dark shape. You take hold of the rig's control levers again and look down, reassured to see your virtual hands wrapped around the virtual levers. You move them both forward slightly and your view thrusts towards the object. You ease off as you get about a metre away.

"Jack, can you enhance the view a bit please." The view becomes lighter and less blurred. Now you can see what you're dealing with.

From beneath, the mine looks just like the model you printed. You use the rig's levers to manoeuvre yourself round to the rear of the mine in order to study the propulsion unit. Your priority needs to be stopping it from moving towards the shipping lanes and colliding with a ship.

"Two mechanical arms reach round, synchronised with your movements, feeling uncannily like extensions of your body. Your hand movements drive the mechanical arm's bionic fingers"

You ask Jack whether he can detect any incoming signals to the mine, hoping you might be able to jam them and cut off any external control. Unfortunately, he assesses the mine is autonomous, making it much more difficult to deal with. You consider your options, conscious that the mine is getting ever nearer to one of the busiest commercial shipping lanes in the world.

You know the obvious next move but you also really want to recover this mine if you can. It's the most advanced example that you've seen. If the enemy has got a lot more of these, then you know you need to try and get it to the experts in the labs so that they can study it and develop countermeasures.

"Okay, Jack, can you keep me moving at the same speed as the mine please."

Once Jack has taken over control of the UUV, you move your hands to grab on to the underside of the mine gently. In your field of view two mechanical arms reach round, synchronised with your movements, feeling uncannily like an extension of your body. Your hand movements drive the mechanical arm's bionic fingers. As they latch onto the mine, your gloves apply gentle pressure to your fingertips, allowing you to feel its smooth surface.

You visually inspect the propulsion unit. It looks capable of providing a lot more speed. You wonder why the mine is travelling so slowly. Perhaps it's malfunctioning. Maybe it wasn't supposed to be released, although none of that will be much consolation if it blows a hole in the side of a tanker. You probe the propulsion system with one of the UUV's mechanical digits. You think it should be straightforward enough to disable. Suddenly, your view is obscured by an effusion of bubbles. You feel the mine detach from your grip and then see the mine ahead of you. It's picked up considerable speed and is moving away from you.

"Jack, can you catch it up?"

"Negative, it's travelling too fast."

You're now left with no choice. You ask Jack to prepare the mine destruction weapon system.

"Jack, discharge the weapon."

"Please confirm the command," he responds crisply.

"Discharge the weapon." On your command, you watch the small mine neutraliser shoot off and quickly intercepts the mine.

A second later, you see a small white sphere erupt underwater. It oscillates as it reaches out towards you. You rush to take the lenses out of your eyes before the explosion sweeps over you, and then sit there in the rig waiting for your heart to slow down before you contemplate going to provide your post mission report. ■

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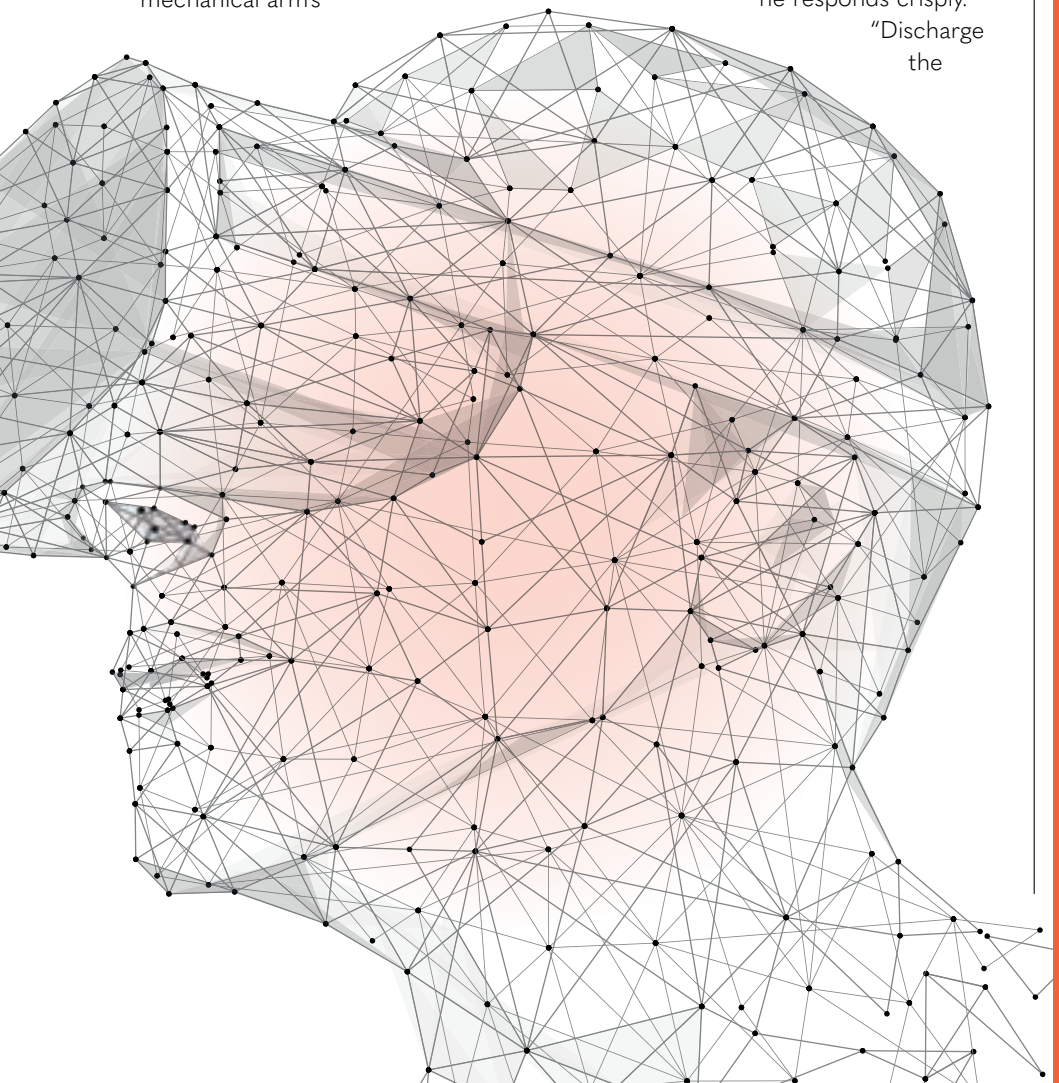

The team behind the tool

Over the past year, Aleph Insights and Nottingham University created the Human Interface Horizons tool on behalf of the Defence Science and Technology Laboratory (Dstl) via the Human Social Science Research Capability (HSSRC) framework.

Aleph Insights
Chris Wragg, James Bayliss

University of Nottingham
Rob Houghton

Human Social Sciences Research Capability (HSSRC)
Kerry Tatlock

Defence Science and Technology Laboratory (Dstl)
Graham Sabine, David Thompson

The cyberspace and network security officer

You pull your t-shirt on as you slam the door to your bunkroom behind you. You're running a bit late. You need to swing by the food dispenser on your way to the ops room.

What to have? It's going to have to be the bacon and egg muffin. You think about your order, holding it clearly in your mind before pushing it through to the food station, then make your way down the stairs to the shuttle stop outside. You pause, concentrate and envisage a shuttle car arriving to take you to the ops room via the food station. After a couple of minutes a car comes along. The door flips open like the unfolding of a beetle's wingcase. You get in and verbally confirm your route.

The shuttle car pulls off and you stare mindlessly out the window. You observe the various uniformed personnel swarming around the base. Even over the Strauss being played inside the car, you can hear the distant roar of aircraft engines.

The shuttle car comes to a gentle halt and you hop out and jog to the food station. The screen above the dispenser on the left is displaying your name. You walk to it and a warm paper parcel is waiting for you. You grab it and get back in the car. As you unwrap your breakfast, the Strauss pauses and a message comes through the speakers reminding you that eating in shuttle cars can make a mess or create unpleasant odours for future passengers. You decide to ignore the advice.

By the time you've finished your breakfast, the car has pulled up outside the sprawl of temporary buildings which accommodates the ops room. You run to the door, noticing a cleanerbot zig-zagging around. You toss the crumpled, greasy paper in which your breakfast was wrapped in its general direction before pushing open the door. One minute to spare before you're offically late.

The room is a hive of activity. Military and civilian personnel sit at desks staring at monitors, with others striding around purposefully between them. There is a low buzz of chatter. An officer walks past you, in his pristine uniform. The creases down the sleeves of his shirt look like they've been pressed by a precision robot, which they probably were. He glances at you and furrows his eyebrows. You look down and notice the ketchup stain on your t-shirt. You mentally shrug. You were recruited for your cognitive abilities and willingness to have various implants, not your sartorial elegance. You survey the room. Over in one corner, you see the door you're looking for. You

make your way over to it and step into the small room. It's darker inside, and the atmosphere is almost tangible, a fug of body odour and stale coffee. There are two couches positioned next to each other, like the type you might see in a psychiatrist's surgery. Lying on one of the couches is a figure, seemingly catatonic. Every so often their hands or feet twitch.

You lie down on the couch next to the figure and pull your glasses out of your pocket. Time to get yourself jacked up to the system. You put your glasses on and feel with your mind for a connection with the network. While you do this, you go through your mantra. Starting to prepare to receive data.

It's by will alone I set my mind in motion…

You let your body relax and then you feel it, your brain seems to jolt as you begin to see the world around you. A tapestry of environments, cyber, electronic, physical. All depicted as one large network of data, flowing from nexus to nexus. Even though it's vast and complex, you are able to comprehend it at an intuitive level. You sense it, not just visually, but you can feel it, hear it, even smell it. And you can manipulate it, roam around it – travelling without moving.

At the moment, you are viewing it in its entirety from outside, giving you a feeling of vertigo. You need to enter it, so you will yourself into the data flow. You can feel it, physically pulsing through you, all its different flavours. There is data from the myriad networks utilised by the military forces operating across the AOR. You are receiving feeds from the communications infrastructure, the full range of deployed sensors, all the network traffic across the system.

You can't perceive all of it in detail, but with support from AI, you can understand its flow, gauge its health, see any problems and respond to them or direct resources to deal with them.

You feel another conscious presence alongside you and feel its thoughts enter your mind.

Ah, you're here at last. I thought I was going to be trapped in here forever.

I'm only a couple minutes late. Anything to report?

There's something weird going on with the mesh network we have on the ground. A few of the nodes are acting strange, but I haven't been able to get to the bottom of it. I've already dispatched a ground patrol to go and make a physical check.

Okay. I'll look into it.

Great. I'm clocking off then. Anna will be here to relieve you at lunchtime.

Got it. Oh, can you clear up your coffee cups on the way out. They're starting to make the room stink.

"You put your glasses on and feel with your mind for a connection with the network. Your brain seems to jolt as you begin to see the world around you. A tapestry of environments, cyber, electronic, physical"

And then you are alone, just you and the data.

You start to concentrate on the ground mesh network that's used to provide edge computing capabilities to all of the deployed platforms and systems operating across the AOR. There are quite often problems with individual nodes. They have a tendency to be squashed by large trees or inhabited by squirrels, but the network was engineered with a high degree of redundancy. Problems with nodes can easily be circumvented by redistributing the load. You start to travel through the stream of data coming from the mesh network, following it from node to node, like a shark hunting its prey.

You reach one node and sniff. The scent coming from it reminds you of something. You've smelt it before. It's sweet, which normally indicates everything is fine, but there's something artificial about it. Candyfloss, that's what it smells like. You try to recall any previous occasions you have come across that smell. It has a strong association for you, but what with? You examine some of the diagnostic data coming from the hub, sifting through it, looking at its patterns, feeling its texture. It appears normal, in fact it has the appearance of textbook typical data. This in itself makes you suspicious.

Then you remember the smell. The last time you came across it was when you were training with synthetic data. Someone must be generating synthetic data for the network node and injecting it into the system somehow, presumably to cover up its real output. You're not sure how this could be done. The AI intrusion detection system should have noticed this and brought it to the attention of your colleague on the previous shift.

You need to get closer to the network node in question, so you push yourself inside the node itself, feeling all of its major components, its circuits, its chips, its ports. Something about one of the ports doesn't feel right, like a tiny stone in your shoe. You realise someone must be plugged into the network node directly. That's how they're doing it. Your instinct now is to defend the system. Who knows what they might have been able to insert onto it. Before you close the node down, you issue a short non-lethal burst of electricity across its surface. Anyone in physical contact with it should just have received a nasty surprise.

Having sorted the immediate problem, you emerge out of the node, rising higher and higher. You need to see the network as a whole again, restoring its functionality, tracing any malware and making sure it hasn't been compromised elsewhere. You gaze down on the network, like so many neurons connected, fizzing with seemingly random activity. For a moment, you consider how your own brain would appear to an outside observer. Thoughts flit unbidden across your mind.

This is my morning, my day begins. I wonder what's for lunch. ■

Chartered Institute of Ergonomics & Human Factors

EHF2022 Online: 11-12 April
EHF2022 Live: 25-26 April, Birmingham

Ergonomics & Human Factors 2022

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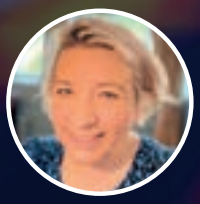
Speakers

Lectures, keynotes and talks on a range of topics and across multiple sectors will be delivered by a great line-up of speakers including:



Suzy Broadbent
Healthcare Safety Investigation Branch

Professor Neville Stanton
Southampton University

Dr Alonso Vera
NASA Ames Research Centre

Professor Leonard O'Sullivan
University of Limerick

Themes

EHF2022 will showcase the following themes:

Tickets from £50 +VAT!

- Automation
- Climate change and sustainability
- Future mobility
- Healthcare
- Human factors in practice
- Neuroergonomics
- Physical ergonomics
- Responses to the pandemic

WE'LL ALSO BE FEATURING:

- **User Experience:** creating a digital world accessible to all.
- **Cross-sector learning:** maximising knowledge and experience across domains.

CALL FOR SUBMISSIONS

SHORT PAPERS

We're looking for papers highlighting application and impact of human factors & ergonomics, short case studies, early research results or work in progress.

Your two page format will be peer-reviewed and published in the proceedings.

Deadline: 14 January 2022

How will you be involved?

For all details go to: **conference.ergonomics.org.uk** **#ehf2022**

Membership

Taking the next steps

I recently took up a new sport and enjoy practising it, learning new skills and meeting new people. I have no intention of competing professionally but if I did, I wouldn't know where to start so some guidance would be very useful.

This reminded me of some of our Associate Members. Many members tell us they joined us to find out more about human factors, to learn and to improve their skills. We have many members who nurture their interest in human factors as their time allows and who remain part of our community for years without upgrading to professional membership. But some of you may be keen to get recognition for your expertise and the work you're putting in, or you may already have a broad knowledge base and may have been applying human factors for years (maybe without calling it that).

If you'd like to see where you are on your way to professional membership, it may be useful to know that there are tools and support available when you take that next step. Our Professional Competency Checklist (ergonomics.org.uk/PCC) is a central part of every professional membership application and is a great self-assessment tool. By going through it and referencing activities and learning during your career, you can assess for yourself which areas of human factors you're already very familiar with and which other areas you may want to focus on. As a further step, you could then access our online events, masterclasses and publications or choose a CIEHF-accredited course to help fill any gaps you've identified.

If you'd like to talk it through, please contact us. We'll be happy to have a chat, put you in contact with another member to answer your questions, or help you find a mentor who can support you on your way.

Becoming a professional member of the CIEHF may not be everyone's goal but if it's yours, don't be shy – talk to us!

Iris Mynott, Membership Manager
i.mynott@ergonomics.org.uk

A sad loss for all

We are very sad to report that CIEHF Fellow Arthur Stewart has passed away following an aggressive illness. Arthur joined the Institute just a few years ago but made his mark in that period through his expertise, his volunteer time, his unfailing cheerfulness and friendship and his leadership in our community. We will all miss him. An obituary will follow.

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
Craig Kerr
Angela McLean
Katie Phillips
Mohd Najib Abdullah Sani
Wai Yoong

REGISTERED MEMBERSHIP
Rich McIlroy
Jean Rhodes
Joseph Smyth
Kwok Yick Ting Andy
Alex Riley
Nick Shorter
Hanniebey Wiyor
Debbie Thacker
Andrew Wright
Michael Cooper
Samuel Waters
Dominic Russell
Louise Walker
Lucy Milson
Mohd Hafizul Hilmi Mohd Noor
Radin Zaid Radin Umar
Christopher Parker
Philippa Tredget
Timothy Hayes

FELLOWSHIP
Lucy Hobson
Alex Lloyd

REGISTERED CONSULTANCIES
Arup
Corporate Risk Associates
Human Factors Everywhere

Membership

The Chartership challenge

Did you know that the CIEHF is the only ergonomics organisation in the world that can offer Chartered status to its members? We worked hard to get this recognition for the discipline and we're committed to helping you attain the standard of professional competence needed so you can enjoy the benefits of Chartered status personally.

What are the benefits?

It takes time and effort to successfully apply for Registered Membership or Fellowship – the two grades that enable you to become Chartered. It takes sustained effort to ensure you carry out and record the continuing professional development (CPD) activities needed to maintain Chartered status. So what does it give you?

- All applications are assessed by other Chartered members so this peer recognition should give you a huge sense of pride that they consider you've reached the highest professional standards needed.
- In many cases, it means higher pay and better prospects. In forward-thinking organisations, Chartered status is a requirement for career progression. It builds trust in you by your clients.
- As soon as you're Chartered, you can publicly demonstrate your commitment to the profession through use of the unique post-nominals C.ErgHF and by using the title 'Chartered Ergonomist and Human Factors Specialist'. The title conveys authority and competency, enabling you to build your own brand!
- The need to do CPD to maintain your Chartered status gives you the impetus to learn more, gain more experience and to challenge yourself to become better at what you do. We're here to help by offering opportunities for you to train, deliver talks, carry out voluntary work and become a leader in the CIEHF community, for example.
- CIEHF accreditation is recognised internationally and we encourage anyone, no matter where they live or work to step forward, get Chartered and with it, get the acknowledgement they deserve.

So who can become Chartered?

Anyone, if they can fulfil the competence requirements and demonstrate commitment to the profession.

There is no single route. Our Chartered members come from a wide variety of backgrounds and have a huge range of skills and experience, from healthcare to UX, from psychology to engineering.

Rest assured, we'll help you with your application so you've got the best chance of success, and we continually promote things you can do to enhance your CPD.

Our collective competence is needed more than ever in industry and in every sector, so make getting Chartered one of your New Year's resolutions!

NEW YEAR, NEW LOOK, NEW OPPORTUNITY

We've been working very hard over many years to lay the foundations that are enabling us to start building the Institute into a world-class organisation. Lockdown forced us into online working and delivery sooner than we might have planned, but it's meant that we've connected and engaged with many more members and potential members than ever before. Over the past 18 months, we've ramped up our activities to bring events and publications to a wide international audience who are noticing our efforts and are enthused by what the discipline has to offer and the impact it can make.

We're on a firm financial footing and this year we've invested in the necessary infrastructure and improved technology to ensure our systems are fit for the 21st century and will much better support this current and future activity. A new database will increase administrative and business efficiency. And through a thoroughly refreshed and reorganised website, you'll be able to more easily manage your membership, book your place at events and access your member benefits.

We've also taken the opportunity to invest in a Learning Management System (LMS) to accommodate training and development offerings, working alongside our accredited course providers and other partners to bring more opportunities for learning to members and non-members alike. Integration of the LMS with the new database will enable seamless movement between the website and the learning environment.

We'll launch in the New Year so please be patient and bear with us while we move from our old systems and get it all up and running. No doubt there will be teething troubles and further development needed. But rest assured, we'll be doing our utmost to make it all as ergonomic as it can be!

OBITUARY

Hugh David

Hugh David was born in 1937 and became interested in computing in 1958 when studying mathematics at Manchester University. He'd had to register as an extra-mural' electrical engineering student to learn to programme the Manchester Mercury computer, a valve machine.

In 1961, after National Service in the Royal Artillery, he joined a design team developing a portable computer for field artillery. He designed and built a model of the interface using a 'window' system to prompt the user. He then joined the Department of Ergonomics and Cybernetics (as it was then) at Loughborough University producing an MSc thesis on the cybernetics of libraries. In 1970, while teaching in the department, he completed a PhD thesis on the ability of air traffic controllers to predict potential conflicts.

Hugh moved on and worked at the Eurocontrol Experimental Centre, studying Air Traffic Controllers and Air Traffic Control using methods in disciplines ranging from neurophysiology to social anthropology. He spent much of this time involved with the development, measurement, running and analysis of large-scale real-time simulations, developing and acquiring practical experience and expertise not written up in the literature. He also developed a suite of statistical analysis programs (STATCAT) in ANSI FORTRAN IV, designed to provide a 'user-friendly' interface for workers, before the term was coined and widely used. Elsevier published the complete package in 1982 as a 750-page book.

In 1996 he became an Independent Research Fellow at Eurocontrol and carried out a series of studies on the measurement of strain and stress on controllers. He also began an examination of the displays used by controllers, which led to in-depth studies of the air traffic system.

Hugh retired from Eurocontrol in 2002 but he continued to work in a private capacity studying Air Traffic Control and controllers, as well as the whole air traffic system. He completed a skeleton re-design of the air traffic system, applying systematic design to the complete system, to show that an efficient, economical, satisfying system can be created by using existing technology in a planned fashion.

He wrote and had published numerous academic and conference papers and two books, *Control Room Simulation: The Real Life of Real-Time* in 2017 and *The Air Traffic Kludge* in 2018.

He joined the Ergonomics Society (as the CIEHF was then) in 1970 and continued his membership throughout his life, becoming Chartered in 2015. Hugh died in 2019.

The voice of reason?

Ned Hickling argues the case for speech recognition systems

Nigel Heaton's recent article in *The Ergonomist* on the success – and limitations – of speech recognition systems was of considerable interest to me. I am a user of such systems, and indeed this article was produced using voice dictation software. I have, for the first time, had to ask myself some questions as to why voice dictation succeeds for me.

In the early 1970s, I worked as an insurance claims clerk where secretaries took shorthand dictation from me. After a few months, the formulaic semi-legal jargon became familiar to me. That was my first foundation stone: learning how to speak in a formalised form of language.

From the age of eight until the present day I have continued to sing classical and church music. Therefore, I have received considerable training, cajoling and experience in having clear diction. My second foundation stone.

In the mid-to-late 80s I was expected to start typing and producing my own printed documents. My attempts to learn touch-typing were not successful and I stumbled along using a combination of maladaptive single and double handed typing which continues to this day and, if anything, has become worse in output accuracy. In addition, I experienced pain in my shoulders, trapezius and neck often culminating in a work-shattering migraine.

In 1993 I went to a computer fair looking for an item of hardware but also browsed available software. For £5 I saw IBM Simply Speaking. More out of curiosity than expectation I bought it and before long it was installed upon my work computer. Within a year, IBM gave away a copy of Simply Speaking Gold on the front cover of a magazine: what a bargain! Recognition accuracy improved and my productivity went up. On a good day I was managing 30 words per minute.

Two years later another computer magazine sported a free copy of IBM Via-Voice. The great tomorrow was here today. It could manage continuous voice dictation and at times I reached the dizzying heights of about 60 words per minute. I gauged myself as more productive by about a factor of four relative to keyboard input.

That is not to deny that sometimes the software, like humans, suffers acoustic confusions with substituted words or phrases that could be befuddling, entertaining and sometimes downright scurrilous. More of this anon.

A considerable length of time passed, it learned my vocabulary, I had more than 2000 customised words and acronyms and life was comfortable and productive. In hindsight I realise that sometime during my use of Via-Voice I began to think as I was speaking: I was planning ahead on my sentences and paragraphs. The risk of 'stream of consciousness' style of text must have diminished markedly.

Sadly, the day arrived when Via-Voice was no longer compatible with the latest version of Microsoft Windows and IBM had stopped their development of retail voice recognition software for Windows-based application.

I took the plunge and for the first time ever paid the full retail price for Dragon Dictates, Version 6. It learned how I spoke by my reading an extract from *Alice in Wonderland* and President Kennedy's inaugural speech. I then invested about a day of my time teaching it my specialist vocabulary. Subsequently I have purchased versions 8, 9, 11, 13 and am currently using version 15.61.

Being a bit nerdy, I bench marked my performance with Version 6 and estimated my accuracy at around 70%. Interestingly, my productivity had not increased and I guess that is because it is a function of my pausing to think, as I dictate.

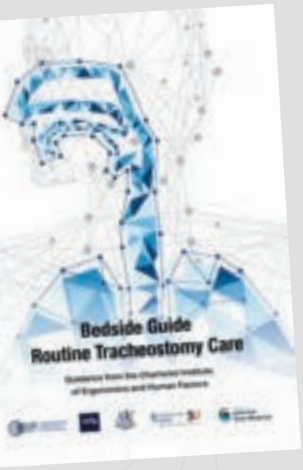
Amongst colleagues who worked closely with me, I am notorious for some of the acoustic confusions that have slipped through my proofreading. I once sent a draft report to the client who then phoned with a tremulous voice and many sniggers in the background to ask, "On page five you mention 'these furious whores'". Where are they operating on our company premises, and would the unions object if we remove them?". I had used the phrase 'various scores' and failed to notice that the software repeatedly misheard me.

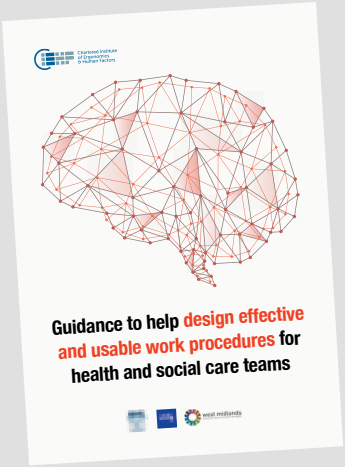
Of course, you will have already guessed that Nigel hasn't persuaded me to give up using speech recognition software, but, given the foundation stones I now recognise in myself I do wonder what the other ones might be that I haven't identified. It also leads me to wonder whether we need to spend more time identifying the prerequisite skills needed to enable people, in this way, to be liberated, more productive, and with reduced physical risks. ■

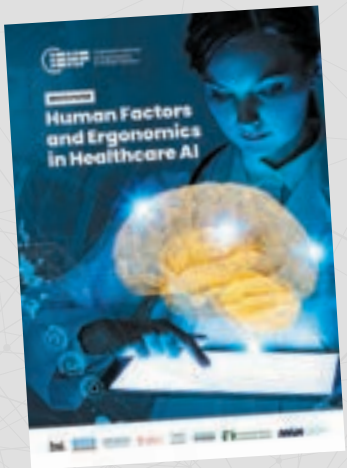
If you want to share your view on an idea or issue in human factors, get in touch with us at editor@ergonomics.org.uk

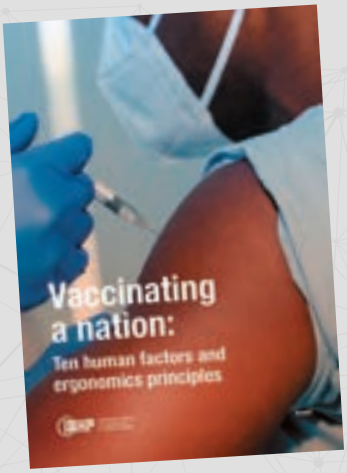
HUMAN FACTORS ADVICE AND GUIDANCE

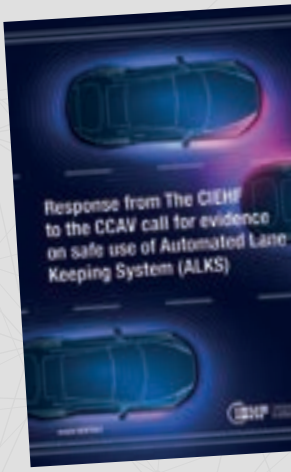
Human Factors is a science that combines physiology, psychology, engineering and technology for improving life, wellbeing and performance.











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www.ergonomics.org.uk