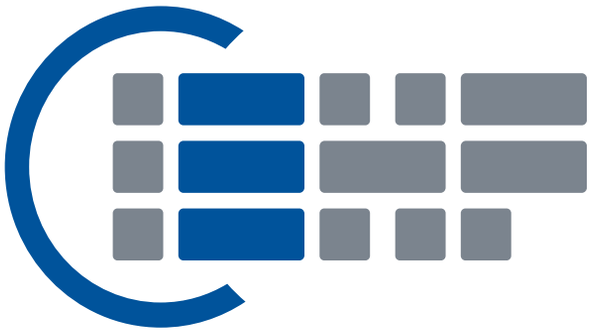

Chartered Institute
of Ergonomics
& Human Factors

The Human Connection

How ergonomics & human factors can improve lives, business and society

About this document

The Institute of Ergonomics & Human Factors was recently awarded a Royal Charter which marked the start of a reinvigorated journey. Part of our Strategic Plan in the five years following is to explain to a wide audience how ergonomics and human factors works in support of human values, social capital and organisational wellbeing.

We also have a role to futher engage with business leaders, government and policy makers to promote the quality and productivity benefits of applying ergonomics and human factors. One way we will do that is through this document.

This represents our first version of what we hope will become a 'living document'. Our initial set of more than 20 case studies are only a small subset of the vast range of activities that have been conducted by our members over many decades.

Within this document, we have striven to produce a comprehensive set of clear and resonant stories that illustrate the impact of ergonomics and human factors.

This document is intended to be of value to a wide range of audiences, including government, policy makers, industry, third sector groups, educators, research funders, regulatory bodies and collaborators. Ultimately we hope that this will become a document that we can all use to help to understand the complexity, range and value of the discipline of ergonomics and human factors.

Professor Sarah Sharples

President of the Chartered Institute of Ergonomics & Human Factors 2015-16

"I'm delighted to see this document which highlights the extremely valuable contribution made by human factors professionals within a wide range of industrial settings. I'm personally aware from my work within the rail industry of the positive impact that systematic human factors activities can have on the workplaces of rail employees and the experience of rail passengers.

Increasingly human factors professionals are being integrated as part of design and engineering teams within the railway industry, with positive effects on productivity of the rail system as a whole.

The work of the CIEHF to achieve Chartered status further demonstrates the value of this profession, and I welcome the collection of case studies within this document to help to explain how important considering human factors can be for many different professions."

Professor Andrew McNaughton, Technical Director, HS2 Ltd

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Ergonomics Everywhere

Ergonomics and human factors has been a scientific discipline since the late 1940s and has evolved to become an activity embedded in many organisations throughout the UK. It has impacted changes in and improvements to workplaces, technologies and systems.

At the Chartered Institute of Ergonomics & Human Factors, we understand the need to identify clear messages to influence industry, policy makers, research funders and educators, around why ergonomics and human factors is important, how it adds value, and what the priorities should be when considering how ergonomics and human factors should be implemented.

Applying ergonomics & human factors ensures that systems, products and services are designed to make them easier, safer and more effective for people to use.

Benefits for industry

- Working with a chartered ergonomist and human factors specialist early in the design process will lead to cost savings, better quality outputs and improved brand reputation.
- Ergonomists and human factors specialists do not work alone, they partner with colleagues from different specialisms and together they create better solutions.
- Ergonomics and human factors methods will help design more effective workplaces, enable more efficient work, and create a safer and healthier working environment for all.
- Ergonomics and human factors does not need to be expensive and will deliver good return on investment.

Considerations for policy makers

- Organisations that mandate human factors reap the long term benefit through a stable and skilled workforce and a productive work environment.
- Ergonomics and human factors is about far more than error or incident analysis – we focus on solutions to problems, and design resilient systems, resulting in fewer accidents.
- Chartered status demonstrates the unique and specific contribution of ergonomics and human factors within organisations, and identifies individuals with specific skills to deliver solutions in a wide range of sectors and contexts.
- Thinking about people early on in the design process leads to better design, and helps to manage through-life costs.

Priorities for research funders

- Ergonomics and human factors is a distinct discipline that requires funding to advance scientific understanding of human capabilities, to ensure that future technologies and systems are effective, efficient and safe.
- Ergonomics and human factors is core to engineering, and underpins and interacts with many other disciplines, from computer science to psychology to product design.
- Ergonomists and human factors specialists have a range of technical and teamworking skills that enable them to be excellent scientific researchers but also deliver research with clear societal and industrial impact.
- We need to understand human factors to solve engineering, innovation and design problems of the future.

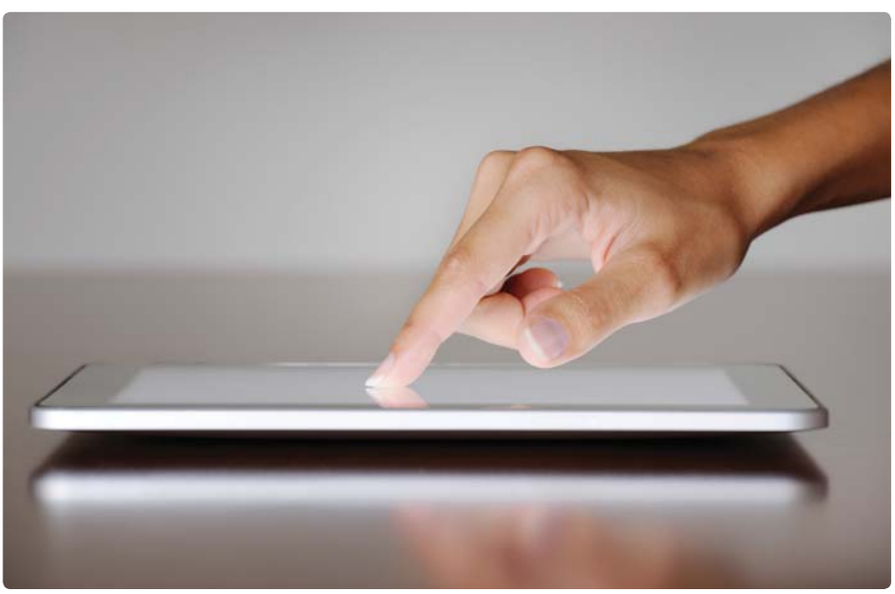
"The CIEHF has taught me a huge amount about how ergonomics and human factors can help businesses to improve the efficiency, safety and comfort of their workers. I was delighted to attend the Institute's Chartership launch in January 2015. This document communicates very clearly the benefits this discipline can bring to a wide range of sectors and will be a great resource to anyone who wants to understand how ergonomics and human factors can support them in improving their business."

Nicky Morgan, MP for Loughborough

Thoughts for educators

- Ergonomics and human factors provides an exciting, interesting and challenging career opportunity.
- Ergonomics and human factors is core to a number of other academic subjects such as design and technology, and computing, but also links to science, geography, psychology, business and PSHE (personal, social, health and economic) education.
- Including elements of ergonomics and human factors in other disciplinary training programmes such as engineering, business, computing, architecture and design, will provide students with professional and analytical skills which will improve their practice and ability to adopt a systems perspective to problem solving.

Skilled application of ergonomics and human factors will lead to resilient, productive, connected, healthy and sustainable workplaces.



Ergonomics and human factors is a discipline that can help people solve problems. Whether designing a new technology to support traffic control, or understanding why patients struggle to use personal medical devices, skilled application of ergonomics and human factors in design, implementation and evaluation will lead to resilient, productive, connected, healthy and sustainable workplaces.

An investment in ergonomics and human factors work will lead to strong returns, delivering better solutions, new knowledge and short and long term changes in people, systems and workplaces.

The Human Connection

Ergonomists and human factors specialists have been at the heart of changes to safety critical systems, resulting in accidents being avoided and lives being saved.

Making things safe

The range and diversity of applications of ergonomics and human factors is immense. In aviation, the adoption of a human factors approach has changed the design of flightdecks and aircraft interiors. For many years, the high-hazard industries have recognised the importance of minimising the risk from human error. The nuclear sector has led the way in understanding, measuring and improving reliability, and UK nuclear regulation is seen by many as the gold standard.

In healthcare, ergonomists and human factors specialists work in partnership with clinicians, managers and IT specialists to contribute towards a safe and resilient 21st century healthcare system. Much focus has been placed on improving communication between clinicians, ensuring that teams of doctors and nurses work together to make effective decisions and reduce the likelihood of harm. In addition to this important work, many pieces of equipment that we find in a clinical setting, from ambulances, to drips that deliver life-saving drugs, have been developed and evaluated by human factors experts.

Making things effective

Effective work systems come about through the user-centred design and evaluation of technologies that support the operator in complex work. In rail, tools developed by human factors experts are now routinely used to assess the workload experienced when operating different types of signaller workstations. These assessments not only make sure that our railways are safe and run efficiently, but also help to support the design of new, advanced signalling systems that are essential for us to be able to take advantage of automation technologies and high speed rail.

Ergonomics and human factors has at its heart the consideration of the wellbeing of the human operator. As well as the societal and ethical need to ensure that people at work are comfortable, healthy and happy, there is economic value to ensuring that our workforce is operating in safe conditions.

As well as the societal and ethical need to ensure that people at work are comfortable, healthy and happy, there is economic value to ensuring that our workforce is operating in safe conditions.

Ergonomics and human factors improves workplaces by developing tools that support the design of comfortable tasks that reduce discomfort and make injury and sickness absence less likely.

Ergonomics research is behind the regulations that have been implemented nationally to ensure the design of safe workplaces – and this work continues, as our workplaces evolve from the desktop and traditional factory environment to mobile and active work systems and as automation continues to be introduced into factories of the future.

We see examples of ergonomics and human factors embedded in design in all aspects of our lives. Supermarket checkouts have evolved in their design with the support of ergonomists and the markings on emergency service vehicles were carefully developed on the basis of research by human factors specialists.

Making things usable

Eleven million people in the UK are over 65. For these people, usability is not only something that leads to them finding a product less frustrating to use, it can also save their lives. Ergonomists have been involved in helping to design accessible medicine packaging using knowledge about the strength and dexterity of older adults, and have considered the way in which medicines are labelled.

Human factors helps us to travel and navigate through our increasingly complex worlds. The UK motorway signage is held up as a beacon of excellent design. Human factors specialists have helped to ensure that technology-based road signage is developed to be usable and understandable, helping our crowded road networks to be as efficient as they possibly can be.

Human factors is at the heart of the user experience going beyond safety, effectiveness and usability to the pleasure and experience of interacting with products.

Human factors is at the heart of the user experience, going beyond safety, effectiveness and usability to the pleasure and experience of interacting with products, and using products to enhance our lives.

We encounter the work of ergonomists and human factors specialists in many types of technologies that we use every day. From the red button on our TV remote, to new interfaces in our cars, to the design of information as we move through an airport. The work of ergonomists and human factors specialists has made our technologies more usable and our experiences more positive.

How do we do it?

What makes ergonomists and human factors specialists unique? What are their skills, and how do they deliver these improvements in design?

All ergonomists and human factors specialists build on knowledge from disciplines such as anatomy, physiology, design and psychology, and take what we term a 'systems approach'. They study:

- Physical capabilities: strength, physical form (height, weight), physiological responses and the variation amongst a wide population, from children to older adults.
- Cognitive capabilities: how people think, process information, make decisions and complete tasks.
- Organisational factors: how we can influence culture, understand safe behaviour and motivate people to work effectively.
- Social factors: what people want and how they behave, as individuals and in groups.
- Systems: how the people, technologies, products and physical workspaces interact, and how the complexity of these interactions can be taken into account through design.

Ergonomists and human factors specialists need to be able not only to understand the specifics of an interaction between one person and one interface, but also to be able to predict the impact of making a small change to a single device on the overall system.

Ergonomists and human factors specialists work with users and enable them to participate in the design of new systems and workplaces. They get involved at all stages of design and evaluation, from early concept development, to evaluation of fully deployed systems.

Ergonomists and human factors specialists are trained to understand users and their goals. By evaluating their behaviour and performance they are able to work with users to develop exciting new systems for the future.

Ergonomists and human factors specialists also work as part of a team, to deliver change to the way in which products and systems are designed.

"Ergonomics is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimise human well-being and overall system performance."

International Ergonomics Association

Ergonomics and human factors for the future

This document represents a starting point, and a snapshot of current and recent activities that demonstrate the value of ergonomics and human factors.

Our activities and challenges will continue into the future. As society, engineering and technologies change, we also need to change in the way we apply human factors methods and develop new understanding of the science of how people, technologies and systems interact.

Changes that are already happening which are of significant relevance to our Chartered Institute and its members include:

- Increased awareness of the health risks associated with sedentary work, requiring new equipment and knowledge about the ways that we can ensure that people are healthy in the workplace.
- New methods of energy production, requiring understanding of advanced distributed control, the safety implications of future energy technologies, and the role of the user in personal energy management.
- Autonomy in systems, from manufacturing robots to driverless cars, requiring new understanding of how people and autonomous systems can work together, and how we can design new interfaces to display the activities of autonomous systems.
- Cybersecurity risks and the need to understand the role of the human when designing data systems that are effective, secure and usable.

Working in partnership is key to our success. We aim to increase our relationships with other professional institutions and learned societies, and to work to directly influence policy makers and regulators. This document is a step towards helping us to communicate with colleagues and collaborators.

The human connection is key. The case studies presented in this document help us to demonstrate how ergonomics and human factors can help us as individuals, teams, businesses and society as a whole.

Ergonomics everywhere – making life better.

Case studies of ergonomics & human factors

Title	*Area of ergonomics & human factors*	*Sector*
Simplicity & effectiveness		
1. Understanding passengers	User experience	Transport
2. Improving the usability of PIN pads	Usability	Retail
3. Designing for delight	User satisfaction	Transport
4. Making public information accessible	Information design	Security
5. Responding to incidents	Incident management	Utilities
Comfort & performance		
6. Developing a training simulator for tram drivers	Simulation	Transport
7. Encouraging green behaviour	Sustainability	Retail
8. Improving a computer user's comfort	Workstation assessment	Office
9. Improving parcel sorting	Manual handling	Distribution
10. Increasing productivity and reducing risk on assembly lines	Task design	Manufacturing
11. Assessing workload in rail	Workload assessment	Transport
12. Maintaining control in a highly automated system	Human-centred design	Transport
13. Improving alarm systems	Alarm system design	Transport
14. Optimising control room design	Control room design	Transport
15. Providing the best workstation	Workplace design	Retail
Efficiency & safety		
16. Designing for patient safety	Participatory design	Healthcare
17. Safer neonatal care	Workspace design	Healthcare
18. Improving birthing pool design	Product design	Healthcare
19. Improving staff and customer welfare	Retail design	Retail
20. Reducing and preventing musculoskeletal injuries	Workplace design	Manufacturing
21. Reducing repetitive strain	Computer aided design	Security
22. Compiling a health and safety strategy	Health and safety strategy	Transport
23. Designing effective protection	Protective equipment design	Defence
24. Designing armoured vehicles	Armoured vehicle design	Defence

Chartered Institute of Ergonomics & Human Factors

Case Study 1

Understanding passengers

Sector: Transport

From the outset, HS2 was set a strategic objective by the Department for Transport to deliver a step change in passenger experience. HS2 needed to examine its emerging design as a whole system. It was recognised that passengers see their time on HS2 part of a wider journey and this gave an excellent strategic viewpoint.

The aim of the work carried out by ergonomists was to provide a strategic framework that would research and describe the passenger of the future, their needs, the experience that they might want at each step of their journey and the capabilities and functions that HS2 would require to deliver the service.

Exploring the experience of travel

Ergonomists used ethnographic and other primary research methods to explore the current experience of rail travel, to look at current passenger behaviours and identify the pinch points and opportunities.

Observations and interviews with staff and passengers led to the development of a service hypothesis. This described the journey steps and explored the desired experience at each stage. It outlined a proposition for the service that was built around the fundamental basics (the service DNA) that needed to be delivered reliably and consistently every day. It also identified the desire from passengers for a service that was adaptive to their individual needs and was live to real events.

Further research was undertaken to validate the hypothesis and from this a Passenger Experience Strategy was developed. The strategy identified the basics of the service, basics which have to be delivered before any value-added services can be considered. These included both emotional basics such as safety, reliability, ease of use, efficiency, honesty, transparency and quality, and physical basics such as cleanliness, comfort, and good organisation.

It also provided a vision for adaptive services which are built around passengers' needs and not those of the operator. It covered key service principles including services being simple and sensible, giving choice and flexibility, and that everything starts with the passenger.

Ergonomists also conducted a number of applied research programmes to forecast the impact of mobility and an aging population on station design including walking speeds and boarding/alighting speed.

A study was done using a combination of research literature and an observational study at UK railway stations to look at mobility and walking speed. The observations gave a baseline of walking speeds for a cross-section of the population, and the literature gave a guide on how those population groups would change proportionally in the future. This allowed us to look at how the average walking speeds of a passenger

User experience

Considering the user experience is at the heart of ergonomics and human factors, and ensures that experiences of system and product use have value to a user. By understanding user goals, and the settings in which they are based, from travelling to using a consumer product, we can help designed experiences be useful, usable, desirable and accessible.

Impact

Improved customer engagement
Improved user experience

> *"This work is evidence of how a human factors led process can deliver strategic and top level vision to major projects."*

group might change. The research into mobility has led design decisions around the numbers of escalators and the location of lifts.

Making a difference

A strategy considering the passenger and staff experience in the design process was developed deployed throughout the organisation designing and developing HS2.

It has taken the issue from a theme to usable tools and methods that can be used across the design organisation.

Finally, the people-centric system thinking provided by ergonomists has been used to create a vision statement for the whole of the HS2 project called the 'Big Picture Vision'.

This document encapsulates the vision of what HS2 will be as a transport system. It describes how it will operate and what that means for passengers, staff, other stakeholders and those working on HS2 in the design and construction phase. This is a key strategic document for HS2 sitting alongside its 'Design Vision'.

This work provides a people-orientated perspective on complex systems that is a different and wider view than many others that are routinely taken. The outputs of this work have provided a robust framework for HS2 to deliver on its objective to provide a new benchmark in passenger experience.

Consultation with others

Research on boarding and alighting trains was carried out in collaboration with researchers at University College London.

Wider applications

User experience is particularly important to consider when delivering services, such as transport, leisure activities or commercial products.

A positive user experience often goes unnoticed, but a negative experience can lead to dissatisfaction and lack of repeat business.

If we wish to encourage people to change behaviour (such as taking public transport) then considering the user experience is vital if people are to receive positive benefit from their behaviour change.

Produced and published by the Chartered Institute of Ergonomics & Human Factors.

Acknowledgements
This project was carried out by CCD Design and Ergonomics.

Chartered Institute of Ergonomics & Human Factors

Case Study 2

Improving the usability of PIN pads

Sector: Retail

In 2002-2003, more than 20,000 PIN (personal identification number) pads were installed in Post Offices throughout the UK so that customers could still access their money locally, following a Government decision to pay pension and benefits directly into customers' bank accounts.

At the time, the use of chip and PIN was limited to the banking sector's Automated Teller Machines (ATMs) and there were very few PIN pads available for use in retail environments.

The PIN pad selected by the Post Office was functional but not optimally designed from a usability perspective. For example, customers who were elderly, with limited dexterity, or with sight loss experienced difficulties using the PIN pad due to the physical design of the key pad.

Understanding users' needs

Ergonomics professionals adopted an inclusive approach to the specification, review and improvements to the design of these PIN pads, adapting them for the needs of people with physical disabilities and sight loss, through interaction with actual users.

Initial user testing of the PIN pads found that the pads were usable by the majority of customers for the limited amount of interaction needed. However, older people and people with sight loss, with dexterity impairments and wheelchair users needed modifications to the PIN pads to be able to use them effectively.

For those with sight loss, this meant including a key pad guide and tactile markings to improve navigation across the key pad. For older customers and those with hearing loss, a more pronounced audible feedback was needed.

Further testing also showed that inserting a bank card into a slot on the PIN pad caused difficulties for some customers. This included not being able to find the card slot, difficulty putting the card into the slot and pulling it back out again, and putting the card in the wrong way round.

Modifications to improve usability included more visible indicators of where and how to insert the card, and tactile markings on the card to indicate how to orientate it.

These changes were tested by groups of up to 60 people who were elderly, had sight loss, hearing loss, mobility or dexterity impairments to determine the optimum design of the modifications.

Usability

Usability is the part of ergonomics and human factors that defines the extent to which something can successfully be used by a target audience to achieve certain goals.

The most effective way to measure this success is through user testing, which will reveal which aspects of the design work well and which need further modification.

If done at an early stage, this activity can save time and money in the long run and provide a better, more satisfying user experience.

Impact

Improved customer engagement
Improved user experience

> *"The result of the project was a modified design, rolled out to all Post Offices, which is usable by the vast majority of the population, including those with access needs."*

Making a difference

Several modifications were made to the original PIN pad designs to improve the usability for those who had difficulty in using the pads. These were specifically those customers who were elderly, experienced sight loss, hearing loss, mobility or dexterity impairments.

- A cover was put over keys that were not for customer use so that the top keys were 1, 2 and 3.
- A tactile pimple was added to the number 5 key to help customers with sight loss navigate around the key pad.
- A yellow funnel was added to the card slot to make it easier to identify the slot and to insert and retrieve the card.
- An illustration was added above the card slot to help customers insert their card the right way up.
- Post Office bank cards were notched on one edge to help customers determine which end of the card to insert into the slot.

Ergonomics input was also provided in the development of training for Post Office counter clerks. A workshop was designed and facilitated which included representatives of disability access groups and Post Office training specialists.

Original PIN pad

Final design of PIN pad

Consultation with others

Throughout the ergonomics work on the PIN pad, input was sought from special interest groups including the RNIB, the Multiple Sclerosis Society, Parkinsons Disease Society, the Stroke Association and various local accessibility groups.

Produced and published by the Chartered Institute of Ergonomics & Human Factors.

Wider applications

The PIN pad, such as that used by the Post Office, is just one example of an input device in the retail sector that is used by the majority of the general public.

Designing for a wide ranging population can be challenging but the early application of ergonomics and human factors principles and methods ensures that as broad a range of capabilities as possible is taken into account in the design and user testing stages. This results in a device that is highly usable, fit for purpose and provides a quality user experience.

Other examples of this type of public design application are cashpoint machines, ticket machines and parking meters.

More restricted target populations may occur with devices used within businesses, for example, to log picked orders in warehouses or shelf-stacked inventories in supermarkets.

Further information

An international standard, ISO 9241-11 Ergonomic requirements for office work with visual display terminals, provides guidance on usability.

It explains how to identify the information necessary to take into account when specifying or evaluating usability in terms of measures of user performance and satisfaction.

Guidance is given on how to describe the context of use of the product and the measures of usability. It includes an explanation of how the usability of a product can be specified and evaluated as part of a quality system, for example, one that conforms to ISO 9001.

Acknowledgements

This project was carried out by Royal Mail Ergonomics Team, RED Design Ergonomics Ltd, HF Solutions Ltd and InterAction of Bath Ltd.

Chartered Institute of Ergonomics & Human Factors

Case Study 3

Designing for delight

Sector: Transport

Prestige cars are marketed on emotive terms such as 'delight'. How such terms are measured for new automotive innovations is open to investigation. There seem to be few such measures that work across different technologies or early in the design process. Jaguar Land Rover funded this research to develop such a measure to help them identify those technologies early in the design process that may generate greater levels of consumer delight and acceptance.

Driver acceptance of in-vehicle technology design is seen by Original Equipment Manufacturers (OEMs) as dependent upon its emotional, cognitive and experiential effect on the consumer.

The aim behind innovative design changes is not only to produce a better product, but also to create consumer demand for that product. In such a competitive sector it is of the utmost importance to produce a design that meets these needs otherwise the competitive edge will be lost. While a great deal of marketing research is conducted to position a brand and also to gauge consumer reaction to the finished product, there seems to be little systematic research at early design stages. Rather, this is guided by the intuition of the designer using past experience and product history.

In particular there seems to be no objective means to measure customer preferences for novel design solutions to determine if they will increase consumer purchasing desire.

Understanding driver acceptance

A three-year research programme, conducted at Cranfield University and commissioned by Jaguar Land Rover, aimed to develop a measure of driver acceptance of in-vehicle technology designs taking into account a wide ranging review of the literature in marketing, ergonomics, design and psychology. The research found that driver acceptance is a multi-dimensional concept dependent upon emotional, cognitive and experiential factors. A pilot instrument was designed and validated against available advertising materials. Research to develop and validate the instrument aimed at measuring consumers' affective responses to innovative in-vehicle technologies and is referred to as the 'Profile of Emotive Designs' (PED).

There were three main goals to achieve for a suitable instrument. Firstly, it had to work for different modes of presentation, such as storyboard/ pictures of the design, through to prototype and the actual end product in the target vehicle. Secondly, it had to discriminate between different technologies indicating which would receive the most favourable reaction in consumers and therefore should be developed. Finally, it had to work across quite different designs, from gear selectors to light switches. Focusing on in-car innovations, the instrument was developed to capture perceived usability, social and external factors, novelty, delight and a

User satisfaction

Considering aesthetics and emotional response is a critical part of the holistic approach of ergonomics and human factors. By incorporating methods that help to 'design for delight' we can move beyond 'form vs function' and design products that are both pleasurable and usable. This approach has commercial value, as we know that people will pay more for a 'luxurious' experience, and is an important part of building customer loyalty and satisfaction.

Impact

Improved user experience

Improved customer engagement

> *"The aim behind innovative design changes is not only to produce a better product but also to create consumer demand for that product."*

general measure of mood. These dimensions presented themselves as important in the measurement of emotive reactions to designs.

Making a difference

The responses across three different in-vehicle technologies were subjected to principal components analysis to identify the constructs underlying each of four scales: Technology Acceptance, Moderating Factors, Affective Appraisal and Emotional Valence.

Calculating mean response scores for each scale revealed a pattern of results showing that the scales discriminated between different design technologies in the expected direction and for different modes of presentation.

A series of studies found that the PED did produce the expected ranking across three very different technologies, supporting its generality of use. Scores from pictures/descriptions, videos and in-car experiences also produced surprisingly comparable results, except for aspects of ease of use which required physical interaction with the design technology. This suggests the PED would be useful at all stages of the design process, producing indicative scores before the finished design is available.

Developed through a process of exploratory factor analysis the PED has stable underlying constructs. Confirmatory factor analysis suggests that the data are modelled reasonably well. At a practical level the PED discriminated between technologies in how favourable they were to the consumer and was predictive of intentions to purchase. In these respects the instrument is unique in the literature.

Wider applications

User satisfaction is key in the high technology market, where brand and experience integrate with usability. Products such as smartphones, personal fitness devices, home heating controls and future office furniture benefit from design approaches that combine satisfaction and usability as well as engineering requirements.

Further information

R Edmunds, L Dorn & L Skrypchuk (2014). The profile of emotional designs: A tool for the measurment of affective and cognitive responses to in-vehicle innovations. In: M A Regan, T Hornberry & A Stevens, eds. 2014. *Driver acceptance of new technology.* Surrey: Ashgate Publishing Ltd. pp105-120.

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Acknowledgements
This project was carried out by Cranfield University.

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Case Study 4

Making public information accessible

Sector: Security

The Civil Contingencies Act (2004) requires local authorities to inform the public about health protection measures in the event of civil emergency. Emergency preparedness leaflets are a common means of achieving this. These leaflets are produced to fulfil mandatory requirements, with little known about how effective they are for receivers in terms of being understandable, informative, useful, memorable and encouraging desirable behaviours.

Testing the efficacy of information

There is research evidence from a variety of domains, for example warning signs and labels, risk perception and persuasive communications, available to guide the design of emergency preparedness information and tailor it to receiver needs. Ergonomists used this research to derive guidelines for the design of emergency communications and applied it to the design of a trial leaflet. Specifically, they studied the emergency preparedness literature routinely distributed by a nuclear site operator to houses within a 2km radius of their site. Their nuclear safety information leaflet (NSIL) was used as a tool to test the efficacy of guidelines derived from research and to explore the effectiveness of leaflet distribution as a means of encouraging emergency preparedness.

Baseline measures were collected by delivering questionnaires to 3886 households, recording memory for, and self-reported understanding of, nuclear safety information. This understanding was based upon general knowledge and also upon a distribution of NSIL 3 years previously, and so these measures afforded an opportunity to evaluate the effectiveness of periodic distributions of emergency preparedness information. 631 households returned the questionnaire. Responses indicated high levels of non-receipt of the leaflet and that many receivers did not read or understand it. Memory for specific advisories was also poor, ranging from 7% to 68%. These baseline measurements indicated that periodic distribution of emergency preparedness literature, and the leaflet itself, were only partially effective.

During the intervention phase, a trial leaflet was designed on the basis of research evidence and focus group evaluations of the original NSIL. The trial leaflet incorporated much of what would be predicted to be best practice in the design of emergency communications, incorporating research relevant to information content, wording, the use of color and pictorials, message formatting, memorability and compliance. Six focus groups from the target population also contributed to the design of the trail leaflet, making suggestions in relation to information content, areas for clarification, and formatting.

Information design

Designing public information so that it not only contains the information that people need to know, but is also clear, understandable, useful, memorable and encourages the desirable response in the receiver.

Impact

Improved user experience
Improved safety
Improved wellbeing
Financial savings
Improved customer engagement
Better organisational strategy
Improved corporate engagement

> *"A set of evidence-based guidelines for the design of emergency preparedness literature was developed. No such evidence-based guidance was previously available and it is now in the public domain."*

Making a difference

In June 2008 the site operator delivered their NSIL. The trial leaflet and a questionnaire were delivered to 1350 of those households in the same month. Of the 112 households that responded, a larger proportion found the trial leaflet easier to understand (59%) than the NSIL (24%) and a larger proportion (57%) preferred the trial leaflet, as compared with the NSIL (31%). The primarily subjective measurements taken here suggest some advantage for the trial leaflet.

Objective data about people's relative performance with the leaflets was also was collected. 302 participants studied one of the two leaflets in an experimental setting. Objective measures of memory were recorded once after the study period and again either one week or four weeks later, so memory for the safety advice presented in the two leaflets was directly compared. The trial leaflet out-performed the NSIL in terms of overall memory for the advice elements. Specific pieces of advice that were particularly well remembered after study of the trial leaflet as opposed to the NSIL were: not using mobile phones, not leaving the area, not collecting children from school, and following instructions.

The main improvements were as follows:

- The material was organised so that details of the nature of the hazard, the consequences of exposure, and avoidance instructions were clearly and explicitly presented.
- The trial leaflet was substantially shorter than the original leaflet. Recipients were directed to an authoritative source of additional information in the trial leaflet.
- Some modification of the text enabled the readability index to be reduced from 61 to 56 and the reading grade from 8.9 to 8.
- The negative consequences of non-compliance were emphasised when appropriate, for example "You should not leave the area because if you do the roads may become gridlocked".
- Definitive and explicit wording was used when appropriate, for example, "You will reduce the effects of exposure to radiation".
- The colour scheme was presented in red and white. Red is well known to be associated with danger.
- Pictorials were used as well as words to illustrate the advice elements. This is helpful for non-native English speakers and people who may not be able to read well.
- A minimum size 14 font was used throughout to improve readability and the text was structured into a tear-off section of summary advice.

Besides being better remembered, the trial leaflet was also judged easier to read and to contain less unnecessary information. The trial leaflet was shorter and had some technical information removed, and this probably resulted in it being easier to read. Interestingly, the reduced length and ease of reading did not influence intended compliance, self-reported understanding, or the trust in the leaflets.

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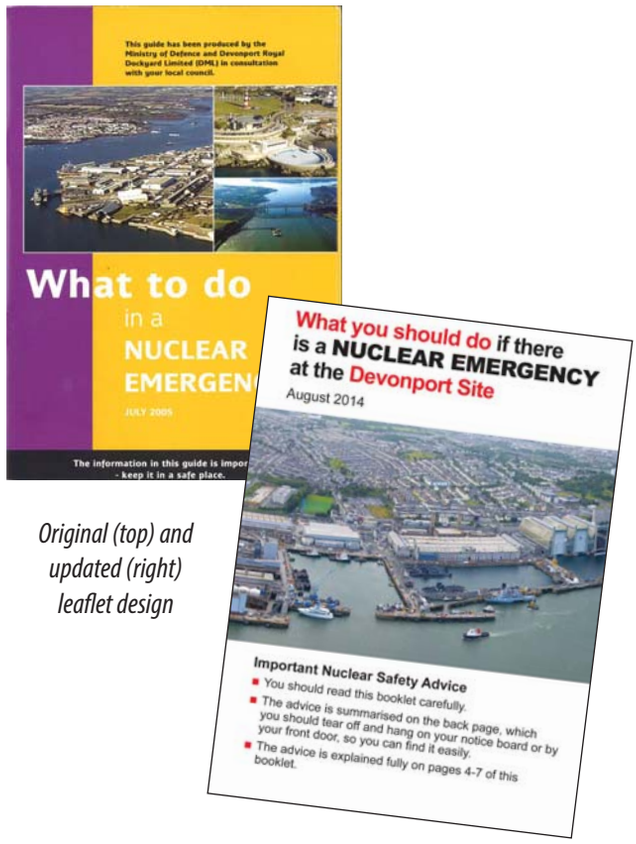

Original (top) and updated (right) leaflet design

Wider applications

Methods and approaches such as those presented here can be applied in many circumstances where a response to incidents is needed. Transport, manufacturing, healthcare and energy are all sectors where a clear and organised response to safety critical incidents is essential to ensure safe operation and protection of human wellbeing.

Further information

E Hellier, J Edworthy, L Newbold, K Titchener, M Tucker & E Gabe-Thomas (2015). Evaluating the application of research-based guidance to the design of an emergency preparedness leaflet. *Applied Ergonomics,* 45(5), pp1320-1329.

Acknowledgements

This was a collaborative project between the Centre for Brain, Behaviour and Cognition, School of Psychology, University of Plymouth; the Home Office and Devonport Royal Dockyard, Plymouth.

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Case Study 5

Responding to incidents

Sector: Utilities

A water company considered that its arrangements for responding to incidents were ineffective. Service interruptions arise from process failures or external events, not all of which are avoidable or foreseeable. It had processes to minimise customer impact whilst restoring service. There was concern that those processes were not delivering the required benefits.

The Emergency Planning Manager considered that poorly formatted and designed emergency procedure documentation was the problem and he asked ergonomists to 'improve the ergonomics of the documents'.

Examining procedures

The water company had a suite of procedures for dealing with failures such as burst water mains and water quality issues, but recognised both that they were not always followed and the response was not often optimal. There was a perception that they were always 'on the back foot' and sometimes appeared to aggravate the situation.

Their initial aim was to rewrite the procedures to comply with ergonomics best practice to improve their usability. This recognition that the underlying issue was human-based was valuable as a starting point for the work. Ergonomists were commissioned to provide advice on aspects of the procedure such as format, wording and use of colour.

The initial engagement comprised developing an understanding of the nature of the various events, the objectives of event management, the role of the procedures and how they were intended to be used, etc. as a precursor to reformatting and redesigning them. It rapidly became apparent from this systems-based perspective that the underlying issue concerned the approach to event management and the associated arrangements. As a consequence, our intervention was expanded to address the wider systems-based issues.

Working closely with functions across the business, such as operations and customer services, we re-examined the challenges of the existing suite of procedures from the perspective of decisions that underpin successful event management.

This examination revealed that although the documentation would benefit significantly from a complete re-structuring, the underlying challenges concerned such issues as recognition of an event, internal communications, escalation of control, and a need to shift the focus from the asset and process failure (such as a burst main) to service interruption (such as customers without water).

The work coincided with a wider organisational desire to improve their customer focus and to change the culture towards being more of a service organisation than an asset management organisation.

Incident management

Systems and organisations need to be designed not only to support routine day-to-day running but also to be able to respond when unexpected events occur. Because unexpected events can be rare and unpredictable, using human-centred methods such as risk and reliability assessments or scenario generation can help ensure that we are more prepared and able to respond when incidents occur.

Impact

Improved working conditions
Improved job design
Improved customer engagement
Better organisational strategy

> *"What was initiated as a simple re-write of procedures developed into a programme of work that changed the manner in which the organisation manages events."*

Making a difference

Ergonomists developed a new approach to the recognition and management of events, providing clarity of roles and of the necessary decisions. Working with the organisation, they developed a more risk-based approach, with an emphasis on the initial stages of event management (creation of a team, effective risk assessment and communication).

They also completely restructured the procedures. The original suite was text-heavy. It was of little assistance during an event and hence was rarely consulted. The ergonomists separated out information that would support acquisition of competence and moved it into a new training programme. They developed a simple set of event management cards that would provide suitable prompts during an event and would therefore actually be consulted.

The bulk of the response to events is undertaken by the workforce alongside their day jobs. They therefore need to understand how the objectives change as they take on event management roles.

The training was also a means of facilitating culture change across the organisation, to enable all staff to understand the importance of a customer focus throughout their activities. A number of very clear benefits emerged from this programme of work:

- A more customer-focused response to incidents with consequent improvements in customer satisfaction.
- Improved arrangements to support more rapid and effective decision making, and therefore more accurate and timely response.
- Effective and successful event management improves the organisation's reputation, and can potentially turn a cost into an opportunity.
- The training that has been rolled out across the organisation, together with the visible improvement in the management of events, act together to increase staff confidence, and also act as a catalyst for culture change. The effectiveness of the arrangements has also increased regulatory confidence.

All of these together demonstrate that the organisation has gained significant benefit from engaging with ergonomists.

Wider applications

Methods and approaches such as those presented here can be applied in many circumstances where a response to incidents is needed.

Transport, manufacturing, healthcare and energy are all sectors where a clear and organised response to safety-critical incidents is essential to ensuring safe operation and protection of human wellbeing.

Produced and published by the Chartered Institute of Ergonomics & Human Factors.

Acknowledgements
This project was carried out by Greenstreet Berman Ltd.

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Case Study 6

Developing a training simulator for tram drivers

Sector: Transport

There was a need to train tram drivers on new routes and signalling for track sections that were not yet available to drive in the real world.

Waiting until the track was built before carrying out training would delay the opening and putting untrained drivers onto real tracks would pose a safety risk.

To decrease costs and improve safety, human factors professionals were asked to develop a simulator that would allow drivers to begin their training before going out on the actual tracks so that once the track was open, they were ready to complete their real-world training.

Assessing training needs

Human factors professionals worked with a multidisciplinary team that included software engineers to develop the Tram-Pro system.

Firstly, a training needs assessment was carried out to establish the training 'messages' to be communicated and to develop the specification of the software and hardware required.

As the simulator was aiming to provide a kinaesthetic learning experience, the simulator was closely aligned with the On the Job Training (OJT) using 'Minder Drivers' that drivers were already familiar with.

To this end the software was developed to:

- Include a 3D virtual experience.
- Accurately model movement of the tram.
- Include controls to enable acceleration and braking.
- Include an accurate 3D exterior environment.
- Include all track features such as curves, gradients and movable points.
- Emulate the signalling system.
- Include 'virtual minder' audio.
- Record a log file for every session.

During the training needs assessment phase a detailed specification was developed including moves that the trainees are required to perform as well as operational scenarios that the trainees needed to encounter during the training. The software was then developed in accordance with this specification.

The user interface was carefully designed to reduce the necessity for trainees to be computer literate as it was feared that this could dilute the expected benefits that could be realised using the simulator. The entire 250-strong driver pool was then trained in the simulator over a period of two weeks.

Simulation

Simulation is a training technique in which substantial aspects of the real world are replicated in a fully interactive fashion to create an immersive experience for trainees.

The technique makes it possible for trainers to manipulate situations so that trainees are presented with various problems that allow them to develop and practice complex skills in a safe environment.

Simulation may involve technology but it also may consist only of actors and fellow staff who play roles in a simulated situation.

Impact

Improved user experience

Improved safety

Improved job design

> *"Whilst simulator training is commonplace in aviation and now in heavy rail, this approach is novel in light rail, but 98.7% of drivers had a positive response to the training."*

Consultation with others

Consultancy Ian Rowe Associates worked in collaboration with 3D modelling company ARCmotion, engineers and client stakeholders to develop the tram simulator. Stakeholders from the Office of the Rail Regulator were also engaged.

Making a difference

With use of the simulator, once the new lines became available, they could be brought into revenue generation in a shorter period of time and with a reduced safety risk. Specific benefits included:

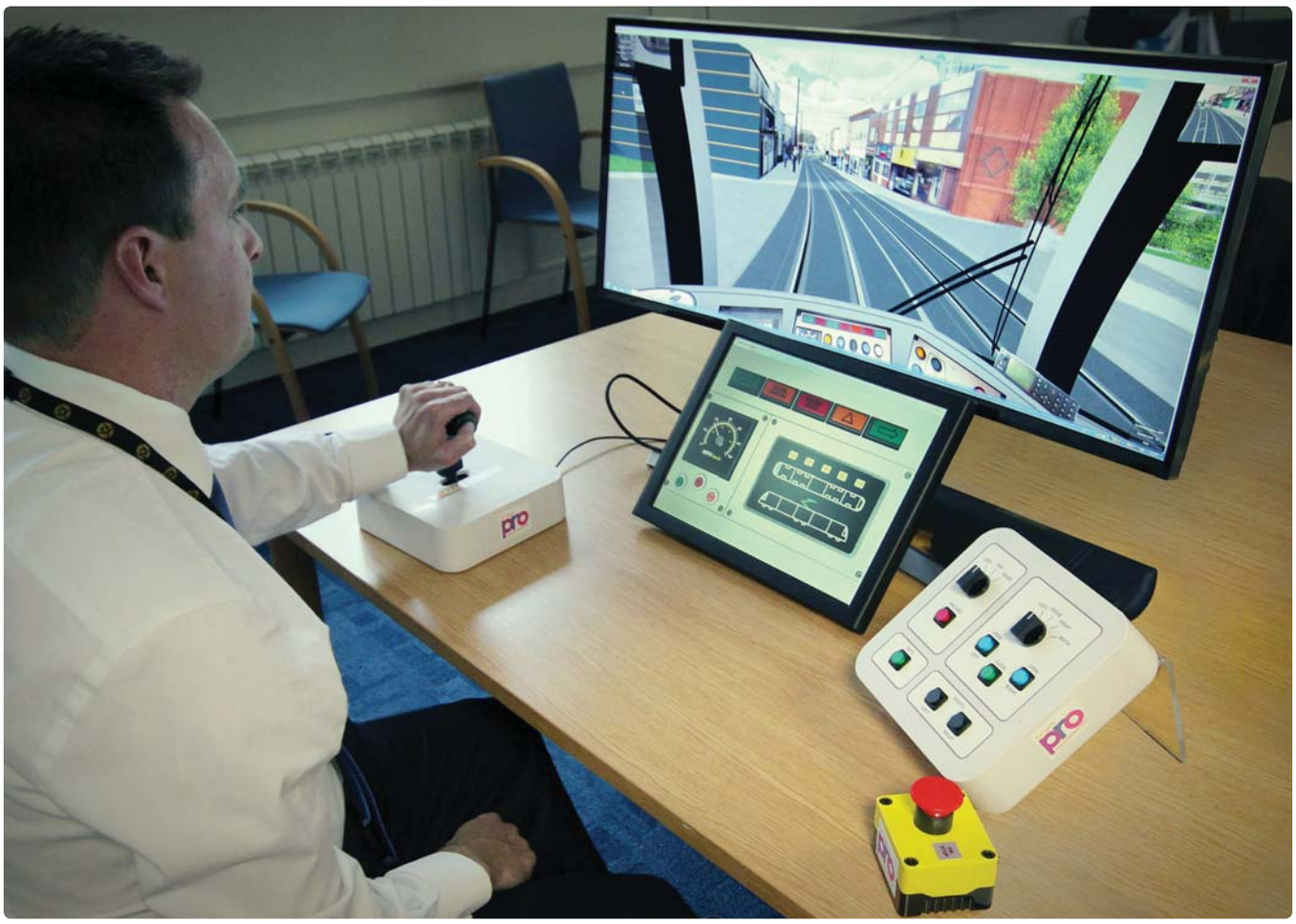
- An estimated 50% reduction in overall training time.
- High Driver to Trainer ratio (8:1).
- An increase in training quality and consistency.
- High user satisfactions levels.
- Elimination of service disruption during driver training times.
- Used for training and familiarisation of other operational functions, such as control room staff.
- Provides auditable driver training records.
- Used to provide initial assessment of potential recruits.

Wider applications

Computer-based simulators are regularly used to train pilots and train drivers.

Simulation is also being used more and more in healthcare, where staff replicate a particular situation using manikins or actors to allow healthcare providers to learn the more complex skills needed to deal with emergencies or difficult interactions with patients.

Simulation can be used in any training situation to give trainees the opportunity to practice skills in a safe environment.



Further information

Further information about the tram simulator along with a video of it in action, can be found at www.tram-pro.com.

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Acknowledgements
This project was carried out by Ian Rowe Associates Ltd.

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Case Study 7

Encouraging green behaviour

Sector: Retail

Energy management has become a key part of organisational life across all industries and is proving an area of increasing interest as a response to carbon reduction targets. This interest is also reflected in the increase in corporate responsibility carbon commitments amongst UK retailers which detail far-reaching carbon reduction targets and stategies.

Running alongside important ethical considerations associated with climate change are gradual, long-term pressures such as rising energy prices and increasing fuel poverty.

Ergonomists carried out a two-year qualitative case study with a large UK retail organisation. The study explored energy mangement from a socio-technical perspective, and considered the inter-relationships that have rarely been discussed together in a workplace environmental study.

Previous efforts and their effects

The retailer has clear published carbon targets, aiming to halve emissions from a 2006/2007 baseline by 2020 and become a zero carbon business by 2050. Consistent reduction in energy consumption has been observed as a result of the existing behavioural strategy, however, in order to further improve it is recognised that some review and change could enhance existing practices.

Stores were instructed through the central energy behavioural strategy to nominate their own Energy Champions to be trained on energy issues and to influence their peers to complete energy saving tasks. This was not incorporated as part of a job per se, but seen as an add-on task to an existing job role. Motivation for these Champions was largely constructed around personal commitment to carbon reduction and financial savings for the organisation.

Data from previous research have already indicated that neither of these motivations was likely to be universally appealing in the wide organisation, so although individual Energy Champions were very successful, particularly at the outset, the network was unlikely to sustain on-going impact.

In addition, the approach did not reflect potential for multiple goal conflict, and that the extra responsibility might be resented by some Champions. Although some Champions relished their position, and used it effectively to encourage other people to take behavioural action, others expressed frustration with being given additional tasks to perform.

Initial research through focus groups and interviews indicated that staff needed very specific feedback on clear, understandable targets in order to increase their motivation to engage in energy-saving behaviours. Competition was also very effective in increasing staff motivation. Energy targets were sometimes ignored if they conflicted with other customer-focused targets that were considered more important.

Sustainability

Reducing our energy consumption is an important consideration for individuals and employers. The way that we design jobs and products can affect behaviour related to energy use. People working in organisations are influenced by goals, which may relate to personal targets or overall organisational aims.

Using a systems approach allows us to understand what competing goals influence work behaviour, and to design jobs to encourage behaviour and actions that support sustainability.

Impact

Financial savings

Improved job design

> *"Managers at the headquarters of the retailer valued the energy cost saving at £4 million in the first year of intervention."*

This goal conflict needed to be addressed in the way energy-saving behaviours were prioritised.

Making a difference

Data inspired two job design interventions that were implemented in over 1000 stores, focusing on energy management accountability and performance management.

The intervention involved incorporating energy practices such as closing doors to prevent heat escaping, closing fridges, turning off lights, etc., into existing job structures through job redesign.

It was theorised that it was counterproductive to see energy as a primary organisational goal, as it risked the perception of opposition to primary sales goals in terms of staff time and effort. Therefore energy management was specifically designed as a secondary goal in the organisation to be aligned with existing cultural characteristics through job design, practices and processes. This is consistent with existing theory on managing multiple goal conflict through simplification brought about through alignment with existing goals.

Accountabilities for simplified energy tasks were allocated to appropriate Line Managers in their own departments. Performance of these tasks was then incorporated into associated performance management and training processes and practices.

This low-cost intervention was then tested in 800 test/control conditions stores over the course of a full year, using metered energy consumption as a measure.

Two hypotheses regarding improved task completion and reduced energy usage in test stores vs control stores showed significant results. Managers at the headquarters of the retailer valued the energy cost saving at £4 million in the first year of intervention.

There are plans within the organisation to roll out the intervention across all of the retailer's 3500 UK stores, as well as globally.

Wider applications

Considering our energy use is relevant in all aspects of our work and life. Ergonomics and human factors methods can help to design our homes and workplaces, as well as the products we use, to encourage sustainable behaviour.

Consultation with others

The work described in the study came about as part of an inter-disciplinary collaboration between three separate Schools within Loughborough (Civil and Building Engineering, Design and Business and Economics) and draws on expertise in human factors/ergonomics, the sociology of organisations and organisational psychology.

Further information

S Christina, P Waterson, A Dainty & K Daniels (2015), A socio-technical approach to improving retail energy efficiency behaviours. *Applied Ergonomics*, 47, 324-335. DOI: 10.1016/j.apergo.2014.08.003

Acknowledgements

This project was carried out by Loughborough University.

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Case Study 8

Improving a computer user's comfort

Sector: Office

A company wanted to address the problems experienced by an office worker who had Raynaud's syndrome, a disease that caused the blood vessels in her hands and feet to spasm, limiting blood supply and making them very cold. She also regularly had pain in her hands, mid-back, both shoulders and neck, as well as lower legs when working at the computer and reading papers. In addition, she reported visual discomfort/eye strain which she associated with working on multiple spreadsheets on a single small screen.

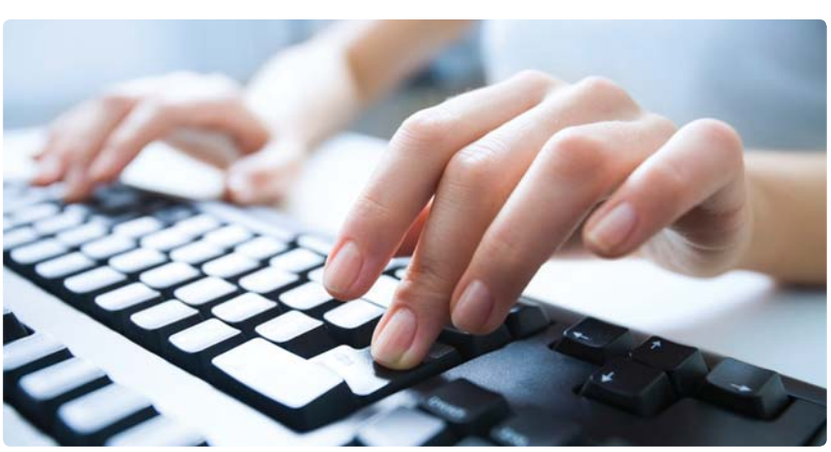
Understanding the user's needs

A detailed assessment of the user and her workstation was undertaken. This comprised understanding what the user's work involved, and careful observation of her undertaking typical work at her workstation, as well as taking photographs and some measurements of the workstation.

The assessment was done in line with the Health and Safety (Display Screen Equipment) Regulations (1992), but went beyond a standard assessment.

The aspects of the environment examined included: the suitability of her equipment; her posture; the movements she had to make in carrying out her work; her legroom; the number of breaks she took; and any accommodation made for dealing with her health condition.

A number of problems were identified. It was found that the user regularly wrote on and read or referred to papers which were placed to the left of the keyboard, requiring her to twist her neck to view them. The specialist keyboard she had was too wide, meaning she had to stretch to the right to use the mouse.



Workstation assessment

A workstation assessment is a careful analysis of a user's tasks, environment and workstation, including the desk, chair and any equipment relating to it. The purpose of the assessment is to establish whether workstation equipment and practices have the likelihood of causing the user harm and to identify ways in which to make the work and workstation safer and more comfortable for employees. This often has the benefit of improving productivity and engagement at work.

Impact

Improved wellbeing

Improved user experience

Improved working conditions

"This computer user can now work without significant discomfort, which has improved her morale, and reduced the risk of absence related to her condition."

The wrist rest constrained her posture and her specialist mouse was too small. Her legroom was also restricted due to the hard drive being positioned below the desk (approximately below the screen).

Making a difference

To alleviate the problems experienced by the user, the following changes were recommended:

- A document holder/writing slope to be placed between the screen and keyboard, which allowed her to view documents with a neutral neck position.
- A larger mouse and a narrower, shorter keyboard with a separate number pad which could be removed when not required, rather than an integral number pad on the main keyboard.
- A second screen for the multiple spreadsheet work the user did.
- Lowering the screen and bringing it closer to the user to help her avoid leaning forward when viewing it.
- Moving the hard drive, allowing freer movement of the chair and the user's legs. A USB extension cable was required to allow free movement of the mouse.
- A heated footrest to help with the symptoms of the user's Reynaud's Syndrome. She already had fingerless gloves which she regularly wore for work.
- Advice for the user to take regular breaks from the keyboard and to move around and change her posture during the breaks.

The company implemented the recommendations, requiring an investment of approximately £400 in equipment. The workstation was reviewed approximately 6 weeks later when the changes had all been implemented.

The user reported a significant reduction in her discomfort with the new keyboard, separate number pad and mouse, and document holder/writing slope. She also reported improvement in her leg comfort with the increased legroom and found the heated footrest very helpful.

This computer user can now work without significant discomfort which has improved her morale and reduced the risk of absence related to her condition. The simple, relatively low cost changes were easy to implement, and the organisation was happy with the outcome.

Wider applications

Workstation assessments can ensure that conditions in any type of working environment are suitable for those who use them.

Assessments can save employers money by identifying the factors that are affecting employee comfort, and by providing cost-effective solutions to help avoid any reduced productivity or a rise in illness and absenteeism.

Assessments can be used to ensure that people with health problems, discomfort or disabilities are appropriately accommodated and enabled to participate fully in the workplace. They can also be used to help those who are absent from work for health reasons to return to work in a safe and comfortable way.

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Acknowledgements
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Case Study 9

Improving parcel sorting

Sector: Postal service

Royal Mail collects, processes and delivers more than 1.1 billion parcels each year throughout the UK and a high proportion of these are small packages. Manual sorting was a labour-intensive task with items being sorted into mail bags which had to be sealed, labelled, loaded into wheeled containers for despatch, then be opened and tipped to empty the contents at their destination. Manual handling activities relating to mail bags are amongst the most physically demanding and labour intensive tasks in Royal Mail.

In order to improve the efficiency of the parcel sorting process a 'sleeve' had been introduced to allow parcels to be sorted directly into wheeled containers. However, this sleeve was not adequately durable resulting in high costs for repair and replacement. Postures for unloading the parcels at the destination were poor too because the working height was too low.

Exploring the parcel sorting process

The parcel sorting process and use of sleeves was explored in two user workshops which also included a design exercise. The five most promising designs resulting from the workshops were developed and discussed with a fabric design specialist and mock-ups were created for user testing.

Initial user testing involved 24 participants fitting the sleeves into the wheeled containers, loading them with parcels, securing the parcels within the sleeves, opening the sleeve and unloading the parcels. The sleeves were evaluated by observation and collecting user feedback on questionnaires and by informal discussion.

One of the lids and one body of the designs were clearly better than the others and these designs were combined into a single sleeve and taken forward for further development.

Manual handling

Handling large or heavy objects remains part of many jobs. Carefully considering the layout of a workspace, taking into account the variability in people's physical attributes and ways they might complete tasks will minimise physical discomfort and injury. This type of assessment normally requires observation or simulation of the tasks being completed to fully understand the ways that tasks are done.

Impact

Improved user experience
Improved working conditions
Increased productivity
Improved wellbeing

"As a result of this work, there has been a reduction in bag handling tasks that has cut the sorting time for parcels by around 25 minutes for every 1000 parcels."

Original manual handling method and cages

Springs were used to support the base of the sleeve to hold the parcels at a good working height to unload them. Tests were carried out to determine the optimum spring strength.

Making a difference

This work has resulted in:

- A more efficient parcel sorting process.
- Reduced manual handing risks by removing the need to lift, sort and empty mail bags.
- Improved working postures when sorting parcels because the parcels are presented at a good working height.
- A reduction in bag handling tasks that has reduced the sorting time for parcels by around 25 minutes for every 1000 parcels.
- An easy-to-use design that has been well received by the staff.
- A more durable sleeve which has reduced the failure rate and costs of repair and replacement.

Improvements were made to the preferred design and 90 prototypes were manufactured to be used in operational trials. The sleeves were well received by the trial participants. The trials showed that the design was suitable for sorting and carrying parcels between offices, removing the manual handling tasks associated with lifting and emptying mail bags and presented the parcels at a good working height for sorting. Further improvements were made to the sleeve as a result of user feedback and a final trial was carried out with a further 40 sleeves at one mail centre prior to the design being finalised.

Once they had been proven successful the sleeves were introduced across the entire Royal Mail network to carry small parcels between all the mail processing centres and local delivery offices. Over 70,000 sleeves are currently in use.

Wider applications

Auto-levelling container bases/sleeves can be used for a wide range of manufacturing and retail situations to reduce reach and bending when lifting items out of a container.

The user-centred design process with user workshops and testing can be used effectively in many design scenarios and is likely to enhance the design and improve user acceptance.

New parcel sleeves in use

Acknowledgements

This work was carried out by Royal Mail Ergonomics Team and RED Design Ergonomics.

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Case Study 10

Increasing productivity and removing risk on assembly lines

Sector: Manufacturing

A leading global water technology company with operations in more than 150 countries manufactures marine systems for boats and yachts for the marine market. When out at sea, boat owners demand products that are reliable and durable, especially during the most demanding types of weather and work.

In accordance with health and safety best practice, the company conducts active monitoring of all risks in the UK and European plants. As part of this process and to maintain continuous improvement, the company was seeking to reduce health risks on two of its assembly lines.

Analysing and observing tasks

Ergonomists were asked to provide expertise to support changes on the line and to help improve performance and productivity. Their investigations included:

- Task analysis of all activities on the line.
- Direct observations of postures adopted by operators during the task cycle.
- Interviews with line operators and other stakeholders such as supervisors and safety engineers.
- Evaluation of a prototype jig, built by the tool-room, with the aim of reducing some of the lifting associated with the assembly line tasks.

The ergonomics investigation was integrated into the assembly team's ongoing activities. The tasks were discussed with a wide range of different stakeholders so that the project was participatory and a key part of its ongoing continuous improvement process.

The musculoskeletal risk associated with the current arrangements was identified and prioritised and the prototype jig was evaluated with respect to the effect the improved design would have on the different aspects of the task.

Practical, business-friendly recommendations were made about the work procedures, tools and equipment used within the process. The company was helped to identify and understand where altering the assembly processes would not only reduce risks but also enhance productivity. Issues including training, operator job aids, environmental factors in the workplace and workload were also considered.

Task design

Task design is a process whereby all steps of a task are looked at systematically, along with the the equipment used and the environment in which it takes place. This helps to ensure that people's performance and safety on the task is optimised.

Impact

Improved working conditions
Financial savings
Improved job design
Increased productivity
Improved wellbeing
Improved safety

> *"I really liked the simplicity of the final reports in identifying and pinpointing the specific ergonomics issues on our assembly processes, with the use of photos to highlight the issues."*

UK and Europe Environment, Sustainability, Health and Safety Manager

Making a difference

The factory was revisited six months after the initial work to review progress and discuss the benefits of the alterations.

Most of the recommendations had been implemented and the new line was up and running successfully. Perceived benefits included:

- 10% increase in throughput (60 units versus 55 units).
- Elimination of a two person lift of assembled units above head height.
- 50% reduction in lifting of the heaviest component.
- Elimination of stooping to pick inventory.
- Increased accuracy of fitting and inspection tasks, thereby reducing errors.
- Raised levels of staff empowerment and engagement.
- Increased job and task satisfaction.
- Decreased sickness and absenteeism rates (so far since July 2013).
- Reduced levels of musculoskeletal and visual discomfort, fatigue and stress.
- Fewer returns from customers.

Staff commented that the reports produced by the ergonomists made it very easy to understand the issues and to incorporate the solutions into future layouts.

Wider applications

Ergonomists can use task analysis and task design techniques to reduce costs, increase production and improve safety in almost any manufacturing context where people work.

The techniques ideally should be applied right at the start of any design process, and iteratively throughout, for maximum return on investment in plant, machinery, workstations and equipment.

Produced and published by the Chartered Institute of Ergonomics & Human Factors.

Acknowledgements

This project was carried out by System Concepts Ltd.

Chartered Institute of Ergonomics & Human Factors

Case Study 11

Assessing workload in rail

Sector: Transport

Workload assessment was required to determine capacity of rail control operations with different types of automation technologies and for different types of control sites. Researchers developed a suite of tools that could be used by companies such as Network Rail to measure workload in railway control tasks. These tools have helped operations staff make decisions about the way that workload impacts routine roles as well as specific activities such as maintenance.

Developing workload assessment tools

The programme of research developed and applied various forms of work analysis tools to support workload and task loading assessment and human-centred automation. The workload tools, specifically the Operational Demand Evaluation Checklist (ODEC) and the Integrated Workload Scale (IWS), have been used to make safety and performance related assessments. These tools have enabled ergonomists to conduct an offline analysis of the potential demand of workstations with different levels of complexity, in different parts of the rail network. IWS is a short subjective assessment tool that has been specifically designed for rail workers to report on the level of workload that they are experiencing at a particular point in time. The tools were developed, piloted and validated in real practice in over 30 signal boxes and control centres.

The work analysis tools, representation techniques and insights into appropriate automation, were used subsequently to support the determination of roles for staff and technical/automated systems in the National Operating Strategy programme for a number of major regional control centres. The guidance for human-centred automation was also used to support the Strategy.

An example of a new technology that has been supported by these methods is the Train Graph, a predictive tool modelling future rail traffic to help with an operator's situational awareness. This was evaluated in post-implementation studies and is now being incorporated into Network Rail's Traffic Management System.

Development of the methods for signalling and network control enabled subsequent research with rail electrical control and intelligent infrastructure, the first such work worldwide.

To meet cost reduction and work effectiveness goals, the ODEC tool has been used as a basis to help operational managers balance the work associated with facilitating access to the track and with routing trains to timetable. Efforts at benchmarking for crew sizes and efficiency of performance against other European railways also drew from the ODEC tool and automation guidance.

Workload assessment

Within complex work settings it is important to understand whether people are being required to do too much (high workload) or too little (low workload). If they experience high workload then they may become stressed, or make errors; if they do too little they may become distracted or demotivated.

Using ergonomics workload tools can help managers to understand the different demands and loads experienced in different parts of organisations, and with different types of technology.

Impact

Improved job design

Better organisational strategy

Improved safety

> *"From 2007 to 2015, all Network Rail resignalling and re-control projects (approximately 180) involved use of the workload tools."*

Mike Carey, Head of Ergonomics at Network Rail

Making a difference

The work analysis approaches and the guidance on automation have been used in the following ways:

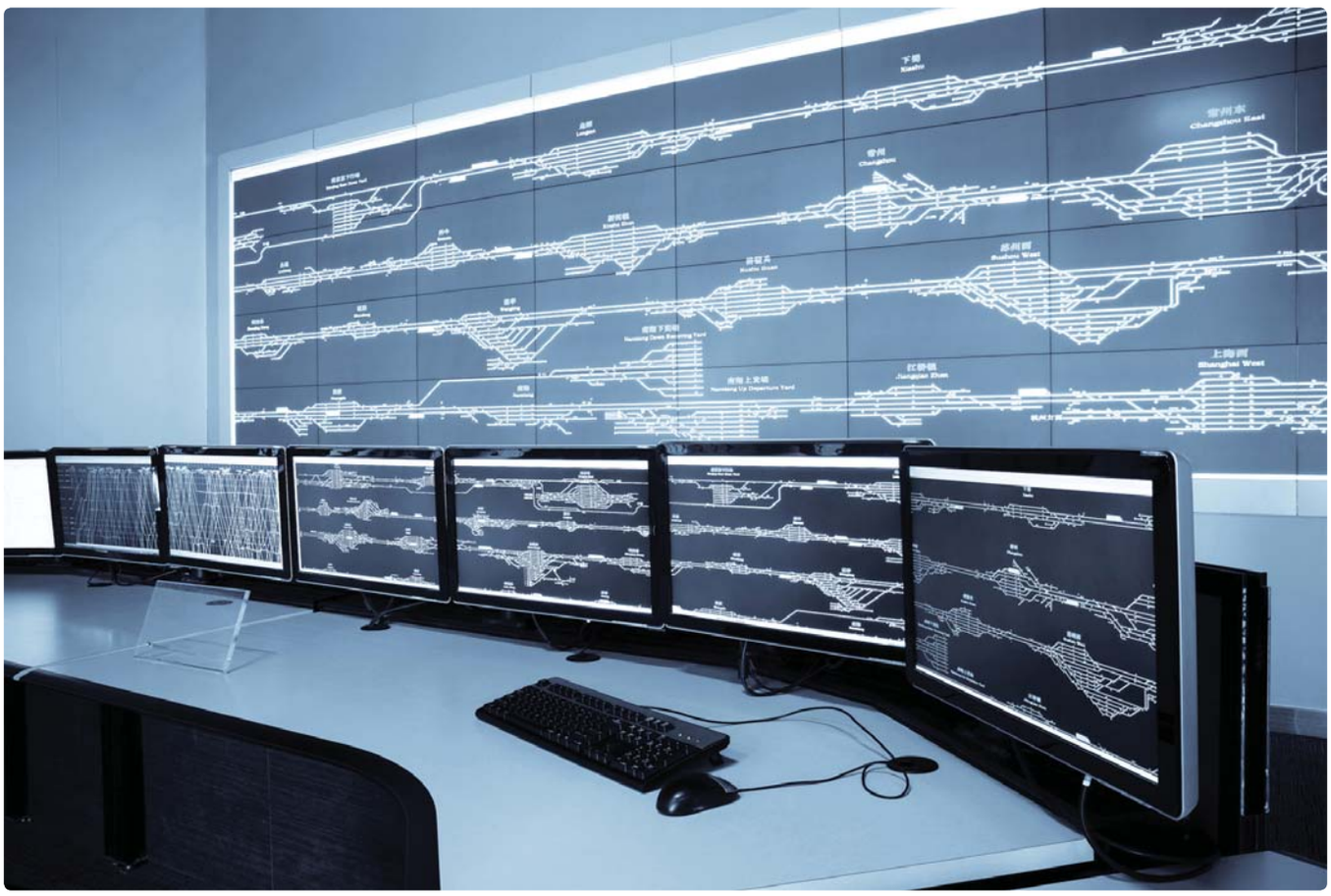
- To reduce design risk for enhanced new control centre designs.
- To optimise the level of reliable performance in signalling and control.
- To support crew sizing decisions with the aim of reducing operating costs by giving a larger area to one operator.

The use of these tools since their development has consistently increased and they are now routinely used to support replacement, upgrading and redesign of signal boxes.

Wider applications

Understanding workload is important in all safety-critical contexts. By combining different methods we can learn more about when to introduce technologies into work to help operators, and how different work designs affect operators.

These tools also help us to distinguish between those things we can measure in the workplace and the workload experienced by the operator.



Further information

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Acknowledgements

This project was carried out by the Human Factors Research Group at the University of Nottingham in collaboration with the Network Rail Ergonomics Team.

Produced and published by the Chartered Institute of Ergonomics & Human Factors.

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Case Study 12

Maintaining control in a highly automated system

Sector: Transport

The aim of the Victoria Line Upgrade, carried out between 2005 and 2012, was to increase the capacity of the railway by 33% to meet the predicted future demand. As part of the programme a new Signalling and Train Control system was designed to help deliver an increase from 24 to 33 trains per hour (TPH). In 2015 this control room delivered a train service of 34 TPH, beating the 33 TPH in the original plan.

On a railway that is 30 minutes from end to end, with 15 platforms in each direction, this means there is less than 2 minutes between trains. This is reassuring for passengers but a potential headache for those monitoring and controlling the service. Human factors experts helped to ensure that the increase in capacity could be managed by controllers through the use of human factors integration and systematic and sympathetic user engagement.

Meeting the needs of operators

In a highly automated system like that employed on the London Underground Victoria Line, the Control Centre system needs to achieve two main design aims:

1. To ensure the Control Centre Operator has an accurate picture of the state of the railway at all times so that they can detect, predict and respond to any performance degradation, for instance, a slow service, large gaps between trains, or events likely to cause service disruption.

2. To ensure the Control Centre Operator can identify and respond appropriately to an unexpected service or safety-affecting event in the required time frame to minimise disruption to the service and maintain passenger safety, whether this event is a signalling failure, driver illness or a fire, flood or terrorist threat.

So the system needs to support the operator in both primary roles of monitoring and maintaining situation awareness, and strategic planning and response, and allow the operator to move seamlessly between them.

Comprehensive London Underground human factors standards meant that the requirement for human factors was identified early. The London Underground standard encouraged compliance with the Human Machine Interaction design standard BS 9241 and in particular the requirement to engage in user-centred design. User-centred design helps to ensure that equipment meets the needs of the operators, and is easy and intuitive to use, which increases efficiency and safety.

Human-centred design

Human-centred design balances what people actually need and want with what can actually be delivered given technical, organisational and financial constraints.

A programme of human factors activities integrated with the project activities, from concept to implementation, will enable timely user engagement in design and provide recommendations at the appropriate stage of development.

Impact

Improved user experience

Improved job design

Increased productivity

Improved safety

> *"The upgrade was carried out with a minimum of disruption to the travelling public and was one of the highest performing lines during the London Olympics."*
>
> London Underground 2012

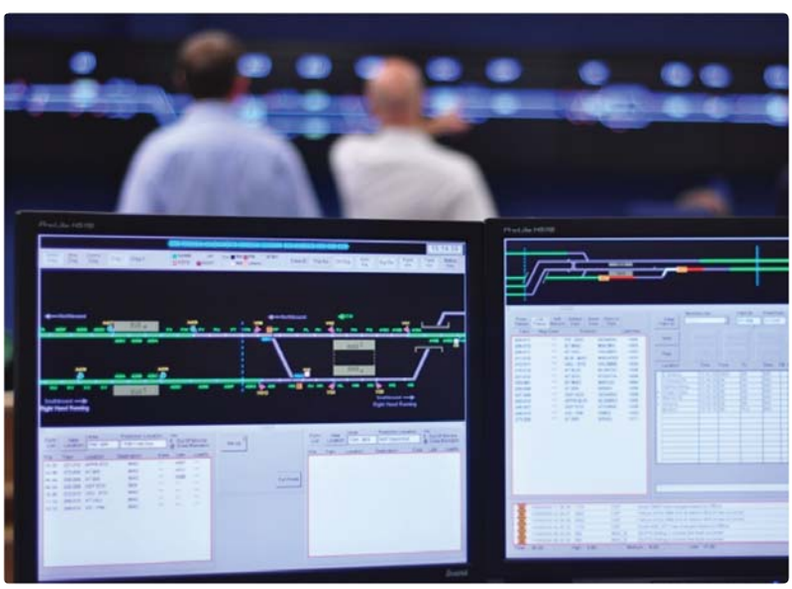
Making a difference

A vanguard team of users was engaged in 2006 and supported the design through to completion in 2012. Vanguard team members remained consistent throughout and were involved in all stages of the design through user interviews, focus groups and workshops. They would use the new systems once commissioned and they had detailed experience of the role they were representing and the systems currently used to complete their tasks. They could see how their input defined the system, which promoted buy-in and a high level of user acceptance. As a result of their vanguard experience they were able to provide an excellent level of training to others.

The users were engaged in the design process throughout the project to ensure that the system produced met their requirements and supported efficient, effective and safe working. The new system resulted in significant changes to the signaller role from one of active railway control to one that required vigilant monitoring interspersed with periods of activity to respond to events that affect the service on the railway. The design needed to ensure that the system supported the signaller in their goal and promoted situation awareness and acceptable workload.

Scenario-based workshops were used to evaluate proposed designs using prototypes at different fidelity levels such as paper, computer with minimal interaction, and high fidelity simulators. Affinity diagram workshops were used to explore issues such as alarms classification, information required on the overview diagram mimic and function allocation.

The result of the systematic and sympathetic engagement of the users and thorough human factors integration into the project, was the delivery of a service control system that is valued by the operators, balances operator workload, maintains operator situation awareness and vigilance, and delivers the capacity increase required.



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Wider applications

Major alterations to system design normally change the way that tasks and jobs need to be done.

Human-centred design methods should be used when changes which may affect the way in which people can or should do their jobs are proposed. This applies in many different contexts, from cockpit design to new technologies to be used by patients in a hospital ward.

Consultation with others

London Underground Human Factors Engineers and London Underground Operational Upgrades teams were involved in this project.

Acknowledgements

This project was carried out by Siemens Rail Automation in partnership with London Underground.

Chartered Institute of Ergonomics & Human Factors

Case Study 13

Improving alarm systems

Sector: Transport

Users of alarm systems must only be presented with information that is of relevance to them at a time when they will be able to act upon it in order to control or mitigate the impact of the event that triggered its presentation.

Achieving this simple objective is a difficult undertaking in complex railway environments where multiple and widely distributed assets and people interact according to specific railway procedures to deliver services.

When these assets and people deviate from procedures, or fail, they do so in ways that are specific to the rail industry. Yet the rail industry does not have a unified approach to alarm system development. Instead, a number of disparate guidance documents providing useful but narrow development information are used selectively and generally.

Clear and consistent guidance on rail alarm system terms and definitions are needed to ensure efficient delivery from the start of system development to ensure first time acceptance and minimum development costs.

Clarity and consistency

A lack of clarity and consistency in guidance defining what rail alarm systems will present to users creates confusion during development. This confusion can mean that when the alarm lists and user interface designs are developed, users struggle to understand why some alarms are presented and how they should respond to them. This can result in retrospective work during system testing to achieve acceptance before commissioning.

Two complementary activities were carried out to address this problem:

- The context of use for rail alarm systems was defined.
- The terms 'Alarm' and 'Alert' were clearly and consistently defined for rail applications to provide a basis and rationale for developing appropriate alarm and alert lists for presentation to users.

Existing guidance document reviews identified a lack of clarity and consistency around their chosen terms and definitions, especially for 'Alarm'/'Alert', and their relationships to each other. To improve clarity, relevant and consistent content from standards and guidance, information from baselines studies and Subject Matter Expert testimonies were given as visual representations, which are superior to the lexicon and glossary presentations previously used.

Alarm system design

Alarms are present in many safety-critical environments and are used to alert us to things that require our attention. But in many cases multiple alarms are displayed at once, and they may combine visual, auditory and even tactile signals such as vibration. This can lead to confusion, overload and distraction, and may result in important information not being acted upon.

Ergonomics and human factors methods can help identify situations when alarms are not effective and to develop guidelines to support their design.

Impact

Improved safety

Increased productivity

Improved user experience

Improved wellbeing

> *"This work provides an improved way to develop alarm systems and avoid alarm handling problems by clearly and consistently defining what to develop, and why."*

Jon Wackrow, Head of Human Factors Engineering, London Underground

The visual representation of the context of use and of alarm systems allows the relationships between them to be seen while written articulation provides clear definitions for rail alarm terms. Using the same elements it becomes clear what each is with respect to those elements, and how they are comparable and different.

Making a difference

The rail-specific definitions for 'Alarm' and 'Alert', which are clear, consistent and comparable to each other describe what it is that rail alarm systems should be delivering. They are also a tool for the review of information intended to be presented to alarm system users to help ensure eventual alarm lists are appropriate and alarm (and alert) rates are manageable.

They also help to ensure that users' expectations are met with respect to what they might be presented with and how they should respond. These definitions help to ensure that when an alarm is triggered by an event, the users are presented with information that is of relevance to them at a time when they will be able to act on it to control or mitigate the impact of the event.

The visual representations and definitions are being used in London Underground and are successfully providing a shared understanding by all alarm system stakeholders, to the benefit of the development of systems.

Complementary rail alarm system development process steps support delivery and first time acceptance of systems that are characterised by clear and consistent presentation of appropriate information as alarms and alerts.

The work establishes a clear model for rail alarm systems. The definitions are evidence-based, unlike others that are based on glossary and lexicon. A shared understanding of these terms by all rail alarm system stakeholders is essential to efficiently develop good alarm system designs following a sound alarm system development process.

Consultation with others

The analysis and development of the rail alarm and alert definitions was carried out with help from London Underground System Architects and operations and maintenance staff.

Wider applications

The visual representations of the terms 'Alarm' and 'Alert' within a rail context can be modified for other industries by understanding their business requirements for alarm systems. These can be derived from baselining their existing alarm systems and using expert testimonies about what should be presented to alarm system users.

The interaction between alarm and alert definitions, and the alarm system development process is important. Successful delivery of useable alarm systems can only be achieved if meaningful alarms and alerts are presented at a manageable rate, and they are clearly and consistently defined and displayed.

Produced and published by the Chartered Institute of Ergonomics & Human Factors.

Acknowledgements
This project was carried out by London Underground.

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Case Study 14

Optimising control room design

Sector: Transport

In 2009, Banedanmark, the company responsible for maintenance and traffic control of most of the Danish railway network, embarked upon an ambitious €3.2 billion project to upgrade Denmark's entire national rail signalling infrastructure ('F-bane') before 2021, and the Copenhagen mass transit system, 'S-bane', by 2020.

Before human factors involvement, architects designing the control rooms produced an amphitheatre-style control room layout design to fit in a semi-circular space envelope. It was aesthetically appealing on paper but was not designed to optimise operations.

The architects sensibly sought operator feedback on their design. Operators wanted the desks arranged in clusters to facilitate teamwork. Unfortunately this meant that the design could only accommodate 26 of the required 32 desks. At this point human factors support was solicited to solve the control room design issues.

Analysing tasks and workload

Human factors specialists applied task and workload analysis techniques which demonstrated that the large, two-person desks in the original design were, in fact, not required and that one-person desks would suffice. This proposal was supported by the operators and other project engineers.

Human factors-initiated desk and control room layout mock-ups were then produced and tested with stakeholders, including operational representatives and human factors advisors from the supplier and customer teams.

Control room layout trials used wooden cut-outs which could be arranged on an image of the control room space envelope. Human factors principles were explained on posters which were displayed in the trials workshop room. Different teams of stakeholders identified different layouts using the cut-outs until an agreed design was achieved.

The smaller, one-person desks meant that the operational requirement for 32 desks in a cluster layout was achieved. Layout drivers were identified as sightlines to equipment and other team-members, and proximity of signaling areas of control.

Control room design

Control rooms are often complex, containing multiple displays and supporting a range of different operators who are completing tasks that require them to understand the overall state of a system. User-centred design methods can help understand user requirements in normal circumstances and emergencies, and ensure that the appropriate number of people with the appropriate skills are able to oversee activities in all types of situations.

Impact

Improved job design

Financial savings

> *"Before human factors intervention, twelve monitors per desk had been proposed. This was reduced to eight monitors as a result of the task and workload analysis and mock-up trials."*

Human factors advice was also provided to address the likely acoustic issues that would be encountered with the curved control room wall.

Making a difference

The resultant design optimised operational requirements and teamwork.

The trials found that a curved desk shape was preferred. Before human factors intervention, twelve monitors per desk had been proposed. This was reduced to eight monitors as a result of the task and workload analysis and mock-up trials.

Human factors intervention significantly reduced the manpower requirement for the control room, saving future operating expenditure. Furthermore, human factors activities demonstrated that fewer monitors were required on each control room workstation.

This resulted in installation and maintenance savings, as well as an enhanced user experience and operator acceptance. The control room layout was designed to facilitate teamwork.

Task analysis material produced as part of the human factors activities will be re-used by the project's training and maintenance teams.

Wider applications

In domains such as transport, manufacturing and energy management, control rooms allow operators to oversee safety-critical operations, so it is essential that all those responsible understand the state of the system and can react quickly to intervene when needed.

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Produced and published by the Chartered Institute of Ergonomics & Human Factors.

Acknowledgements
This project was carried out by Thales Cyber and Consulting Services (formerly Quintec).

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Case Study 15

Providing the best workstation

Sector: Retail

Ergonomists were asked by the Nationwide Building Society to provide workstations that go above and beyond minimum legislative requirements in order to support the wellbeing and the productivity of their staff.

Assessing employee needs

Highly qualified and experienced ergonomics specialists performed individual assessments with employees experiencing musculoskeletal discomfort.

Because the ergonomists were working in partnership with Nationwide, they gained a comprehensive knowledge of all the office and branch environments and designs, physical and technology equipment and systems used, as well as sound knowledge of the job roles employees undertake. This meant that a proportion of cases could initially be assessed by telephone resulting in cost efficiencies. For more complex or multi-faceted issues, employees were assessed in person at their workplace.

The assessment provided a personal and individualised service to ensure optimum comfort was achieved by providing employees with the equipment, competence and confidence to work comfortably wherever they were.

The ergonomists ensured that all the recommendations that were made to the Attendance and Wellbeing team were appropriate, practical and where possible easy to implement. As 'one size' does not fit all, individual assessments are often necessary and cannot be entirely avoided by good initial design. However, a low rate of necessary assessment is an indicator of good ergonomics practices being in place from the outset.

Ergonomists helped the Attendance and Wellbeing team ensure a continuous improvement process which included supporting them to create a user-friendly service and being involved in the design of new workstations to ensure they will be suitable for a majority of the workforce.

An Occupational Health & Wellbeing specialist working with Nationwide said: "Supporting the needs of over 17,000 employees across 700 locations creates challenges. Our partnership approach has meant that the ergonomists understand these, and works with us to ensure we are building a centre of excellence that is also commercially viable."

Workplace design

When designing a workplace, it is vital to keep in mind the capabilities and limitations of the employee.

Poor workstation design can lead to fatigued, unhappy and uncomfortable workers.

This is likely to result in painful and potentially expensive injuries, lower productivity and poor service or product quality.

Impact

Improved working conditions

Improved wellbeing

Increased productivity

> *"Every aspect of my condition and how it affects my comfort at work was considered. Solutions were very encompassing, covering recommended breaks and methods to ensure the habit of these, chair adjustments and workspace layout."*

Jennifer, employee

Making a difference

In a recent survey of those referred to the Workplace Adjustment Service, over 80% said that the ergonomics assessment had met their individual needs well or very well, over 85% were satisfied or very satisfied with recommendations made and over 94% reported that they felt physically better or much better as the result of it.

A facilities assurance manager said: "Through their preventative ergonomics evaluation work on our equipment, furniture and branch designs, the ergonomists helped us to reduce the amount of potential ergonomics issues at source. Their work also gives me confidence that when I am delivering reasonable adjustments, I am doing the right thing and providing an appropriate solution. I also get very helpful ongoing support to check the validity of activities when circumstances change."

The Nationwide Occupational Health & Wellbeing specialist said: "The ergonomists were receptive to adopting a partnership approach to the development and delivery of their services. This means that our employees get meaningful and practical support and advice."

Wider applications

People vary considerably in body dimensions and physical capabilities, so it is rare that one workstation fits all. Any workstation used by any employee can suit them well, poorly, or not at all.

Applying a systematic ergonomics assessment process ensures that all aspects of the tasks, equipment, environment and organisation are considered to help the employee achieve their full potential and wellbeing at work.

Produced and published by the Chartered Institute of Ergonomics & Human Factors.

Acknowledgements
This project was carried out by System Concepts Ltd.

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Case Study 16

Design for patient safety

Sector: Healthcare

Before 2006, NHS Ambulance Trusts around the UK produced their own vehicle specifications for design. This resulted in over 40 different designs for emergency ambulances in the UK. This posed an increased risk to patient safety due to confusion about the location of equipment and interior layout with variations in each vehicle type.

In May 2004 the Department of Health commissioned a strategic review of NHS ambulance services in England, focusing on how the ambulance service could shift from providing resuscitation, trauma and acute care towards "Taking healthcare to the patient: transforming ambulance services in the community".

The aim was for patients to receive improved care by consistently receiving the right response, first time, in time and that more patients would be treated in the community, resulting in more effective and efficient use of NHS resources.

It was identified that the demand for ambulance services was rising by about 7% per annum (approximately 250,000 extra calls) and that the role of the ambulance service was changing, with only 10% of calls relating to life-threatening emergencies and many of the residual 90% having primary care or social needs.

The challenges of emergency care

A series of projects with East Midlands Ambulance Service, East of England, Great Western, North East, and Yorkshire Ambulance Service was carried out to look at the design of vehicles, equipment, working systems, clinical protocols and patient pathways.

The ergonomists worked with paramedics by 'riding along' for many hundreds of hours during days, nights and weekends to gain an understanding of the challenges faced in delivering pre-hospital urgent and emergency care.

Human factors methods and tools included hierarchical task analysis (a systematic method for unpacking and describing complex tasks), link analysis (a tool to capture interactions and relationships) and postural analysis to understand working activities and compromised safety.

A report was then produced outlining challenges relating to different aspects of ambulance design and detailing specific issues related to those design challenges. Every aspect of the ambulance was looked at in detail.

Participatory design

Working directly with users and manufacturers ensures that user needs are well captured and understood.

By conducting detailed analyses of the way in which tasks are completed, and testing those analyses in mock-ups of proposed redesigns, more effective solutions can be developed and costs from re-engineering can be reduced.

Impact

Improved working conditions

Improved wellbeing

Improved safety

Financial savings

> *"Achievement of the single specification ambulance was as a result of a very successful collaboration and I was delighted to note that over £2.5 million has been saved over the past 3 years."*
>
> Chair, National Ambulance Fleet Strategy Group

Making a difference

The solutions were developed with manufacturers of vehicles and ambulance equipment and published to share the ideas across the international community.

Prototypes were built and tested to validate design recommendations and then presented to the Chief Executive Officers of the UK Ambulance Services. They were used to develop the national specification for emergency ambulances.

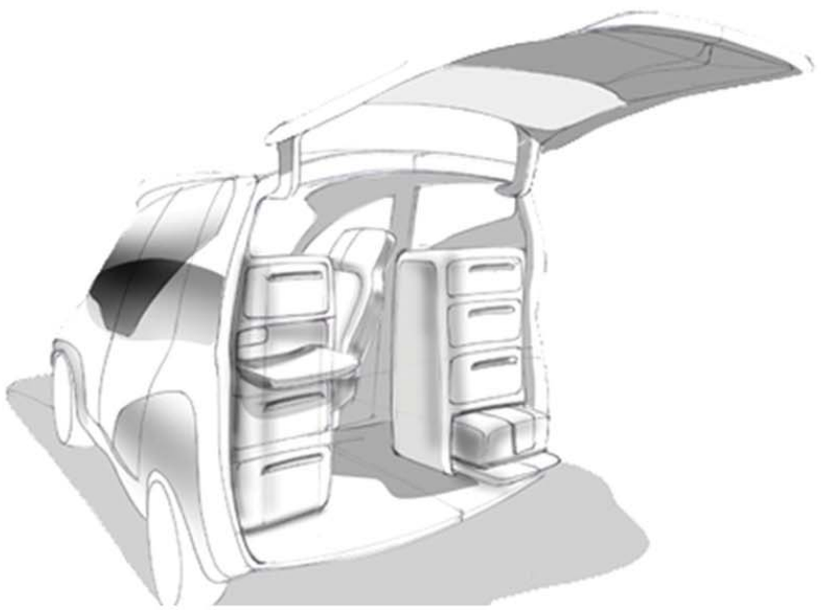
The ergonomics recommendations have had an impressive impact on society, providing tangible benefits not only to healthcare workers but to those being assisted by the UK's ambulance fleet every day. These include:

- Financial savings of £2.5 million over three years.
- Improved patient safety through the standardisation of design.
- Improved working conditions for healthcare workers.
- UK-wide adoption of a standardised interior and exterior design.
- Ergonomics input for the NHS Supply Chain 'Mobile and Relief Clinical Services' national contract.

Wider applications

Wherever there is a need for bespoke design for a work setting, it is vital that manufacturers are engaged in discussions around user needs. This helps them to understand how their products and designs can be most effective, and how their use varies between users and for different work tasks.

There are many applications of this collaborative design approach in healthcare, transport, service industries and manufacturing, where 'off the shelf' products may not be available.



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S Hignett, A Jones, E Crumpton, D Harrow, O Evans, M Kunur, S Halls, D Kafka, R Coleman (2007) *Designing future ambulance transport for patient safety: research undertaken.* National Patient Safety Agency/Helen Hamlyn Trust.

Acknowledgements

This project was carried out as a collaboration between researchers at the Helen Hamlyn Research Centre, Royal College of Art, London, the Healthcare Ergonomics and Patient Safety Unit, Loughborough University, and staff from the NHS and the Ambulance Service Association.

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Case Study 17

Safer neonatal care

Sector: Healthcare

The design of the modern Neonatal Intensive Care Units (NICUs) varies but is often one large, open room with the cots (incubators) side by side. This has observation and access advantages but also disadvantages, for example, noise levels, lighting and privacy. Recently there have been moves toward more family-centred care, accompanied by a trend to increase the number of single rooms. In addition, technology developments in NICUs have increased the spatial requirements for clinical activities.

The Department of Health asked healthcare ergonomists at Loughborough University to determine the space required to care for and treat neonates using human factors principles to ensure efficient and safe working conditions.

The ergonomists observed 87 clinical tasks with 28 staff providing care to 15 newborn babies and then confirmed that the tasks were representative of daily work activities and that no major activities had been omitted.

It was found that there was insufficient space for families and staff. There was no family space for the parents to stay with their child, storage was limited, there were no nursing trolleys and clinical bins in the cot space, and staff sometimes worked in awkward positions due to the cramped space.

Simulating the environment

The ergonomists developed a simulation scenario to test their space recommendations with clinical tasks for emergency admission, connecting ventilators, inserting gastric tubes, giving drugs and taking a chest x-ray. They also simulated a visit to the new born baby from the mother on her hospital bed.

The simulation was carried out in a full size mock-up with 21 clinical staff. Staff actions and task behaviours were recorded with multi-directional video data which were then were analysed frame by frame to plot the movements of each participant, equipment and furniture during the tasks.

It was found that the average space needed for an individual neonatal intensive care unit cot space was 13.5m^2 (or 145.3ft^2). When circulation and storage space requirements were included this increased to 18.46m^2 (or 198.7ft^2).

An expert panel of clinicians and architects reviewed the recommendation and agreed that the average individual cot space of 13.5m^2 (or 145.3ft^2) could accommodate variations in working practices.

Workspace design

As well as designing specific products, ergonomists and human factors specialists can help understand how the space within which we work can be best designed.

This can help encourage effective communication in a workplace, as well as considering the comfort of all those present. It is therefore extremely important that the needs of all people are considered, especially when a setting combines workers and members of the public.

Impact

Improved safety

Improved working conditions

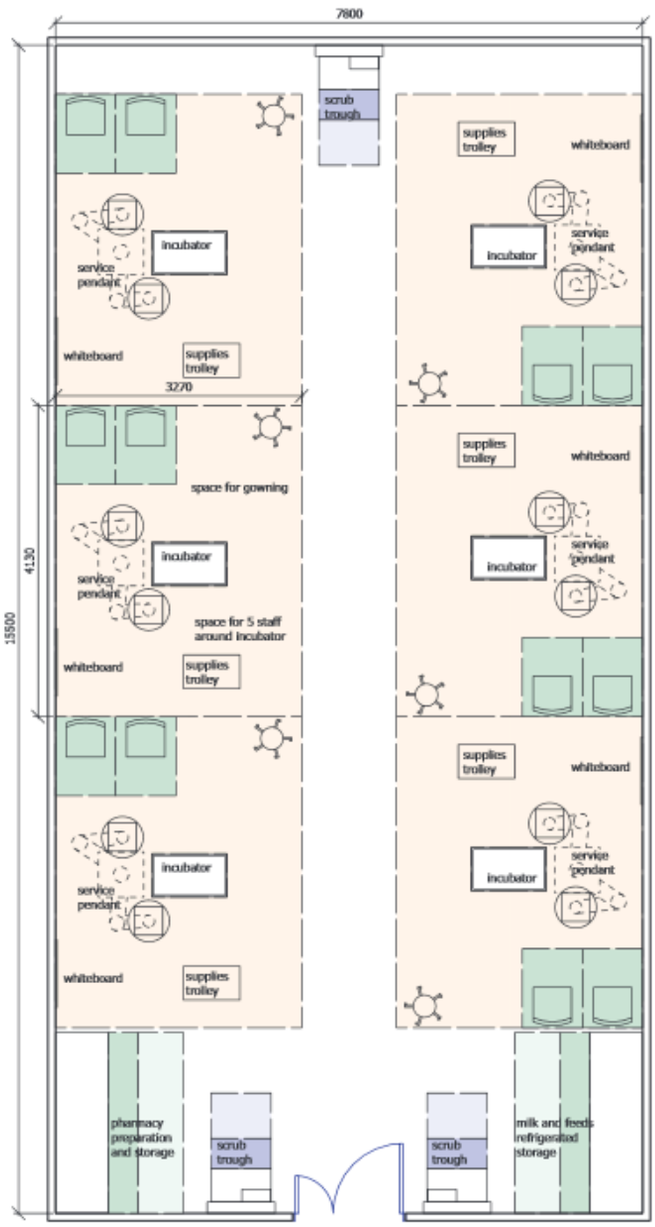
“This research has fed into ‘best practice’ guidance on the design and planning of new healthcare buildings and on the adaptation/ extension of existing facilities.”

Making a difference

This research has fed into Health Building Note 09-03, produced by the Department of Health, which gives 'best practice' guidance on the design and planning of new healthcare buildings and on the adaptation/extension of existing facilities.

The guidelines provide information to support the briefing and design processes for individual projects in the NHS building programme. The Care Quality Commission uses these guidelines to assess neonatal units.

The guidelines have also informed the reconfiguration of services and the refurbishment of maternity units in Shrewsbury and Telford Hospitals NHS Trust and The Whittington Hospital NHS Trust.



Example layout of multi-cot neonatal unit from DoH building note

Wider applications

This approach can be applied in any setting where people are working together, such as a GP surgery, an operating theatre, a retail business or a safety-critical control room.

The way that we design workplace equipment and layout can affect communication and collaboration, making it easier for workers to support each other and for members of the public to speak to professionals.

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Consultation with others

The research was carried out with the help of clinicians working in the neonatal environment.

Acknowledgements

This research was carried out by Loughborough University.

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Case Study 18

Improving birthing pool design

Sector: Healthcare

In the early 1990s, water birth was gaining in popularity. However, at the time, the state-of-the-art birthing pools resembled large barrels and had not been designed for any of the users.

Mothers found it very difficult to get into the birthing pool and almost impossible to get out in an emergency.

Midwives were not able to monitor and examine mothers in the pool without putting strain on their back and neck.

Original design of birthing pool

Accommodating multiple users

The needs of people using the pool were identified:

1. The mother, who needed help to enter and exit the pool and who needed to be supported in a range of positions during labour.

2. The midwife, who needed a comfortable working position with knee room by the pool and the ability to reach the mother for examinations and monitoring.

3. The baby, who may need assistance very quickly in an emergency situation.

4. Maintenance, cleaning and infection control support staff, who need to be able to carry out their tasks quickly and effectively.

Activities from videos and interviews were then analysed before work with mothers, midwives and maintenance engineers began.

Product design

Product design is user-centred if the key users of a product are identified early on in the design process and research is done to understand their needs.

This research feeds into the design process to inform all aspects of the design.

User testing may be repeated at various points in the design process and changes may be made to the design in order to ensure that the finished product is usable, safe and effective.

Impact

Improved user experience

Improved safety

Improved wellbeing

Improved job design

> *"I became aware of ergonomic design when I met a health service ergonomist who inspired me to incorporate the principles of ergonomic design into the creation of the original Active Birth Pool."*
>
> Keith Brainin, Active Birthpools

The key features were challenged and resulted in a new design.

A prototype was then built and tested with staff and mothers before approaching a manufacturer to make the finished product.

Making a difference

The pool was entirely redesigned to fit the needs of its users. The new design has:

- Steps and hand rails to assist entry and exit.
- Shaped edges to give armchair style support for the mother and range of supported positions such as sitting, kneeling and squatting.
- A concave side to provide knee room for the sitting midwife.
- An integral seat for delivery and perineal examination.
- A horseshoe-shaped seat that can also be used for rapid exit with the mother able to be floated onto the seat and then evacuated backwards onto a birthing bed much faster than could be achieved with a lifting device.

New ergonomic birthing pool design

This work has revolutionised the design of birthing pools with many hospitals in the UK and internationally purchasing ergonomic birthing pools (www.dailymail.co.uk/news/article-2535103/10million-maternity-fund-hospitals.html).

Wider applications

The approach of constructing mock-ups to understand how a product will be used in practice is extremely useful, especially when a radical design change is proposed.

This approach has also been used in settings such as the design of future train carriages and can ensure that costs are reduced as designs are then 'right first time' when manufactured.

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Acknowledgements

This work was carried out by a Health Service Ergonomist working at Nottingham City Hospital.

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Case Study 19

Improving staff and customer welfare

Sector: Retail

A major building society wanted to ensure that ergonomics, health and safety, wellbeing and accessibility principles were built into branch facilities, workstation design and work processes.

They asked ergonomists for input into The Future Branch project, which involved a major overhaul of a high street/shopping centre branch design. Ergonomists supported the project from development to installation.

Evaluating branch designs

Experts provided ergonomics and accessibility input by examining the initial and subsequent branch plans. They worked closely with the designers to address issues identified. They helped them to work out whether different designs were appropriate, given changes in technology, and they helped the staff to think radically about the whole design and branch look and feel. They also conducted focus groups with current and prospective customers and also competitors' customers to gather insights into the resulting designs.

Ergonomists conducted a detailed risk assessment of customer and staff activities at a fully equipped mock-up. This involved examining 'customer journeys' with feedback from customers and staff, making ergonomics observations and postural analysis of staff tasks, and taking measurements of anthropometric factors such as reach distances, clearances and workspace constraints.

They also evaluated two pilot branch installations in the UK. They examined each area of the branch including all customer service and back office areas. Ergonomics and accessibility assessments and staff/customer feedback through questionnaires and interviews, direct observations, light and temperature measurements, workspace dimensional measurements and computer workstation assessments were collected.

This allowed the ergonomists to evaluate the staff and customer experience and the overall usability of the new design. Lastly, they conducted a finalised review, at a large Midlands branch, including ergonomics and accessibility assessments of further enhancements to the Future Branch design.

Making a difference

By involving ergonomics and accessibility expertise right from the beginning, the design process was more cost effective. Major concerns were identified and addressed early on.

Retail design

Retail design helps to ensure that customer and staff needs in a retail environment are taken into account using inclusive design principles.

Ensuring that the needs of people with varying abilities are taken into account and catered for, can enhance their retail experiences, whether from a worker or customer perspective.

Impact

Improved user experience
Improved working conditions
Improved wellbeing
Improved customer engagement

> *"The ergonomists are an important asset to our design team, adding strategic insight, technical expertise and common sense. Their iterative approach ensures that we have considered all aspects of staff and customer welfare and access during design and development to create settings that are safe, enjoyable and inclusive."*

Building Society Design Manager

This approach also meant that the ergonomists could be more flexible and creative in their problem-solving, which is not always possible when assessing a finished product.

The design input of the ergonomists:

- Ensured staff and customer welfare and accessibility needs were actively considered as an integral part of the design process.
- Reduced the building society's exposure to the risk of musculoskeletal disorders.
- Enhanced the building society's reputation with customers and reduced the risk of Equality Act claims.
- Considered both staff and customer requirements when selecting equipment and furniture, while balancing the needs of the business.
- Identified suitable equipment and furniture in terms of environment, staff and the way they work.
- Helped in making decisions relating to the procurement of furniture and equipment more effective, and provided robust justifications for these decisions.
- Helped the company to meet legal obligations and their duty to include the requirements of all customers and staff, including people with disabilities, minimising reputational risk.
- Addressed issues of non-compliance or risk at an early stage before changes become expensive to make.

Wider applications

Ergonomists can use inclusive design techniques to enhance the customer and staff experience in any retail environment where people work and shop.

The techniques ideally should be applied right at the start of any design process, and iteratively throughout, for maximum return on investment in retail spaces.

Produced and published by the Chartered Institute of Ergonomics & Human Factors.

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This project was carried out by System Concepts Ltd.

Chartered Institute of Ergonomics & Human Factors

Case Study 20

Reducing and preventing musculoskeletal injuries

Sector: Manufacturing

The work performed in a furniture factory was physically demanding and entailed heavy lifting, pushing and pulling of large heavy items, repetitive work with tools such as staple guns, and fine upholstery work using a sewing machine. It also required a large degree of manual handling.

The manufacturer identified a significant number of work-related musculoskeletal injuries amongst the 450 staff which were causing absence from work, inability to undertake normal duties and high staff turnover.

In the two years prior to seeking help from ergonomics professionals, there were a total of 19 musculoskeletal injuries that were reportable to the Health & Safety Executive.

Tailoring ergonomic solutions

The manufacturer asked ergonomics consultants to help them to decrease accidents and incidents resulting in musculoskeletal injuries, ill health and associated cost and to reduce the potential for liability due to musculoskeletal injury.

In order to achieve these objectives, the consultants gained support from the board to implement an ergonomics programme with the staff. They identified an ergonomics champion and created a robust reporting system. Tailored ergonomics training packages were developed and delivered to train staff in basic ergonomics concepts, identifying and quantifying physical ergonomics risks and implementing ergonomics solutions to reduce risk. This programme was then implemented on the shop floor.

Following the ergonomics training staff identified a number of key issues that were increasing exposure to musculoskeletal disorder risk factors. These included:

- No job rotation which increased exposure to musculoskeletal disorder risk factors and often resulted in 'bottlenecks' occurring on the production line.
- No training on ergonomics or musculoskeletal risk factors and how to prevent these issues.
- Poor working postures caused by some handheld equipment used for highly repetitive activities.
- Individual differences in how some handheld equipment was used that resulted in some staff working in poor wrist and upper arm postures.

Workplace design

Physical discomfort in the workplace is often a combination of the effect of the design of a specific product and also the way that it is implemented within the work setting. Therefore a good workplace design approach will combine appropriate selection and evaluation of work products and devices, along with a consideration of the way that work is organised.

For example, by reducing the repetitive nature of work, physical comfort can be improved. Considering work design in tandem with product design we can ensure that work is as comfortable and safe as possible.

Impact

Improved wellbeing
Improved working conditions
Improved job design
Financial savings

> *"Following intervention, there was a decrease in injuries. The payback period for this project was five months."*

- Production lines that 'ended nowhere' causing poor workflow.
- Line managers not empowered to make changes on their own lines.

Making a difference

Several interventions were applied to address the issues raised:

- A system of job rotation was implemented. Initially only staff who had the skills moved between the appropriate jobs. Other staff were upskilled to allow for effective job rotation patterns to be implemented.
- Tailored ergonomics and manual handling training packages were formulated for each department. These packages were delivered in-house by trained staff. The training was specific to the jobs the employees were doing and were largely practical based taking place at the workstations.
- Line managers were empowered to make relevant changes on the lines to reduce ergonomics risk factors.
- More conveyors were implemented on some lines to ensure an improved flow of work and reduce manual handling between lines. These conveyors were already on site but not being used so there was no cost to this intervention.
- Employees were trained on best practice when using hand-held tools to improve upper limb postures.

Reportable musculoskeletal injuries decreased to three during the year of training and programme implementation. The following year they had one RIDDOR reportable musculoskeletal injury. Year three and four post intervention saw no reportable injuries.

The ergonomics champion presented the participatory ergonomics programme to their insurers resulting in a £60,000 per annum reduction in insurance premiums.

Return on investment over four years was £9.51 for every £1 spent. (This is solely based on insurance premium savings and projected absence from RIDDOR reportable injuries.)

Project payback period was five months.

Wider applications

The process of identifying an ergonomics champion and implementing a training programme to improve work practices and decrease injury is applicable to most workforces and can bring about the same sort of improvements for staff and for the company as a whole.

This type of intervention is suitable for environments such as laboratories, construction sites, warehouses, baggage handling operations and many other types of workplaces.

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Case Study 21

Reducing repetitive strain

Sector: Security

Personnel within a manned operator booth were required to open a window and collect and pass items to vehicle drivers and passengers. The design of the booth meant that it was cramped and the posture to open the window required uncomfortable and irregular limb movements. As these actions were repetitive and frequent, the occurrence of repetitive strain injuries increased among staff.

Modelling user needs

Ergonomists were commissioned to review the design of the current booths and provide ergonomic re-design options. An assessment of design and musculoskeletal disorders was completed to categorise the aspects of the current designs which were deficient and leading to musculoskeletal disorders. Computer software was then used to identify where problems were arising and to design a new booth.

Initially, the 3D CAD modelling software was used to create a 'usable design area' (UDA). The UDA is an anthropometrically and biomechanically correct 3D layer that incorporates the representative viewing cones and reach envelopes for the operators. Then a 3D model of both the existing and new booth designs was built.

Viewing cones and reach envelopes for 5th percentile females and 95th percentile males were then imported into the 3D models of the designs to determine whether they catered for the extremes. The UDA was used to determine where there were any clashes. For example, an operator sitting in the main operator position must be able to look out of the booth window and into the adjacent vehicle to complete a facial recognition task.

Using the UDA, and specifically the visual cones, CAD modelling indicated whether an operator of a specific anthropometrical stature could view the vehicle passengers within their normal viewing cones. If the window blocked, or partially blocked the line of sight, the booth design was not satisfactory as the operator would have to move out of a normal posture to complete the action. Essentially, the primary use of the 3D modelling software was that it allowed ergonomists to quickly and easily assess whether designs were ergonomically correct or not.

A new booth design was developed using the same UDA, ensuring that no clashes occurred within the design. It was then possible to appreciate operator constraints and capabilities and include them as an integral part of the design process.

Computer aided design

Computer-Aided Design (CAD) enables us to consider a wide range of user physical sizes and shapes without the need for extensive user testing.

By using CAD to predict how different users will 'fit' a workspace we can ensure that as many users as possible are considered. CAD also enables us to take the user's view, allowing us to not only assess physical fit, reach and strength but also to predict what a user will be able to see whilst they are carrying out their job.

Impact

Improved job design

Improved wellbeing

Financial savings

> *"The benefit of using the modelling software was that this process meant that the number of design iterations was reduced as a compliant design could be produced first time round."*

The benefit of using the modelling software was that this process meant that the number of physical design iterations was reduced as a compliant design could be produced first time round.

The design was assessed using the System for Aiding Man-Machine Interaction Evaluation (SAMMIE), software that creates 3D models of users to test the dimensions of the design. A full-scale mock-up of the booth was then built and tested with booth operators.

Making a difference

The usable design area and use of SAMMIE should ensure the booth designs do not facilitate sub-optimal postures to be adopted by operators and, in particular, they have enough room to open the booth windows using regular limb movements.

This should reduce the number of musculoskeletal disorders experienced by staff. There are approximately 8,000 operators across the UK and overseas. Reducing repetitive strain injuries would reduce the number of working days lost to illness and injury, as well as promoting a more acceptable and efficient working environment.

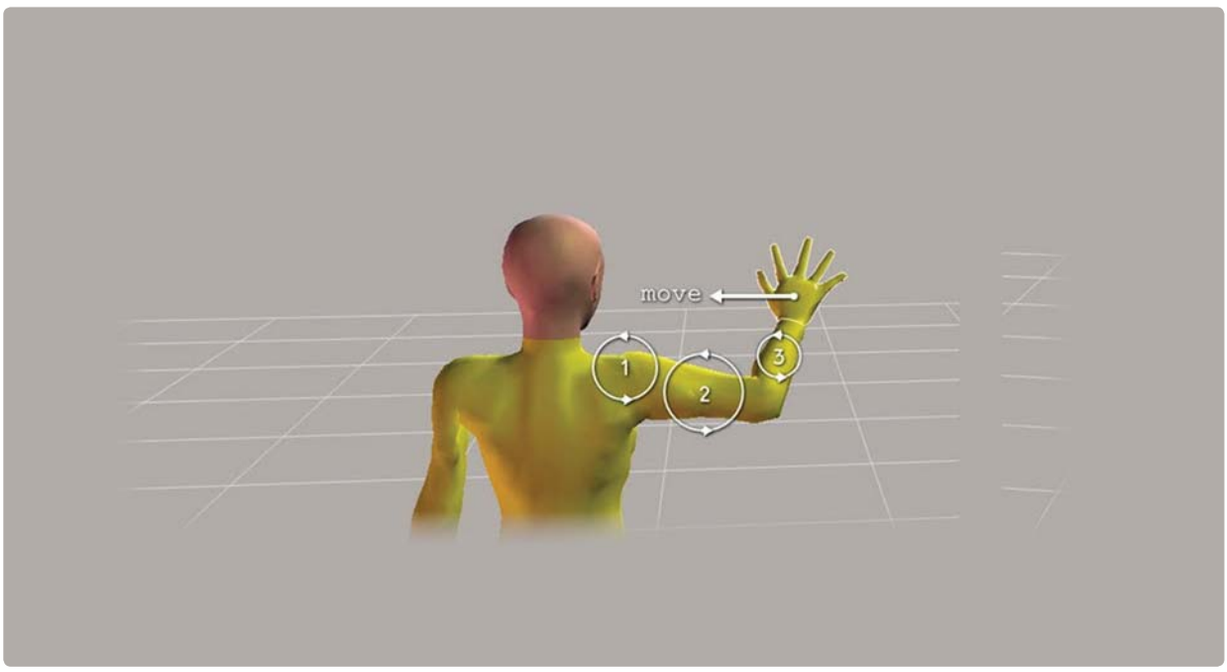
Successful implementation of the booth designs, both existing and new, could see future expansion outside the primary locations. It is possible that the design could then be rolled out to almost 140 locations across the UK and abroad.

Wider applications

The areas where these methods can be applied are wide ranging. They are useful in any situation where the user physically interacts with their environment.

These include the design and layout of equipment and furniture in public places, control room workstation and control panel design, and vehicle design and interiors for all types of passenger transport.

In addition, the modelling process can be used in safety and maintenance evaluations, as well assessing operator fields of view and fit and reach dimensions for any given scenario.



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Case Study 22

Compiling a health and safety strategy

Sector: Transport

A health and safety strategy is essential, particularly for large business, to ensure that health and safety policies are implemented in a coherent and systematic way.

A user-centred strategy engages individuals at all levels of an organisation and ensures that their views are listened to and taken into account.

A user-centred approach

The Highways Agency was moving from a Government Agency to become a new organisation called Highways England. Previously, as a Government Agency, the Highways Agency could not be criminally prosecuted for a health and safety failure. The new company, Highways England, no longer has Crown Immunity, but is subject to the full legal framework for health and safety in England.

There was a tragic incident in which a Highways Agency Traffic Officer suffered a fatal accident. Following investigation, a driver was convicted and the Highways Agency was subject to a Crown Censure. A company in which such an event occurred might be subject to prosecution under Corporate Manslaughter legislation for which the penalty is an unlimited fine. Regardless of the possibility for prosecution, no-one wanted to work in an organisation in which avoidable deaths occurred.

The Highways Agency recognised that taking a more user-centred approach in which individuals at all levels were engaged might help with some of the pluralistic ignorance problems, where individuals all believe that the Highways Agency should get better at health and safety against a background of thinking they were good enough.

Consultants carried out a literature search to determine what would deliver the desired behaviour changes. The main findings were that organisations who claimed to be world-class at health and safety do not have a common approach or agreed metrics for what 'good' looks like. However, they have an explicit commitment to 'good', normally in the form of core values that describe behaviours of individuals in any circumstance.

High-performing organisations were interviewed to determine how they achieved effective health and safety performance. It became clear that organisations had effective strategies for stakeholder engagement, training and an understanding of the importance of lead indicators that measured more than traditional factors such as lost time injuries and accidents.

Health and safety strategy

Effective health and safety programmes are about much more than guidelines. An holistic approach to a strategy for health and safety enables all those within the organisation to change their approach and attitudes to behaviours that might previously have been viewed as safe.

Safety culture denotes the behaviour of an organisation as a whole towards health and safety, and can be improved by such a strategy.

Impact

Improved customer engagement
Improved user experience
Improved processes

> *"The strategy was taken by the Health and Safety Director and incorporated into a 5-year plan for Highways England."*

The benefits of engaging with a wider audience were also recognised, particularly the Tier 1 and Tier 2 contractors who deliver most of Highways England projects, so a number of workshops were run outlining the aims and objectives with Tier 1 and Tier 2 contractors and considerable feedback was collected on how to improve the strategy.

Making a difference

Consultants conducted extensive interviews with the whole team to explore what they wanted out of a new health and safety strategy and how they thought it could be achieved. It soon became apparent that their visions could be categorised into eight areas:

- Ambition: setting clear vision and values for health and safety that were both internal facing and external facing.
- Culture and climate: the need to employ techniques to measure and improve the health and safety culture.
- Governance: the importance of delivering effective governance of health and safety to demonstrate that the management system was effective and delivering the required improvements.
- Risk: the need to have a single, corporate view on risk that allowed risks to be assessed, reduced and monitored, and the importance of linking risk management to governance procedures.
- Whole life safety: the need to understand that decisions taken early in project life cycles will have impacts throughout a project and beyond.
- Health and wellbeing: an emphasis on more than just safety is a key component of any effective management system.
- Assurance: three-tier audits, at the local, tactical and strategic levels are required to assure the senior team that the system is functioning.
- Performance monitoring: taking a more innovative and proactive approach to measuring performance whilst recognising that reactive statistics need to be captured and be decreasing.

An action-orientated strategy was taken that was in line with the wish of the organisation to be fit for the future in terms of its management of health and safety.

The strategy was taken by the Health and Safety Director and incorporated into a 5-year plan for Highways England.

Wider applications

This design process could be used in all types of organisations that need a coherent health and safety strategy that works across multiple departments and employees.

Acknowledgements

This project was carried out by a team from Human Applications, ARUP and the Highways Agency.

Chartered Institute of Ergonomics & Human Factors

Case Study 23

Designing effective protection

Sector: Defence

Improvised Explosive Devices (IEDs) are a major operational threat, with the pelvic region of soldiers being vulnerable. Due to unacceptable levels of injuries, the Army raised an urgent need for pelvic protection.

Integrating human factors ensured a 'right first time' solution, avoiding modification to fix problems, costing less than 1% of the total acquisition. The system had high adoption rates from troops, and has resulted in significant reduction in pelvic injuries from IEDs, and saved lives.

Understanding the needs of soldiers

The Ministry of Defence (MOD) recognised that getting the comfort and utility of the pelvic protection right was essential to ensuring that the protection would be worn.

Therefore as well as assessing the penetration resistance of candidate devices and technologies, MOD initiated a process of iterative human factors assessment and trials using levels 1 & 2 of the Human Factors Assessment Framework (HFAF), developed by Defence Science Technology Laboratories to support the successful integration of dismounted soldier equipment.

The HFAF is a flexible framework of human factors techniques of which all three levels were employed in the development of the pelvic protection. The three levels are:

1. Rapid inspection and evaluation to identify immediate issues or risks that may affect the user, with approximately three representative users.

2. Trial with six to twelve representative users in a realistic field environment using subjective and objective metrics to evaluate soldier performance.

Protective equipment design

Equipment has an important role to play in physically protecting people whilst at work, but sometimes people are reluctant to use protective equipment as they find it uncomfortable, believe it slows them down or do not like the way that it looks.

A good design approach will take these factors into account and not only help to design equipment that is comfortable and usable but also make sure that the work culture makes wearing protective equipment an expected part of everyday working life.

Impact

Improved user experience

Improved wellbeing

Improved safety

> *"The garment appears to have made significant surprising reductions in the patterns of injury and ingress of debris."*

Plastic surgeon who operates on soldiers with perineal injuries at the Royal Centre for Defence Medicine.

3. Controlled laboratory trial, using participants or simulations, such as thermal manikins, to provide objective data on human physiological or cognitive responses.

Making a difference

This led to a tiered solution, which allows users to appropriately consider their options before selecting what to wear. Tier 1, for routine use by all troops, meets stringent comfort requirements, with low physiological burden and minimal movement constraint.

- The system is liked by the troops such that they will wear it in extremely hot environments (50 degree heat).
- The system is well integrated with other protection and dismounted equipment.
- Since troops will wear it, it has resulted in significant reduction in life-altering chronic pelvic injuries from IEDs.

The pelvic protection system that was developed as a result of this process has been a great success.

Wider applications

The technologies used in advanced protective equipment design have applications in many domains outside the military, including emergency services, motorbike riders, and those who work with dangerous machinery such as in factories, workshops and on building sites.

These settings will vary in terms of their safety cultures, and in some, the equipment may form part of a uniform whereas in others the equipment may only be worn when completing specific tasks.

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Case Study 24

Designing armoured vehicles

Sector: Defence

The Ministry of Defence is procuring a new family of tracked, armoured fighting vehicles known as AJAX (previously SCOUT Specialist Vehicles (SV)), which will conduct a variety of functions for UK land forces. The aim is to achieve a human-centric design that preserves the safety of the human operator and delivers a highly 'fightable' (usable), state-of-the-art armoured fighting vehicle to front line operators.

Integrating novel technologies

Historically, the application of Human Factors Integration (HFI) in defence terms, within the world of in-service armoured vehicles, has been limited due to the long life of legacy platforms and the development of improved human factors practices only in recent years.

Lethality and survivability are also prioritised for obvious reasons, but the goals and value of good HFI is not always apparent until latent human-related problems are physically realised in operational theatres. Achieving design change can be a technically challenging and costly undertaking once such systems have been fully developed and deployed.

In September 2014, the UK MoD signed a £3.5 billion contract for a fleet of new medium weight, armoured reconnaissance vehicles. Fitted with a state-of-the-art suite of Intelligence, Surveillance, Target Acquisition and Reconnaissance (ISTAR) capabilities, AJAX will provide a step-change in capability for UK land forces. This includes acoustic signal detection, laser warning systems, local direct and indirect situational awareness systems, electronic countermeasures, route marking systems, remote weapon systems, advanced electronic architecture and network connectivity.

For AJAX, the critical role of the human component within the capability delivery loop has been recognised. Preserving and enhancing the safety and 'fightability' of the system for the human operator has been integrated into the multi-disciplinary engineering process as a dedicated workstream, supported by suitably qualified and experienced human factors professionals.

A comprehensive programme of HFI has been initiated in the design and assessment of the AJAX system, in order to meet the challenges presented by the integration of novel technologies within an armoured environment.

Through the HFI process, human-related design requirements are pre-emptively considered in design and tracked by a programme of assessment on progressively realistic system prototypes. Human-related issues identified through assessment are raised and resolved where possible, through application of industry best practice standards for usability and human-centred design.

Armoured vehicle design

As technology advances and the battle space becomes a more complex arena, the specifications of armoured vehicles must change to provide a safe and effective environment for those who operate them.

Vehicles now need to include technology for functions such as acoustic signal detection, laser warning systems, situational awareness systems and route marking systems.

Human factors has a vital role to play in ensuring this complex system works effectively by taking human capabilities into account.

Impact

Improved safety

Improved usability

Improved capability

> *"The goals and value of good human factors integration is not always apparent until latent human-related problems are physically realised in operational theatres."*

Making a difference

The development of AJAX is an on-going programme, in which accommodation of the physiological and cognitive requirements of the human operators are being considered. These include:

- Crewstation design that will account for the full-range of anthropometric variance within the user population, to enable visual and physical access to all safety and mission critical Human Machine Interfaces .
- Optimising AJAX Human Computer Interfaces (HCI) to provide logical, intuitive and unambiguous information to the AJAX crew in order to minimise human error.
- Effective communication, facilitated by the AJAX system, between crew and external supporting units, that will generate manageable workload levels and deliver unprecedented levels of local and wide-area situational awareness.

AJAX will represent a new benchmark for capability within a complex, dynamic and ever-evolving battle space. Understanding the risks of ignoring human-centred design issues and the benefits applying HFI principles in design will be key factors in preserving system safety and achieving the full potential of AJAX's technological and human capabilities.

Wider applications

Application of a structured and measurable Human Factors Integration programme has the potential to improve safety and business performance across a range of high hazard engineering industries, where human operators are relied upon to conduct complicated or safety-critical actions.

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Case study contributors

CIEHF members were encouraged to submit case studies outlining the benefits of applying ergonomics and human factors in their sector. Ten contributors were invited to a thought leaders workshop on 6th October 2015, led by Sarah Sharples, at which all the submitted case studies and the document format were discussed.

- Jon Berman, Director, Greenstreet Berman Ltd, www.greenstreet.co.uk
- Russell Fife, Chartered Ergonomist & Human Factors Specialist, Attwood Leighs Ltd, www.attwoodleighs.co.uk
- Suzanne Heape, Senior Human Factors Consultant, Siemens Rail Automation, w3.siemens.co.uk/mobility/uk/en/rail_solutions/pages/rail_solutions.aspx
- Tanya Heasman, Managing Director, System Concepts, www.system-concepts.com
- Jeremy Lenman, Human Factors Consultant, Atkins, www.atkinsglobal.com
- Corinne Parsons, Lead Ergonomist, Royal Mail, www.royalmail.com
- Philip Rippin, Human Factors Engineer, Mott MacDonald, www.mottmac.com
- Ian Rowe, Director, Ian Rowe Associates Ltd, www.ianroweassociates.com
- Sarah Sharples, Professor of Human Factors, University of Nottingham, www.nottingham.ac.uk
- Will Tutton, Principal Human Factors Specialist, MOD - Defence Science Technology Laboratories, www.gov.uk/government/organisations/defence-science-and-technology-laboratory
- David Watts, Managing Director, CCD Design and Ergonomics, www.designbyccd.com

Case studies included in this document were also contributed by:

- Lisa Dorn, Associate Professor, Cranfield University, www.cranfield.ac.uk
- Margaret Hanson, Chartered Ergonomist & Human Factors Specialist, WorksOut, www.worksout.co.uk
- Nigel Heaton, Director, Human Applications Ltd, www.humanapps.co.uk
- Elizabeth Hellier, Associate Professor (Reader), University of Plymouth, www.plymouth.ac.uk
- Sue Hignett, Professor of Healthcare Ergonomics & Patient Safety, Loughborough University, www.lboro.ac.uk
- Laura Pickup, Research Fellow, University of Nottingham, www.nottingham.ac.uk
- Jon Wackrow, Head of Human Factors Engineering, London Underground, https://tfl.gov.uk/modes/tube/
- Patrick Waterson, Reader in Human Factors and Complex Systems, Loughborough University, www.lboro.ac.uk
- Amanda Widdowson, Human Factors Consulting Lead, Thales Cyber and Consulting Services (formerly Quintec), www.thalesgroup.com

About the CIEHF

The Chartered Institute of Ergonomics & Human Factors (CIEHF) is a professional membership body open to all which recognises, protects and promotes standards of achievement demonstrated by ergonomists and human factors specialists.

Ergonomics emerged as a scientific discipline in the UK about seventy years ago, alongside the growing realisation that, as technical equipment became increasingly complex, not all of the expected benefits of that equipment would be delivered if the people who were to operate it were unable to understand and use the equipment to its full potential.

Initially, issues were most evident in the military sector where high demands were placed on the physical and cognitive capabilities of the operator. As the technological achievements made during wartime were transferred to civilian applications, similar problems of disharmony between people and equipment were found, resulting both in poor user performance and an increased risk of human error.

The analysis of poor performance in 'man-machine' systems (human-machine systems) provided a growing body of evidence which could be linked to difficulties faced by the human operator. This stimulated research by academic and military physiologists and psychologists and led to further investigations of the interactions between people, equipment and their environments.

At a meeting of physiologists and psychologists at The Admiralty in 1949 the term 'ergonomics' was coined from the Greek ergon and nomos ('work' and 'natural laws'). Later that same year the Ergonomics Research Society (ERS) was formed, the first such professional body in the world.

Over the intervening years, ERS evolved to represent the discipline, both in the United Kingdom and further afield. In 1977 ERS became The Ergonomics Society in recognition of the increasing focus on the professional application and practice of ergonomics that stemmed from the ever-increasing theoretical and research base. The Ergonomics Society became a Registered Charity and a Company limited by guarantee in 1985.

As the discipline evolved, variations in terminology arose in different countries. In the USA the term 'human factors' took on the same meaning as ergonomics in the UK. Although the two terms have been, and remain, synonymous to professionals, more popular usage has at times accorded different shades of meaning to each term. Human factors may be considered by some to imply the cognitive areas of the discipline (perception, memory) where ergonomics may be used by many to refer to physical aspects (workplace layout, light, heat, noise). In 2009, The Ergonomics Society was renamed the Institute of Ergonomics & Human Factors (IEHF) to reflect the usage of both terms and to emphasise the substantial breadth of the discipline.

In 2014 the importance of the discipline was recognised by the award of a Royal Charter. This allows the Institute to confer Chartered status on members who meet specified criteria. This includes a high level of qualification and experience and the ability to demonstrate continuing professional development, such members becoming the only 'Chartered Ergonomists and Human Factors Specialists' anywhere in the world.

The Charter was accepted by the membership at an Extraordinary General Meeting in November 2014, with the Institute changing its name once again, proudly becoming the Chartered Institute of Ergonomics & Human Factors.

Designing for People

Chartered Institute of Ergonomics & Human Factors

Elms Court, Elms Grove, Loughborough LE11 1RG
07736 893344
iehf@ergonomics.org.uk
www.ergonomics.org.uk

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