

Human Factors and Healthcare

Evidencing the impact of Human Factors training to support improvements in patient safety and to contribute to cultural change

A report for Health Education England by
the Chartered Institute of Ergonomics & Human Factors

January 2019

Introduction

Human Factors is a broad, scientific, evidence-based discipline that can help people solve a wide range of problems that they face in what they do, every day. In understanding, for example, why patients struggle to use personal medical devices, the application of Human Factors in the design, implementation and evaluation of the devices or in the equipment we use, and the way people work, individually and together, will lead to more resilient, more productive, more connected and more sustainable systems and ways of working.

Human Factors differentiates itself from other contributions to improvement by using a people-centred, systems approach that can be demonstrated to lead to higher safety, to sustained cost savings over time and to better quality outputs on a sustainable, consistent basis.

The Chartered Institute of Ergonomics & Human Factors understands the requirement to identify unequivocal messages that support why Human Factors is a contributory, enabling discipline, why Human Factors adds value, and what the priorities should be when considering how Human Factors should be integrated and implemented in workplace environments.

Working with accredited, qualified Human Factors specialists leads to the design of more effective, more efficient workplaces and safer, more productive methods of working.

Human Factors is far more than error or incident analysis, but rather about focus on rigorous, elegant, evidence-based solutions to problems and building resilient systems that enable people to do the right things, every time.

Training in Human Factors can take many forms, including face-to-face group sessions through to group or individual instruction and demonstration in the workplace. All have merits in terms of effectiveness if applied in the most appropriate way for the target audience.

This report aims to:

- Identify the type, level and impact of Human Factors training undertaken within several sectors in England, including, but not limited to, the healthcare sector.
- Identify and recognise good practice in Human Factors training by means of a set of case studies that demonstrate the effectiveness of Human Factors training.
- Inform stakeholders and partners about potential strategies for the implementation of Human Factors training across an organisation like the NHS on a consistent basis.

Summary

Qualified Human Factors specialists have been at the heart of positive changes to many safety critical systems in six key industry sectors over the past seventy years. Work in manufacturing, transport, energy, the workplace, in defence and in healthcare has resulted in potential accidents being avoided, lives being saved and overall, things just working better. People are inspired and energised when things work better.

In aviation, the widespread adoption of a Human Factors approach has materially changed the way in which an aircraft is operated and managed, both onboard from the flight deck and remotely by air traffic control. Airlines like EasyJet and Ryanair integrate and embrace Human Factors in a high-pressure sector in which successful outcomes must be routinely delivered. NATS, the main air traffic control services provider in the UK that handles about two million flight movements every year employs over twenty qualified Human Factors specialists who, day to day, investigate, study, propose and improve on ways of doing things that involve people to make work safer, more intuitive, more productive and more efficient. This resolute integration of Human Factors, both in the air and on the ground, improves an industry that is focused on delivering minute-by-minute safe outcomes to tight timescales, just as in a healthcare environment.

High-hazard industries have also long recognised the importance of minimising the risk from human error. The nuclear sector has led the way in understanding, measuring and improving reliability, with UK nuclear regulation regarded by many observers as the gold standard. Human factors requirements have been embedded from the outset in defence equipment procurement for decades, the sector in which the discipline of Human Factors has its origins. This set of case studies illustrates how Human Factors currently contributes to safer outcomes key sectors of the UK economy.

Effective systems of work deliver improvement by considering the physical and cognitive abilities of the user and by evaluating the design of the technologies that support the user, so adding value to the work process and enabling complex work to be routinely completed both safely and productively.

By example, in the railway sector, tools developed by Human Factors specialists are used to assess the workload experienced when signalling staff operate different types of workstation. These assessments not only ensure that railways are operated safely and run efficiently, but also support the design of new, advanced signalling control systems that are essential to exploit emerging automation technologies, ultimately to successfully exploit higher speed railways.

Human Factors maintains, at its core, the consideration of the well-being of the person as operator. As well as the societal and ethical need to aim to ensure that people at work are comfortable, healthy and inspired there is economic value to ensuring that people work in safe conditions. Human Factors research led to regulations that have been implemented at a national level to ensure the design of safe workplaces, and this work continues, as does the journey from fixed desktop and factory working to mobile and active mobile work systems and as automation is introduced into the safer, healthier workplaces of the future.

In the healthcare sector, much focus has been placed on improving communication between clinicians, ensuring that teams work together to make effective decisions in the time available and to reduce the likelihood of harm. Many items of equipment found in a clinical setting, from ambulance vehicles to infusion devices have been developed and evaluated by Human Factors specialists.

Significant further benefits can be delivered by adopting a nationwide, focused and consistent approach which will bring a shared awareness and understanding alongside economies of scale. Recognition that Human Factors approaches can provide significantly more impact when expertise is embedded in the system provides the opportunity for a combination of a user-centred approach and the process optimisation approach typified by Quality Improvement. A tiered approach to competence and capacity can ensure that skills in all areas and at all levels of healthcare are fashioned cost-effectively to greater benefit.

A proposed view, outlined in the CIEHF's 'Human Factors in Health & Social Care' White Paper, of how competence and capacity in Human Factors can be attained is included below.

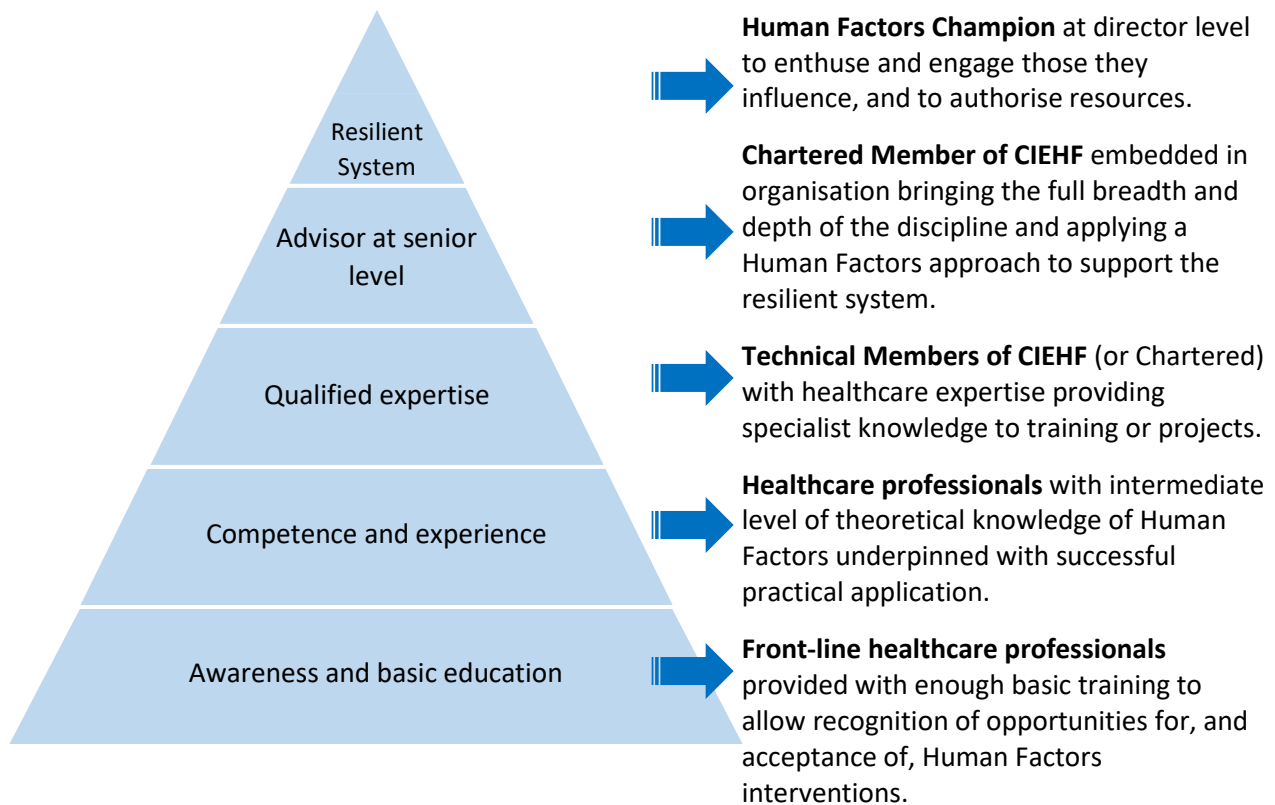


Figure 1: Attaining competence and capacity in healthcare

This report informs the following:

What is the estimated scale of Human Factors training within the NHS, either funded through HEE or through other funding mechanisms?

Case studies 1, 7, & 12 illustrate the scale of Human Factors training. However, although the Chartered Institute of Ergonomics & Human Factors is the only provider of a Chartered qualification in Human Factors and of the specification of the discipline in the UK, CIEHF is not currently the sole provider defining or delivering ‘Human Factors’ training within the NHS. Accordingly, CIEHF is not in a position to assess the scale nor specific content of all ‘Human Factors’ training currently being delivered within the NHS.

What evidence is there, and how robust is it, that Human Factors has a positive impact on patient safety?

All case studies from the healthcare environment illustrate positive impacts on patient safety through the wider adoption and integration of Human Factors.

To what degree has Human Factors training brought about a change in culture in industries or organisations that have implemented it, including, where evidence exists, within the NHS?

Case studies in the ‘Behaviour change and safety culture’ sections of this report illustrate changes in culture following increased understanding, through Human Factors, about how and why people do what they do.

Are there examples of good practice in Human Factors training that provide an opportunity for sharing?

Almost all case studies depicted illustrate opportunities for sharing good practice to effect. Knowledge about Human Factors enhances the understanding healthcare professionals already have about people.

Are there examples of Human Factors training that have been less effective at demonstrating positive impact and an analysis of opportunities for process improvement?

In some case studies, a formal evaluation of the impact and benefits are not available, but this is not unusual. Opportunities for improvement are evident in each of the case studies presented.

Conclusion

This report set out to identify the type, level and impact of Human Factors training in the healthcare sector in England. These case studies illustrate the diversity of Human Factors activity in healthcare, and in other sectors as requested. Human Factors encompasses all aspects and characteristics of people, both physical and behavioural, so the scope of Human Factors, necessarily, is significant. Terminology and definitions of exactly what Human Factors encompasses can vary, and here is a challenge: to categorically recognise and state the extent of activity and training in Human Factors – in any sector, not just the healthcare sector.

The report also targeted the demonstration of the effectiveness of Human Factors training through a set of case studies. All the case studies demonstrate positive change that Human Factors can deliver in one way or another. This is evident either in design changes that enable people to do the right things, or through a permanent change of mind-set that enables people to look at the world in a different, more people-centred way. Also demonstrated in many of the case studies is the fact that the participatory approach that human factors brings is particularly beneficial since this focuses on sharing and support throughout any given project to ensure effective collaboration in designing solutions and the ownership of the final interventions.

Finally, the report set out to recommend potential strategies for the implementation of Human Factors training across a multi-level organisation such as the NHS. The multi-disciplinary nature of Human Factors ensures that the existing skills of those in a project are recognised and utilised. Many healthcare professionals already have the underpinning knowledge and understanding about anatomy, physiology and psychology which is vital in ensuring changes to tasks and workspace bring about benefit to the people concerned. Those skills are already embedded.

Within the healthcare sector case studies in this report, it has been demonstrated that the adoption of Human Factors approaches does not necessarily require capital investment and routinely delivers a significant return versus the base case. Organisations that do embrace Human Factors can demonstrate long term benefits including more stable, energised and skilled workforces and attractive, productive work environments.

CIEHF's proposed view, contained in this report, of attaining competence and capacity in healthcare can incorporate the existing knowledge, skills and experience of the current workforce and enhance this further through specific, tailored education and training in Human Factors to the benefit of healthcare professionals, managers and patients.

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Case studies from healthcare

Behaviour change and safety culture

1. Supporting delivery of care

Setting: Patient care, management of clinical support services, leadership, organisational development and workforce development.

Region: Midlands & East of England

The challenge

As a population we are living longer but are often doing so with long term medical conditions which require treatment. Lifestyle factors such as poor diet, smoking and low activity levels can lead to illness. Providing the NHS services that the population requires and demands is becoming increasingly expensive. Despite such challenges, the NHS continually strives to deliver high quality patient care. What can NHS Trusts do to further support delivery of such care?

Within the NHS, there is growing awareness of Human Factors. The National Quality Board (NQB) published a Human Factors in Healthcare Concordat which states that “Human Factors principles can be applied in the identification, assessment and management of patient safety risks, and in the analysis of incidents to identify learning and corrective actions.” The Concordat recognises the value that Human Factors can offer in improving the quality and productivity of patient services.

With few NHS Trusts employing qualified Human Factors professionals, ways to raise awareness of Human Factors to enable staff to have a greater understanding of the subject and how its principles can be applied to healthcare must be identified. Are there ways in which NHS staff might explore how Human Factors relates to quality improvement? Furthermore, how can staff gain enough knowledge to consider how Human Factors solutions can improve wellbeing and performance for both staff and patients?

The response

In order to increase Human Factors awareness and understanding within NHS staff, a total of twelve two-hour Human Factors and Ergonomics (HFE) taster workshops were delivered to introduce HFE principles and practices in healthcare. The project was part of a campaign lead by Health Education England (Midlands and East) to develop the role of HFE in patient safety.

The workshops were delivered in six locations across the East of England, East Midlands and West Midlands, attended by 105 delegates. The roles of the delegates included those involved in direct patient care, management of clinical support services, leadership, organisational development and workforce development. The workshops included HFE information being delivered by videos, applied theoretical models and exercises which aimed to engage and enable the delegates to consider the application of HFE within their own role and work environment. The workshops were delivered by representatives from tertiary education and private consultancy and included one chartered member of the CIEHF.

Prior to the workshops, all delegates were asked to complete a survey to identify the issues and challenges which they felt prevented the delivery of effective, high quality and safe care. The content of the questionnaires was then used to inform the themes of the workshops. The three main challenges identified were: resources (including workload, money and staffing); systems (including IT/data, policies and processes, communication and learning); and culture (including ownership and accountability, leadership, expectations, organisational culture and environment). Other challenges noted by delegates included staff wellbeing, training and knowledge, time and complex needs.

The impact

Whilst most participants felt that the pace of the workshop sessions gave them enough time to understand and absorb the content, some felt that they would prefer longer sessions. A two-hour workshop can

provide delegates with an overview of HFE but cannot provide depth of knowledge. The workshops could be developed further to include extending the duration of the training and expanding the content covered. It was felt by the training providers that doing so could offer potential improvements in building the workforce for the future and supporting transformation.

The workshops were carried out in 2018 with the aim that delegates will be able to use this awareness of HFE to apply some basic principles to healthcare work, educate others through discussion or progress to more detailed HFE courses for greater knowledge.

Number of staff trained: 105 staff

Course duration: 2 hours

Number of sessions delivered: 12

Effectiveness of training

Upon completion of the training, the feedback from delegates indicated that 99% felt that the workshop had been directly relevant to their work and most expressed an interest in learning more, either for themselves, their team, and/or their organisation. The multidisciplinary attendance at the workshops enabled opportunities for the sharing of good practice, experiences and prompted discussions between different disciplines. It was felt that the workshops supported the development of a more flexible workforce by developing skills that would be transferrable across healthcare settings.

2. Dealing with medical emergencies

Setting: Secondary NHS Provider, multi-disciplinary staff within a Mental Health Trust

Region: London

The challenge

Research has shown that those with severe psychiatric diagnoses are prone to physical co-morbidities such as cardiovascular disease, respiratory disease and diabetes. This contributes to patients with severe mental health illnesses dying up to 20 years earlier than the general population. As this group of patients may require inpatient mental health services, which are often located away from general hospital sites, it is important that mental health inpatient staff have the skills and knowledge to manage acute medical emergencies and long-term physical health needs in addition to mental health requirements. Mental health staff have reported that they feel unprepared and lacking the skills required in managing physical illness. Findings from inquests relating to deaths from natural causes in mental health settings have commonly noted inadequate emergency response training, a lack of, and/or poor use of, lifesaving equipment and poor team cohesion and communication. The management of medical emergencies requires not only the clinical knowledge to deal with the situation but Human Factors skills especially in communication are also required in order to work effectively as a team.

The response

As a result of a series of physical health incidents both locally and nationally, clinical educators at Maudsley Simulation in South London developed an *in-situ* simulation-based training course to support inpatient mental health teams manage medical deterioration. The training aimed to improve the clinical skills required and Human Factors skills such as teamwork, communication and situation awareness. A half day training was delivered to all staff working on two 16-bed psychiatric triage units in London. In total, 53 participants were trained which included staff such as mental health nurses, psychiatrists, healthcare assistants and activity co-ordinators. Simulation training aimed to improve the technical skills that staff required to deal with medical emergencies. In addition, the multi-disciplinary sessions enabled whole teams to be trained together and gave them the opportunity to address latent threats such as inadequate equipment, poor procedures and gaps in knowledge or poor communication.

Following an introduction to the principles of simulation, participants were involved in three high fidelity simulated scenarios on topics which were deemed to be priority areas such as respiratory arrest, diabetic hypoglycaemia, hanging and choking. Each of the scenarios was followed by a structured and reflective debrief during which Human Factors issues were addressed. The course aimed to develop the clinical knowledge and skills required to deal with medical emergencies along with an increased awareness of Human Factors topics such as communication, teamwork and situation awareness.

The impact

The training aimed to improve specific clinical and Human Factors skills related to the management of physical health needs in a mental health setting. Data from questionnaires and focus groups held three months post-training were used to assess participants' knowledge, confidence and attitudes towards medical deterioration pre and post-training. Analysis showed that all three attributes improved significantly post-training.

Qualitative data explored the participants' experience of the training and how they felt it would impact not only their own practice but that of their clinical team. Analysis revealed five Human Factors themes: confidence; team working skills; communication skills; reflective practice and personal responsibility. Participants frequently reported an increased confidence regarding the management of medical deterioration on their ward and a greater ability to cope with such pressured situations. Participants reported an improved understanding of good teamwork and a shift of focus away from the performance of the individual on a specific task and towards the overall team goal. The improved team working described by participants was not limited to management of medical deterioration but was felt in wide-ranging day-

to-day activities on the ward. Participants felt that the training had provided them with a greater understanding of good communication and felt more capable of communicating effectively with colleagues, particularly in challenging, high pressured situations which were relatively unfamiliar in a mental health setting. Finally, participants demonstrated a shift in attitude with increased feelings of personal responsibility for the physical health of their patients. This resulted in a desire to have the appropriate skills for managing medical emergencies along with greater checking of equipment, procedures and policies themselves rather than relying on others to complete.

Incident reporting rates for seven months pre and post-training concerning medication issues, illness and injury, self-harm and suicide were also compared. The data showed that following the training, staff incident reporting on the trained wards increased by 33%. It is felt that the training enabled staff to understand the importance of reporting incidents and recognised it as a starting point for change and improvement.

Effectiveness of training

Although the focus of the training was the management of medical deterioration, the participants were able to apply learning more broadly to other aspects of their clinical work. This could be applicable to any *in-situ* training carried out which enables multidisciplinary staff to work together in a real-life working environment and can assist in the development of a more resilient and reflective workforce.

Reference: Managing medical emergencies in mental health settings using an interprofessional in-situ simulation training programme: A mixed methods evaluation study, M Lavelle, C Attoe, C Tritschler, S Cross, Nurse Education Today, 59 (2017) 103-109.

3. Reducing prescribing errors

Setting: Junior doctors

Region: East Midlands

The challenge

A GMC study conducted across 19 hospitals in North-West England found there were 8.9 medication errors per every 100 prescriptions. This figure is similar to the East Midlands. There is evidence which showed junior doctors made twice as many prescribing errors compared to other prescribing professionals.

Traditionally the training of junior doctors takes place in high-pressure environments and it is reported that such doctors can feel unsupported. Opportunity to receive regular and constructive developmental feedback during junior doctor training is limited and there are currently few effective interventions for reducing prescription errors.

The response

EPIFFANY (Effective Performance Insight for the Future) is a human-centred design approach that helps doctors become aware of Human Factors principles. The approach has led to a large improvement in performance on complex workplace tasks, such as prescribing medicines by making small changes to the way individuals are educated, receive feedback, work as a team, and use clinical decision support technologies for work or study.

The approach creates a safe learning environment, using simulations, including real outpatients for junior doctor-patient encounters, complemented with principles of Human Factors and educational theory like self-regulated learning.

EPIFFANY was initially piloted in 2013 at Leicester General Hospital's, John Walls Renal Unit, University Hospitals Leicester NHS Trust. EMAHSN, Health Education England East Midlands (HEE EM) and Pfizer assisted with an additional rollout at Pilgrim Hospital Boston, United Lincolnshire Hospitals NHS Trust, in 2015-2016 for all junior doctors working in general surgery and orthopaedics.

The impact

EPIFFANY has proved effective at improving prescribing competence for those taking part, and impacting positively on junior doctors' confidence, wellbeing and attitude to work. It delivers improvements through simulations, face-to-face teaching and feedback to realise the large gains in performance made by individuals. Clinical decision support is also made available on mobile devices.

Further impacts include:

- Increased prescribing performance of junior doctors by over 50% across a 4-month rotation in each of two separate units.
- Improved satisfaction with education and training among junior and trust grade doctors.
- Increased wellbeing and self-confidence of junior doctors so they consider remaining in the East Midlands to continue and develop themselves personally and professionally.
- Promoting pharmacists as educators by incorporating pharmacists in the team and empowering them to give individualised feedback.
- Cost avoidance in medication errors as well as potential bed days and litigation.

Effectiveness of training

EPIFFANY has been successfully undertaken in two East Midlands NHS trusts and is being evaluated at three further trusts for sustainability to enable wider adoption. It is also being evaluated in New Zealand and in Greater Manchester AHSN.

4. Theatre cap challenge

Setting: Tertiary NHS Provider, multidisciplinary maternity staff

Region: Midlands

The challenge

In an operating theatre, all staff wear the same colour scrubs (trousers and short sleeved top) and hat regardless of their role or grade. In addition, those who are carrying out the procedure will wear a mask that covers much of their face. In large theatre departments, staff often move between areas meaning that they may not know the name of everyone they will be working with in the theatre team. When wearing scrubs, name badges are not always easily displayed as staff involved in the procedure wear additional sterile gowns. We often forget the names of those we have been introduced to, so, staff may find it difficult to work and communicate effectively if they don't know the name and role of those in theatre. Staff may not know if they are directing a question or comment to the Surgeon, Nurse or non-qualified member of staff. When a Surgeon asks for a piece of equipment during a procedure, if they don't know staff names and roles, they will not know who to direct their request to and risk no one responding. In an emergency, such communication and teamwork challenges may result in delays to patient care.

The response

A midwife who was new to the Trust became aware of an initiative for theatre staff to display their name and role on theatre caps. The midwife recognised how useful this would be, particularly for staff who were newly qualified, or, like themselves, new to an organisation. After seeking opinion on the initiative from the Trust, the midwife decided to display his/her own name and role on the theatre cap by writing on a disposable hat. He/she received intrigue and positivity from colleagues. Initially, despite positive comments, there was little take up from other staff until one of the Consultant Obstetricians also joined the initiative and suggested that the midwife lead the project across two hospital sites. Initially, staff wrote their names and roles onto the disposable theatre hats, however, funding was secured for cloth theatre caps with permanently embroidered names and roles. A survey was conducted amongst the midwives to establish their opinions on wearing the embroidered hats. Support was received from senior management and the Infection Control team. The midwife then designed posters to engage and inform staff about the initiative before the first batch of embroidered hats arrived.

The midwife leading the project undertook a one-day Human Factors training session which included subjects such as the SHEEP model, team building, communication, leadership qualities and respectful challenge.

The impact

The midwife who led the initiative felt that being in theatre as a newly qualified member of staff could be an intimidating experience, especially when not familiar with other colleagues. As soon as she started wearing her personalised theatre cap, she felt that her team members communicated with her in a different manner; staff began communicating with her by using her first name which she felt helped to focus her attention to individual tasks that she had been asked to do. It helped boost her self-esteem and role accountability within a multi-disciplinary team, and she felt that she was a valued team member. In addition to other staff using the midwife's name in theatre, the midwife felt that many staff have remembered her name and now use it outside the theatre setting. Neonatal staff who usually attend theatre in an emergency have also responded positively to the theatre cap initiative, particularly by recognising its part in an SBAR (Situation, Background, Assessment, Recommendation), a technique that can be used to facilitate prompt and appropriate communication handover.

By being able to identify staff and roles, collaboration and cohesive working within a multi-disciplinary team can be improved, particularly during emergency situations. Communication becomes easier amongst staff as names and roles are recognised and used which helps promote accountability within individual disciplines/roles. This has an impact on patient safety by reducing the risk of communication errors.

Patients can familiarise themselves with the staff looking after them which may help humanise the team working to keep them and their babies safe.

Effectiveness of training

As multi-disciplinary staff from the department have undertaken some human factors training which included improvement in communication, it will help in the understanding of the benefits of the theatre cap initiative and enable the identification of further ways to improve patient safety.

Incident Investigation

5. Improving investigation of patient safety incidents

Setting: Senior clinical staff

Region: Southern

The challenge

Institutional learning driven by appropriate investigation of patient safety incidents is an essential element in strategies to optimise healthcare safety. Current investigation practice in the NHS does not comply with expert recommendations on learning from error. Investigations are usually conducted internally by hospitals, and investigators commonly lack Human Factors training. Conflicts of interest and lack of relevant training were identified as key obstacles to effective investigation.

The response

An action plan was developed through pragmatic co-design, calling on Human Factors and implementation science theory and a close understanding of how NHS Hospital Trusts function. An expert working group was assembled comprising experienced clinical staff, managers, clinical governance professionals and Human Factors experts from the Patient Safety Academy. This group defined, through discussion, the principles for developing a regional network for Human Factors-led independent investigations, and a strategy for implementation and testing.

An expert consensus group developed recommendations for independent safety incident reviews and conducted a pilot study at the five acute Trusts in one region in England. Thirteen senior clinical staff were trained in Human Factors-led incident investigation and mentored by the Patient Safety Academy whilst conducting independent investigations.

The training syllabus was based on a Human Factors approach to incident analysis as used in other industries, emphasising objectivity, independence and data driven analysis. It used appropriate models and tools to interpret data and make hypotheses about influences and causes. Human factors principles about the strengths and weaknesses of different types of solutions were taught, and a session was devoted to interaction with carers, families and patients. Participants were required to integrate these principles in simulated investigation exercises based on anonymised and modified real incidents. Training on report writing and recommendations were included, with an emphasis on developing strong solutions.

The impact

This initial experience illustrated the feasibility and potential value of independent expert Human Factors-based review of safety incidents in NHS Trust hospitals. It also provided experiential evidence about barriers which need to be addressed if such reviews are to become more widely adopted. The investigator training was highly rated by participants. Trust engagement with the process was slowed by confidentiality and institutional risk concerns.

Effectiveness of training

Three investigations have been undertaken to date. Comparison with internal draft reports shows a considerable improvement in the depth and sophistication of analysis, and in the strength of human factors recommendations.

Reference: Improving NHS investigation of patient safety incidents. Initial report on the development of a regional programme of independent Human Factors led reviews. P McCulloch, H Higham, L Morgan, D Benson, Patient Safety Academy, Medical Science Division, University of Oxford

6. Using Human Factors to assist investigations

Setting: Senior clinical staff

Region: London

The challenge

There are several challenges facing every industry that stem directly from human capability, which may be contributory in systems failures, some leading to accidents. These include time pressure, long shifts, no breaks, distractions, interruptions and poor communication between departments. Following several high-profile incidents within the NHS, the General Medical Council (GMC) commissioned a team of qualified Human Factors specialists from Oxford University to help overhaul its current incident investigations process with a robust Human Factors approach.

The response

Working with the GMC's 'Fitness to Practice' department, which oversees the monitoring and investigation of doctors and nurses, the Human Factors specialists offered training, advice and recommendations on the current investigation process. They proposed several approaches that will allow investigators and regulators to change their perception of error and accountability. These fundamental methodologies include focusing on factual analysis of the system, understanding that humans can make mistakes and taking all the facts into consideration before deciding on accountability.

The impact

Future investigations around doctors' conduct will take a broad, structured Human Factors-based perspective of the context into consideration.

Effectiveness of training

Leading the Human Factors team working with the GMC, Lauren Morgan, a research scientist and lecturer from Oxford University and a Chartered member of the CIEHF, believes this deployment of Human Factors in healthcare will contribute to improving internal processes.

Procedures

7. Reducing side errors in surgery

Setting: Neurosurgery

Region: North East England

The challenge

Undergoing surgery can be an anxious time for a patient who must put trust in the surgical teams carrying out the procedure. Complications can happen during and following operations and patients are made aware of risks prior to the surgery. However, what can often be feared by patients is surgery being carried out at the wrong side or site. Wrong side surgery is classed by the NHS as a 'never event' which are defined as a 'serious incidents that are wholly preventable', events that, quite simply, should never happen. The consequences of such an error can be devastating for patients and staff.

In an NHS Trust, six side errors occurred in one year, and as a result, steps were taken to prevent recurrence. The steps included a universal 'knife check' which is a verbal check between at least two members of staff to confirm the patient's identity, date of birth and operative site and side. This check occurs immediately before the knife is handed to the surgeon. This measure reduced the error rate at the hospital, however, a further error occurred 18 months after the knife check had been introduced.

An adult male was due to have a procedure to remove a left sided tumour carried out by a Registrar. Although the surgery was being carried out on the left side, the head was positioned by the Registrar as for a right sided operation. The wound site was prepared and draped on the right-hand side and the knife check was completed as usual. The anaesthetist, scrub nurse and Registrar discussed the name, date of birth, site and side of surgery. All agreed the operation would be on the left and that the left-hand side had been prepared. A right sided incision was made, and muscle dissection began. At this point, a Consultant entered the theatre, checked the scans and recognised that an error had been made. The operation was halted, the error pointed out and a hot debrief into how the error had occurred was carried out.

The debrief identified that the scrub nurse and surgeon had left-right dyspraxia which resulted in each normally having to stop and check sides rather than intuitively knowing their left and right. In addition, the patient was in a prone position. The anaesthetist had checked the name and date of birth of the patient from the consent form. However, he had not checked the operative site as he had been positioned at the foot of the patient where the operative site was obscured from where he was standing. In addition, it was discovered that leading questions had been used in the knife check. It was later identified that many staff had developed a habit of using leading questions such as "Is it the left side?" rather than "Which side is it?"

The response

Following the error, Human Factors training was delivered to the neurosurgical team which focused on human performance topics such as errors, situational awareness, decision making, communication, debriefing and checklists. The main emphasis of the training was to explain to staff how and why errors occur and to help staff understand why briefing and checklists can help staff share situational awareness. This was particularly important when considering sided surgery.

Dealing with difficult people was an important topic covered on the training course and this included how to cope with staff who did not feel the need to be part of a checking or briefing process. The training aimed to equip all staff with the skills to resist challenging behaviour and to help staff to understand that the language they used during the knife checks was important, including the consequences of using leading questions.

The impact

Following the training, 15 days of observations were carried out over a 3-month period. At the beginning of the observations, the pre-list briefings were carried out in approximately 10% of the lists; at the end of the observations this increased to 90%. The rate of 90% remained when reviewed five years later.

During the training, debriefing was advocated at the end of the operating lists. Staff tried to implement debriefing as it had not taken place prior to the training. Initially, after the training, 50% of lists carried out a debrief, however, after 6 months, debriefs had been discarded. The reasons for this were twofold. Firstly, team members' tasks finish at different times during a list so there was no single convenient time for everyone to be present. In addition, it was considered that debriefing was concerned with long term process improvement rather than looking at how a specific list had been carried out. So, staff perceived it had a lower priority than the briefing sessions. As a result, hot briefing was encouraged in which both positive and negative issues were discussed as soon as possible after these had arisen.

Number trained: 125 staff from neurosurgical theatres

Course duration: 1 day

In addition, for 15 days over a 3-month period, external Human Factors specialists observed theatre behaviour and then advised. Following the interventions, an internal observation of theatres spanning three days was carried out to assess long-term compliance.

Effectiveness of training

At the end of the Human Factors training and an observational work period spanning 5 years, no further side errors had been recorded. Whilst training initially showed some positive results, the continued safety improvements were likely assisted by the support of the clinical lead for the area. He remained in the department to reinforce the Human Factors messages delivered during the training sessions and ensure they became embedded in the culture of the workforce.

8. Safely relocating a hospital

Setting: Tertiary NHS Provider, multidisciplinary staff

Region: North West England

The challenge

Moving from one hospital site to another is a huge undertaking, and one which must be meticulously planned. It is essential that the transition from one to another does not compromise the care or safety of patients. A regional paediatric NHS Trust hospital in the North West of England that had 270,000 patients and families visit each year was moving from one site to another. The Trust identified the importance of carefully considering the logistics for moving staff, patients and equipment prior to any move.

The response

An orientation and system testing process was led by a multi-professional team that included clinical, simulation and Human Factors expertise. The process enabled a group of NHS staff moving into the brand-new hospital site to have the opportunity to orientate themselves and test systems. They also had the opportunity to suggest redesigns and developments to safe processes prior to the arrival of patients. This was the first phase of the move.

A formal orientation process included visits to the new build and use of healthcare simulation to test established processes and design. A group specifically looked at supporting the move of the operating theatres to a new area containing 14 operating theatres over two floors. Three simulations were devised to test the location of emergency equipment and processes:

- Responding to an unexpected unplanned airway emergency during introduction of anaesthesia.
- Responding to a major blood loss event during surgery.
- Evacuating the theatre suite due to a fire emergency.

Groups were taken through the simulations in multi-professional speciality groups that included theatre staff, surgeons and anaesthetists and representatives from other areas. Initially simulations were carried out in a completed area of the new build and the location of emergency equipment was indicated with pictures. Following the simulations, a robust debriefing and learning conversation was facilitated to identify issues and used the extended team to suggest appropriate changes to processes. Further development and testing was carried out along with other procedures such as movement of patients from one area to another.

Phase two of the move included simulations which were used to test the clinical areas. A multi-professional team was assembled for each theatre area and a case was simulated to ensure all equipment was available and working. Only after successfully completing these simulations were areas used for patients.

The impact

This Human Factors approach enabled identification of numerous processes that required modification due to the different layout in the new build, including siting of emergency equipment, flow of patients through departments, and the optimal configuration and layout of rooms and areas. Errors in organisational systems and processes were identified and redeveloped prior to patient arrival. Front-line staff were engaged and helped develop appropriate, safe processes, increasing their confidence in working in the new areas.

Effectiveness of training

The introduction of a Human Factors approach enabled the NHS staff involved in the project to understand the benefits of its application in areas such as the physical environment, use of equipment, processes and systems. Applying Human Factors to systems and processes before patients were treated in the new environment enabled NHS staff to understand the benefits of a proactive approach which could then be applied to other aspects of their clinical work.

9. Improving patient flow

Setting: Tertiary NHS Provider, Emergency Department staff

Region: Midlands

The challenge

A large Emergency Department (ED) in Birmingham treated over 115,000 patients in 2016. 3.2% of those presented with chest pain. Most of these patients arrived via a non-ambulance route and self-presented at the ED reception complaining of chest pain. On arrival at the ED reception, all non-999 patients reporting with chest pain were booked in by reception staff, handed an A5 size red card and given directions into the main department. The purpose of the red card was to enable any ED staff member to recognise that the patient had chest pain and was therefore a priority. To enter the department, patients were directed along a corridor to the ambulance entrance which did not require security pass access. Once in the main ED, patients were then requested to contact the Registered Nurse (RN) who oversaw co-ordinating the department. From there, patients would then be directed to the assessment area of ED where they would make themselves known to the assessment staff and an ECG would be carried out. This system was inherent with risk and danger due to gaps and the unknown suspected heart attack patient walking unrecognised in the department.

A member of staff within ED had undertaken a five-day Human Factors training session and had recognised that some improvements to processes within the department could be made. A request was made for Human Factors input into the department, and, to the chest pain process.

The response

Two members of Trust staff carried out a Human Factors review of the chest pain process. One had attended a two-day Human Factors training course whilst the other was a Chartered member of the CIEHF.

To understand the process fully, observations were carried out within ED where patients with red cards were present and multidisciplinary focus groups were carried out. To understand and identify further where and how the process might fail, a Failure Modes and Effects Analysis (FMEA) was carried out. The FMEA identified that there were points in the system where delays and failures could occur. For example: patients may not find their way into the department; they may fail to identify themselves to the co-ordinating nurse; they may fail to show the red card; they may collapse before they received treatment; or staff in the assessment area may not be aware that a chest pain patient had arrived in the department due to the volume of other patients.

In order to reduce the likelihood of delays in patient ECGs, the process of presenting at ED reception with chest pain to receiving an ECG was changed. The part of the process identified from the FMEA as being of most concern was the route patients took from reception into the main department through the ambulance entrance. This route had been chosen as the ambulance entrance did not require swipe access whereas the entrance closest to the assessment area did. Steps were therefore put in place to enable chest pain patients to have direct access through a swipe door into the assessment area. Reception staff were requested to continue to give the patient a red card and direct the patient to the closer door that led straight into the assessment area. The patient was then instructed to knock on the door showing the red card to gain access to the department which was staffed by RNs, Emergency Care Technicians and Health Care Assistants, all of whom were able to open the door to red card patients. Upon entering the department, patients would immediately be greeted by a member of staff who would either direct them to a cubicle for an immediate ECG (if available) or to a new dedicated chest pain seated area where an ECG could be urgently organised and completed.

The impact

The aim of the study was to improve safety, care and patient experience. By changing the process, the distances patients had to walk were reduced and the simpler route was intended to reduce the risk of patients becoming lost. Removing the need for patients to make themselves known to the RN co-ordinator would eliminate the risk of patients not speaking to and making themselves known to the member of staff

and remove additional delays in the ECG being carried out. The patient being directed to the short access point and knocking on the door displaying the red card allowed timely access and ensured quick identification of the suspected heart attack patient. A designated seating area was newly created solely for suspected heart attack patients. This was placed immediately outside the assessment room and assessment cubicle staffed by a RN and an Emergency Care Technician, both of whom were able to carry out an ECG. Patients sitting on the designated chairs were visible to all staff and the reason for them being in ED immediately clear, this also encouraged timely ECG and assessment.

A FMEA of the new process was carried out and showed that the risks identified as being of most concern previously had either been eliminated or reduced. In order to assess the impact of the work further, a staff satisfaction questionnaire was undertaken to determine staff opinions regarding the change in process and all staff who took part in the survey viewed the change positively. The review process enabled ED staff, via observations and group discussions, to recognise the potential problems with the original suspected heart attack process and all were committed to make improvements. As a result, ED staff felt ownership of the process changes which, with minimal intervention, have remained in place.

Effectiveness of training

Throughout the project, staff within ED received Human Factors education through discussion and involvement in the chest pain work. Following on from the project, one of the ED doctors was considering the layout of the airway drawers located within the Resuscitation bays and wanted to reorganise them so that they were more logical, enabling all staff, whether permanent or temporary to find the appropriate piece of airway equipment quickly in an emergency. Replicating the labelling and layout across all bays in the Resuscitation area would result in consistency for staff and enable those topping up the drawers to do so more easily and accurately. Whilst the doctor from ED contacted the Human Factors team who carried out the chest pain work and asked for some Human Factors advice, the desire to make the improvements came as a result of increased knowledge of Human Factors.

Design

10. Supporting resuscitation of new-born babies

Setting: Paediatric and neonatal

Region: East Midlands

The challenge

During resuscitation of new-born babies, a stethoscope is used to assess heart rate. However, this device gives inaccurate feedback in about one third of cases. Failure to deliver appropriate resuscitation can result in the death of an infant. It was therefore considered that, during this critical time, there was a need to standardise and facilitate heart rate recording in order to reduce instances of inaccurate information.

An appropriately designed device could ensure clinicians are provided with accurate information in a timely, precise and clear manner to allow them to form appropriate opinions about treatment. In order to produce such a device, a clear understanding is necessary of the information required and how it should be displayed and controlled.

The response

A Human Factors study was carried out to understand the tasks involved in new-born resuscitation, the cognitive requirements and the potential for error. The study aimed to identify gaps in existing knowledge about user requirements for the interface design of a new resuscitation device and to maximise usability of the device's touchscreen interface.

In order to create design requirements for a new device, a full understanding of the cognitive requirements of the clinician carrying out the task was undertaken using an approach called Applied Cognitive Task Analysis (ACTA). In order to complete an ACTA, the following was carried out:

- Creation of a task diagram which provided a broad view of the task and identified difficult cognitive components.
- A knowledge audit interview that highlighted aspects of the task that required expertise and the cues and strategies relied upon.
- An interactive scenario-based workshop for appropriate healthcare professionals which determined the cognitive processes involved with key tasks, and any potential for error.
- Creation of a cognitive demands table which summarised and integrated the information obtained from the previous three steps, together with interview data gathered prior to the study. This was a comprehensive record that focused the findings on the goals of the study.

To explore the cognitive requirements and elicit insight from all practitioners, two workshops were carried out in parallel and involved paediatric doctors, qualified and student neonatal nurses, advance neonatal practitioners and midwives. Each group worked through the simulation task discussing the cognitive needs, decision points and potential errors, whilst discussing ways in which the interface of the new device could be designed to meet their needs and reduce the likelihood of errors.

The Human Factors work produced a comprehensive description of essential and preferred user requirements for the interface of a new-born neonatal device. The outputs were:

- A high-level representation of neonatal resuscitation tasks.
- Identification of the cognitive requirements for key tasks, critical information and decision points.
- Analysis of the cognitive demand associated with key tasks and potential errors.
- User opinion on interface design options to support cognitive requirements, reduce potential for error and record neonatal resuscitation events.
- A comprehensive outline of user and design requirements for the interface design and relevant standards.
- A greater awareness of Human Factors for the clinical staff involved in the project.

The impact

This participatory approach ensured a systematic analysis of the resuscitation process, described as 'logical and rigorous' by the subject matter experts involved. The study and its outputs have been used to develop an interface which prioritises simplicity of use whilst optimising performance and minimising error, and which fits into the current clinical pathways for neonatal resuscitation.

The workshop and interviews identified factors relevant to both the device and the design of the interface not previously considered by the design team. Additionally, clinical practitioners discussed the potential for this device beyond the original context considered by the developers.

Effectiveness of training

By including staff in this approach, they were able to gain knowledge and awareness of Human Factors. By educating staff in the scope of Human Factors each can understand the potential impact on the development of devices such as stethoscopes which are used in critical clinical tasks. Further, it is the aim that staff will be able to go on to identify areas of Human Factors application in personal working environments.

11. Standardising ambulance services

Setting: Secondary NHS Provider, Ambulance Service staff, designers and manufacturers

Region: East Midlands, East, West and North East England, and Yorkshire

The challenge

Prior to 2006 many NHS Ambulance Trusts each produced unique vehicle specifications for the design of ambulances, resulting in over 40 different designs. This posed a risk to patient safety due to potential operator confusion about the location of equipment and interior layout given the variations in design of 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 response

A series of projects with the Ambulance Service from several areas was carried out to look at the design of vehicles, equipment, working systems, clinical protocols and patient pathways. Human Factors professionals 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.

Solutions were developed with manufacturers of vehicles and ambulance equipment and were 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. These were used to develop the national specification for emergency ambulances.

The impact

The Human Factors recommendations have had an impressive impact on the public, 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.
- Human Factors input for the NHS Supply Chain ‘Mobile and Relief Clinical Services’ national contract.

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.

The project improved working conditions, wellbeing, and safety, and provided financial savings and increased education and awareness of Human Factors within the Ambulance Service.

Effectiveness of training

Working directly with users and manufacturers ensured that user needs were captured and understood. In addition, such collaborative working enabled discussion of Human Factors principles and its application to the design of environments, equipment, task organisation, systems and processes.

Carrying out extensive observations with the paramedic crew enabled Human Factors professionals to share Human Factors knowledge with clinical staff and provide a basic level of Human Factors training for use in other work settings.

12. Designing out medical error

Setting: Primary care

Region: London

The challenge

A single patient journey can cross boundaries between the primary, secondary and tertiary healthcare sectors. Care is often delivered by distributed teams working in emergency situations within unfamiliar and multifunction workspaces. Medical devices are a component of virtually all healthcare processes from bedside lockers through to life support systems, but usability issues with such devices are often under recognised or unreported.

Designing Out Medical Error, DOME, was a three year, EPSRC-funded, multidisciplinary project aimed at designing safer healthcare equipment, processes and devices. The objectives of the DOME study were:

- To develop a multidisciplinary approach to designing for patient safety that would provide long term engagement and potential for future design collaborations.
- To map, analyse and prioritise the hazards in a surgical ward.
- To develop design solutions using a systems approach and co-design methods.

DOME took a systems approach to the design of the healthcare processes, equipment, environment and information used in the bed-space of a typical surgical ward. Applying this approach to such a common workspace means that the methods and solutions will be transferable to many other clinical specialties and settings. Rather than focusing on a type of error, incident or activity, the project took a holistic view of the activities that take place around the bedside. This approach allowed the systems' influences on the safety of all aspects of care to be considered in parallel. A collaborative approach saw designers and clinicians involved in joint observations, data collection and design activities, and facilitated knowledge and skill transfer between disciplines.

A mixed-methods approach was adopted, utilising methods from psychology, Human Factors, social science, operational management and design. This approach included observations, interviews, surveys, shadowing, mapping of healthcare processes, Failure Modes and Effects Analysis, risk identification and prioritisation, focus groups, causal analysis, generation of design briefs, concept generation, brain storming, co-design, simulation studies and clinical trials and evaluations.

A work analysis was conducted based on 70 hours of observation on five general surgery wards at three hospitals during the day, night and weekend. The work analysis identified 14 top-level healthcare processes around the bedside, each with numerous sub-processes.

Given the large number of activities observed, the processes were risk assessed by healthcare workers, patients and visitors using subjective rating scales. The highest risk processes were identified as hand hygiene, vital signs monitoring, isolation of infection, medication delivery and handover of information. A Healthcare Failure Modes and Effects Analysis was then used to identify how each of the surgical ward healthcare processes could fail.

Nearly 200 potential failure modes were identified in just these five processes. Further analysis of the top 60 failure modes identified the contributory factors. Design was cited as a contributor to the high-risk failures in all five processes. A lack of reminders, and poor monitoring of staff performance and feedback were also common, together with a lack of standardisation, issues with leadership, clear team roles and responsibilities, education, training and patient safety not being a priority.

The response

An iterative design process was followed where ideas were continuously presented to healthcare workers and patients for critical input. One of these, the CareCentre™, was developed primarily in response to the isolation of infection brief, although it also addresses many of the other briefs, demonstrating the merit of considering multiple processes and design briefs simultaneously.

These observations were extended to include the use of other equipment for common bedside processes. It was found that the medication locker was often inaccessible (located on the wall, often with a patient obstructing), gloves and aprons were situated away from the bedside, there was no flat surface for reviewing or writing documents, cleaning wipes were not within easy reach (again, located on the wall), and the hand gel at the foot of the bed was difficult to access from the bedside.

The concept of rationalising all this equipment into a 'one-stop-shop' met with user approval, and through a series of feedback sessions with front line staff, the list of contents of this all-in-one unit was defined, as well as its position at the end of the bed.

The first prototype was produced and taken to over 120 staff for review. This featured a flat surface for writing documents, a medication locker, hand gel, cleaning wipes, aprons and gloves, and a folder holder to contain the patient's charts. The concept was designed to hook over the end of the bed.

The impact

Following further iterations and user feedback, the CareCentre™ is now in manufacture and is in clinical trials. Other outputs from the study include signage for hand hygiene, a re-designed vital signs trolley with retractable leads, a mobile phone application for recording respiratory rate, a medication dispenser that records missed medication, and design requirements for a handover space.

The project brought together clinicians, designers, psychologists, Human Factors and business expertise to develop solutions to potential errors in and around the hospital bed-space. By taking a systems approach to design, the project identified causes common to a range of failures in the highest risk processes.

Effectiveness of training

Investigations that bring together clinicians, designers, psychologists, Human Factors and business expertise to develop solutions to potential errors maximises learning on all fronts and offers the best chance of success. By taking a systems approach to design, causes common to a range of failures in the highest risk processes can be identified. The Human Factors knowledge and techniques gained by the surgical staff could be applied to other clinical areas such as the theatre environment with opportunity for consistent design of layouts, equipment or systems and processes between theatre and ward.

In addition, by focusing on activities rather than error or incident, clinical staff will have the knowledge and skills to consider other potential areas of improvement within the ward environment in a proactive manner rather than responding to errors and incidents that have occurred. Knowledge and experience gained through this practical application of Human Factors is regarded as highly memorable.

13. Safer neonatal care

Setting: Neonatal

Region: Midlands

The challenge

The design of the modern Neonatal Intensive Care Units (NICU) varies but is often a large, open room with incubators side by side. This has observation and access advantages but also disadvantages in noise levels, lighting and privacy. Recently there have been steps 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.

A project to determine the space required to care for and treat neonates using Human Factors principles was carried out with Human Factors specialists to ensure efficient and safe working conditions. 87 clinical tasks with 28 staff providing care to 15 new-born babies were observed. It was found that there was insufficient space for families and staff together and there was no family space for the parents to stay with the child. It was also found that storage was limited, with no nursing trolleys and clinical bins in the cot space. Staff often had to work in awkward positions due to the cramped space available.

The response

A simulation scenario was developed to test space recommendations with clinical tasks for emergency admission, connecting ventilators, inserting gastric tubes, giving drugs and taking a chest x-ray, as well as a visit to the 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 video recorded which was then analysed 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 13.5m². When circulation and storage space requirements were included this increased to 18.46m².

An expert panel of clinicians and architects reviewed the recommendation and information about the application of Human Factors in the project and agreed that the average individual cot space of 13.5m² could accommodate variations in working practices.

The impact

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.

Effectiveness of training

This participatory 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 control room. By undertaking a similar approach, staff will have a greater awareness of the tasks, processes and equipment requirements of other multi-disciplinary team members. The way that workplace equipment and layout is designed can affect communication and collaboration, making it easier for workers to support each other and for members of the public to speak to professionals.

Further evidence

The following statements provide further instances of the successful implementation of Human Factors training and approaches.

"I am a consultant paediatrician in a maternity department which was heavily criticised by inspectors from the healthcare regulator as unsafe and poorly led. Since then, supported by experts in human factors and ergonomics, we have delivered a programme of staff training and practical interventions, which has contributed to transforming the way we work. Just 12 months on, a reinspection has recognised us as a safer, caring department. It feels better to work here, we have hosted a highly popular regional clinical training programme and are influencing other hospital departments. Service users are also reporting on the improvement. We regularly ask our service users how safe they feel and so can track the percentage of women who feel safe in the department. Since we started in December 2017 there has been less variation in this measure and a higher average. This reflects the improved culture towards which the human factors programme has contributed significantly."

Dr Hesham Abdalla, Paediatric Respiratory Consultant, Trust Quality Improvement Clinical Lead & Senior Lecturer, Keele Clinical Leadership Academy, Walsall Healthcare NHS Trust

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*"We have trained nearly 2500 junior doctors and nurses through our Patient Safety and Human Factors training scheme, which has been running in Wessex for the last 10 years. The programme also supports patient safety projects which are shared at an annual conference. We find that the training significantly influences attitudes to patient safety and broadens understanding of the human factors involved in patient care."*

Dr Sarah Noble, Consultant in Emergency Medicine, Patient Safety First Programme Lead

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"I was asked to establish why a new electronic prescribing and medical administration system was putting patients at risk. I took a Human Factors systems approach to establish that there was a clear mismatch between established practice and the design of the system. Design recommendations for both the clinical practice and EPMA was made. As a result, the roll-out of the system was halted. Whilst this is not a typical success story, halting a system that would have put patients at risk was deemed a success. This would not have been done without taking the systems approach and establishing a mismatch between user, system and environment."

Dr William Green, Associate Professor, Director of Research Impact, College of Social Sciences, Arts and Humanities, University of Leicester

Case studies from other sectors

There is clear evidence of Human Factors being successfully applied and used within the NHS and in a variety of healthcare settings, but there are also examples of its use and application in other industries and sectors illustrating transferrable learning and skills that can be applied to healthcare.

Behaviour change and safety culture

14. Human Factors training

Sector: Energy

Context: Foundation training

Due to the breadth of Human Factors as a discipline, industry-specific Human Factors training courses enable participants to focus on the subject matter that best relates to their area of work, whilst at the same time covering a range of Human Factors approaches and activities.

The challenge

A course was required for those in the energy industry responsible for people, safety and the environment such as managers, operators and supervisors with no prior knowledge or experience of Human Factors. The course needed to provide a comprehensive and practical introduction to Human Factors.

The response

A five-day course was provided by the Energy Institute and accredited by the Chartered Institute of Ergonomics & Human Factors. It comprised five modules aiming to convey the meaning and scope of Human Factors and the benefits when applied in a major hazard context. More specifically, the topics covered include:

- Introduction to Human Factors, including human failure events, safety culture.
- Human and organisation factors in risk management, including human reliability analysis and Human Factors in investigations.
- Human and organisation factors in work systems, including procedures, workload and staffing, fatigue, safety-critical communications and management of human and organisational factors.
- Human and organisational factors in design, including introduction and management.
- Non-technical skills, including communication, teamwork, situation awareness, decision-making and leadership.

Between May 2016 and November 2018, six Human Factors courses were run by the Energy Institute which were attended by a total of 54 participants. Course feedback was collected from each session to understand the strengths, weaknesses and areas of possible improvement to the course.

The impact

The training course, covering a broad range of Human Factors areas, provided staff returning to their organisations with the opportunity to apply their knowledge to design of tasks, systems, work spaces, equipment, incident investigation, risk and human performance. Making Human Factors changes and improvements in these areas enables opportunity to improve efficiency and safety.

From the feedback, participants appeared to value the learning opportunities available from the variety of experiences of other delegates and trainers which provided discussion points through group interaction and case studies. For some participants, gaining a general overview of Human Factors and understanding its application was productive. In addition, participants appeared to feel the sessions most beneficial to them

included the use of Human Factors tools and their application, non-technical skills and development and writing of procedures.

Effectiveness of training

Topic areas in which participants felt they wanted a greater focus were split evenly between non-technical skills such as safety culture, human error, communication and active listening, and areas such as incident investigation, task analysis, process design and policies and procedures.

Relevance to healthcare

Providing healthcare staff with a Human Factors short course covering a variety of topics rather than focusing on one subject area such as human performance would enable participants to understand the breadth and scope of the discipline. This would then allow the identification of areas within personal work or organisation where the application of Human Factors could result in improvements to patient care and safety.

15. Changing leadership behaviour

Sector: Transport

Context: Behaviour change

Creating situations and environments to encourage effective behaviour change can be challenging but given enough stakeholder engagement in Human Factors approaches, where those involved can understand the need for change and participate in how change is brought about, successful interventions can be achieved.

The challenge

Highways England places a high priority on the health, safety and wellbeing of all stakeholders including employees, contractors and road users. Safety is the most important of its business imperatives and is its overarching value, sitting above ownership, passion, integrity and teamwork. As a key business imperative, Highways England created a five-year plan to deliver health, safety and wellbeing. One of the first actions in this plan was to create a training programme designed to change the behaviour of all leaders. The challenge was to ensure that this programme ensured that all Highways England leaders had the tools and the understanding to drive appropriate behaviours and to deliver a healthier and safer organisation.

The response

Highways England wanted the training programme to be based around a small set of proven principles and tools shown to be effective in delivering behavioural change. They engaged in an ambitious project to create a programme that would deliver the change the organisation sought. The organisation committed to measuring the effectiveness of the programme and to check that colleagues who attended the programme changed their behaviours and applied some of the tools they were given.

A four-stage process was used to design the programme to ensure that it was fit to meet the organisational needs. Firstly, a comprehensive literature search was undertaken to discover what others had done to change leadership behaviours around health, safety and wellbeing, with the emphasis on what worked and what to avoid when designing a programme. A series of interviews was then carried out with organisations who were either implementing programmes or who had experience in running these programmes. Of interest was how successful these programmes had been in affecting long-term change in behaviour. A review of commercial off-the-shelf products determined what themes these products identified and what success stories were associated with their use. Finally, a series of workshops was run with colleagues within the organisation, asking them to identify challenges and barriers, opportunities, and what good would look like.

The programme had an overarching theme to support the development of a just culture within the organisation. All the evidence supported the idea that central to changing the behaviour of leaders was to provide a supportive culture in which change could occur, so a range of tools was provided for leaders together with a set of techniques they could apply to help themselves and colleagues change and ultimately produce a just culture.

Three broad themes were identified:

- **Access.** Provide leaders with information and tools that increase their knowledge and allow them to practice understanding of what drives behaviour; enable them to understand who is accountable for health and safety, and what we mean by safety culture and climate; allow them to measure and improve safety culture.
- **Manage.** Provide leaders with the ability to understand how to identify and describe health and safety risk; prioritise and communicate about risk to other stakeholders; measure and reward effective health and safety performance.
- **Relate.** Provide leaders with the ability to understand leadership styles and attributes; develop and share a vision for health and safety leadership; improve communication about behaviours, vision and leadership.

Ten attributes of brilliant leaders of health, safety and wellbeing were identified, and tools were provided to allow leaders to develop and improve those attributes. The programme was run over three days; the first two days were followed by a gap of at least four weeks of practical application in the delegates' roles, before the final day was delivered.

The impact

The programme was delivered to around 300 leaders. The initial results indicate that the programme had an immediate effect on some of the reactive measures of safety such as accident frequency rate. The most popular tools leaders applied were:

- A simple behavioural model that seeks to understand behaviours in terms of an individual's capability, opportunity and motivation.
- A culture change tool based on applying a just culture model to incidents (accidents and near-misses) and other errors while trying to understand error-provoking conditions.
- A risk tool that allows leaders to work with their teams to identify and quantify risk so that the right risks can be prioritised and resourced at the right time.

Effectiveness of training

Leaders trained in this way can be enabled to act to support the delivery of a just culture and the ideas and tools developed can become commonplace within the organisation.

Applications in healthcare

Producing a non-proprietary, tailored, evidence-based programme using the latest thinking from Human Factors can bring about real organisational change. A similar approach could be used to engage and involve stakeholders in healthcare organisations to meet health, safety and wellbeing goals.

Incident Investigation

16. Responding to incidents

Sector: Utilities

Context: Incident management

Systems and organisations need to be designed not only to support routine day-to-day operations but also to be able to respond when unexpected events occur. Because unexpected events may 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.

The challenge

A utilities 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. The company's initial aim was to rewrite the procedures to comply with Human Factors best practice to improve their usability. This recognition that the underlying issue was human-based was valuable as a starting point for the work.

Human Factors specialists started by 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. Therefore, the intervention was expanded to address the wider systems-based issues.

Working closely with functions across the business, such as operations and customer services, the challenges of the existing suite of procedures were examined 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.

The response

Human Factors specialists developed a new approach to the recognition and management of events, providing clarity of roles and of the necessary decisions. Working with the organisation, providing expertise and instruction, 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 and was of little assistance during an event and hence was rarely consulted. The information that would support acquisition of competence was moved into a new training programme. A simple set of event management cards was developed 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 needed to understand how objectives changed as they took on event management roles.

The impact

Several very clear benefits from this project emerged:

- 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 act as a catalyst for culture change. The effectiveness of the arrangements has also increased regulatory confidence.

“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.”

Effectiveness of training

The training was a means of facilitating culture change across the organisation, to enable all staff to understand the importance of a customer focus throughout their activities.

Application in healthcare

Methods and approaches such as these can be applied in many circumstances where a response to incidents is required. Healthcare is a sector where a clear and organised response to incidents or unplanned clinical events is essential to ensuring safe operation, protection of staff and patients, and delivery of effective care.

17. Managing major accident hazards

Sector: Oil & gas

Context: Accident investigation

Human failure is often cited as an accident causation factor. Using a human-centred approach helps to focus on scenarios that allow for failures and then to develop modifications to design issues out.

The challenge

The focus in the oil & gas industry had been primarily on identification and prevention of technical failures causing major accident hazard events (MAH) with accordingly less emphasis on the role of human failures.

In order to address human failures in potential MAH's, a process was developed to manage the risk of human error across onshore and offshore assets of a major oil company. By developing sound foundations, the company has started to show significant benefits in managing human failures in MAH scenarios but developing and implementing this process has been challenging and the following explain some of the learning points identified:

- Organisations need to be intelligent customers and choose qualified Human Factors consultants.
- A clear strategy and common methodology is required. Without a common process, results obtained will not be consistent across the various operational sites.
- Focus on major risks. The process is more effective when priority is given to MAH scenarios that are deemed high risk from human error.
- Close the loop from MAH scenarios right through to training and competency. The higher level of detail required in documentation for high risk tasks must fully align with the actions identified from human error analysis and be linked to training and competency for that task.
- Integrate Human Factors into the business, ensuring the workforce and management have enough knowledge and understanding of human and organisational factors.
- Involve the employees. The initial studies, which were not particularly successful, were conducted mainly as desktop studies. These were found to be largely ineffective in understanding how a task is carried out. As a result, always involve the workforce at each step in the process.

The response

The company decided that a move to focus on Human and Organisational factors (HOF) in process safety required a competent Human Factors person to be embedded in the safety engineering department rather than more traditionally within the occupational safety department.

The methodology chosen was to follow the guidance produced by the HSE in their Roadmap for safety critical task analysis. In order to implement this, several in-house procedures were developed to ensure a consistent approach was used across the company.

The first step in the roadmap process was to identify the MAH scenarios where HOFs influence the outcome, so a series of workshops were held, facilitated by an experienced external risk management consultant. These workshops involved engineers from the safety engineering department who reviewed various MAH scenarios to develop and test a defined methodology appropriate for the company. A review of the site Control of Major Accident Hazards (COMAH) Report and corresponding safety studies such as the Hazard and Operability (HAZOP) study was the focus of activity. The output from this process identifies the specific involvement of people in the relevant activity associated with the upkeep of each prevention, mitigation or control barrier.

To complete the task analysis process, it is essential to involve internal technical support from the Human Factors engineer, safety or process engineers and most importantly the supervisors, operators and technicians who carry out the tasks.

The human error analysis actions have been followed up in several ways, depending on severity:

- Where significant risk is found as a result of human error, specific studies are carried out to identify if further engineering controls are required.

- Where procedural controls are required, stop/hold points are added at the specific steps in the procedure that highlight the hazard effect and risk control measures. This also requires a counter signature by a second person before proceeding.
- Where an occupational safety hazard is found, a safety, health, environment and operational integrity note is added explaining the hazard and risk control measures at that specific point in the task.

The checklist for the performance influencing factors was developed after reviewing guidance and it is imperative that this allows a consistent approach when walking through the tasks on site. After completion of the new procedure a review of training and competency is carried out. This requires a clear link between the task, training requirements and competency to ensure human error is minimised.

The impact

The whole process has gained momentum at the company's onshore gas plant, with resources being allocated to support the assessment process and to facilitate updates to site procedures.

During the workshops, several scenarios were identified where a single error could lead to a MAH. Various operators recognised that they were not aware of the possible scenarios following these errors. These scenarios are now the focus of HAZOP studies and changes to the isolation procedures to include STOP/HOLD points and full details of the hazard effect and the risks. The STOP/HOLD points are placed at specific task steps and highlighted in order that operators or maintenance techs have clear information at the appropriate step in the task rather than a generic statement at the beginning of the procedure or mentioned in a separate work permit. This simple step allows increased control of potential human error as a counter signature is required by a second person prior to the task proceeding to the next step.

As this subject is not widely understood by people who are not Human Factors professionals, the company developed specific awareness training courses. Leaders attend a two-day course facilitated by external consultants and the in-house Human Factors engineer, while operators/technicians attend a shorter awareness course of approximately two hours.

Feedback from this latter course has highlighted the need to lengthen the time allowed. These courses are fully aligned with the safety-critical task analysis process using site-based examples to help explain the principles throughout the training. The process requires a large amount of resources and subsequent support and investment from management and is now progressing well across the company with plans to involve project and modification engineers.

Effectiveness of training

Workshops that feature task analysis allow actions and procedures to be identified that mitigate against human error and lead to appropriate training and competency for that task.

Applications in healthcare

Many sectors have safety-critical activities and this approach, which focuses efforts on high risk tasks at each operational site as a priority until they have been fully addressed, would be a beneficial approach in any healthcare organisation where resources are limited. This method would acknowledge the complex systems that exist in most healthcare settings and the associated potential human failures. Whilst specialities within hospitals differ greatly, there may be opportunity to improve patient safety through shared learning and application of consistent approaches.

Procedures

18. Developing a training simulator

Sector: Transport

Context: Simulation

Simulation is a training technique in which 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 situations to be manipulated so that trainees are presented with a range of challenges that allow them to develop, practice and deploy complex skills in a safe environment. Simulation may involve technology but also may consist only of actors and fellow staff who play pre-agreed roles in a simulated situation.

The challenge

There was a need to train tram drivers on new tram routes and on signalling for track sections not yet available. Waiting until the track was built before carrying out training delays public opening. Deploying untrained drivers onto live 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 driving the actual routes so that once the track was opened then drivers were ready to complete real-world training.

The response

Firstly, a training needs assessment was carried out to establish training 'messages' to be communicated and to develop the specification of the software and hardware required that would provide a kinaesthetic learning experience. 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 for the software 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 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.

The impact

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

- An estimated 50% reduction in overall training time.
- High Driver to Trainer ratio (8:1).
- Elimination of service disruption during driver training times.
- Provides auditable driver training records.

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.

Effectiveness of training

Simulation allows an increase in training quality and consistency and high user satisfaction levels. It is a useful tool for assessment of staff to new roles and can also be used for familiarisation of other operational functions.

Applications in healthcare

Simulation can be used in any training situation to give trainees the opportunity to practice skills in a realistic and safe environment. Computer-based simulators are regularly used to train pilots and train drivers but are also being used more extensively in healthcare, where staff replicate a situation using manikins or actors to allow the learning of the more complex technical and non-technical skills needed to deal with a wide range of clinical scenarios including routine procedures, emergencies or difficult interactions with patients.

19. Maintaining control in a highly automated system

Sector: Transport

Context: Human-centred design

Human-centred design balances what users need and want with what users can deliver in the light of technical, organisational and financial constraints. A programme of Human Factors activities integrated with project activities, from concept to implementation, will enable timely user engagement in design and provide recommendations at the appropriate stage of development.

The challenge

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 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 system delivered a train service of 34 TPH, exceeding the 33 TPH target of the original plan.

On a railway that is 30 minutes from end to end, with 15 platforms in each direction, this means less than a two-minute interval between trains running at the same speeds. This is potentially reassuring for passengers but a potential headache for those monitoring and controlling the service. Human Factors specialists helped to ensure that the increase in capacity could be managed by controllers by using Human Factors integration and systematic and sympathetic user engagement.

The response

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 always has an accurate picture of the state of the railway 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 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.

The impact

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 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.

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

Effectiveness of training

Engaging users in the design process throughout a project ensures that the system produced meets requirements and supports efficient, effective and safe working. Collaborative working enables effective learning for all parties and memorable real-world examples of effective design.

Applications in healthcare

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. There are many different complex systems within healthcare and this human-centred approach can be applicable in many different clinical contexts, from emergency department design to new technologies to be used by healthcare professionals and patients in a hospital context.

20. Getting ready for restarts

Sector: Oil & gas

Context: Safety-critical procedures

Human Factors approaches can be used to ensure processes and procedure are fit-for-purpose and are usable at the point of use. This may appear obvious, but many procedures can be written with 'work as imagined' in mind instead of a clear understanding of 'work as (actually) done'. The differences between the two can cause a procedure to fail unless a user-centred approach is taken.

The challenge

A restart following a major maintenance outage is one of the highest risk activities that an oil refinery undergoes. The risk of material releases can be great because of the complexity involved with keeping track of the status of all parts of the system and the dynamic way work activities are completed towards the end of these large maintenance activities.

One challenge is that operations personnel must manage this complexity to get the units restarted on time but without the tools and organisation to effectively verify that every bleed has been closed, every line-up is correct, and every instrument is functional. Systematic management of human performance so that the system is 'hydrocarbon-ready' has been identified as challenging in the past.

During the restart at one refinery following the last major turnaround (TAR) in 2012, two reportable loss of primary containment events (LOPC) occurred due to improper line-ups and drains being left inadvertently open. Additionally, restarts have been delayed due to breakdowns in communication between areas (particularly the process units and the tank field) about proper valve line-ups.

The response

In preparation for the refinery's 2016 TAR, an operations completions programme was developed. The aim of this programme was to eliminate LOPC incidents at start-up associated with human performance, such as drain valve left open incidents. In addition, the programme would provide Operations with the confidence that every stretch of pipe had been checked and that the unit was ready to bring in hydrocarbon.

'Walk the Line' is a programme that focuses on the Human Factors that lead to LOPCs. A programme was designed to apply the principals of Walk the Line specifically to the time between maintenance handing over the unit to Operations and hydrocarbon entering the unit. An overview drawing of the unit broken down into several circuits was developed for each of the 18 units that underwent maintenance during the TAR.

These drawings were designed to be used in tandem with circuit checklists to help Operations verify that each circuit was ready for hydrocarbon entry. Handover checklists specific to restart were added to board and field operator logs a few weeks before restart to facilitate clear communications within and between shifts.

Building and sustaining engagement in the programme was a key objective during preparations and execution of the TAR. To foster this:

- Each Area TAR lead, Area Superintendent, TAR Ops lead, and Operations Manager all impressed upon Operations personnel the importance of the programme.
- Posters were developed and hung throughout the units acting as a reminder on Human Factors and the Walk the Line approach. A helmet sticker was also designed and issued.
- Initial training was delivered to Operations prior to shut down and refresher training was given to each shift a week before the end of maintenance.
- Human Factors-themed toolbox talks reinforcing the importance of the programme were shared with crews near the end of maintenance.

Once maintenance handed the unit back to Operations at the end of TAR, the Shift Supervisor assigned operators circuits to walk down. Using the circuit drawing as a reference, operators walked down their

assigned circuit and completed the associated checklist. Hydrocarbon could not be brought into the unit until a copy of all completed circuit checklists had been sent to the Shift Manager and reviewed for completion at the Operational Readiness Review.

The impact

Use of this programme helped the site achieve its primary goal, a refinery restart without a single LOC incident. It also helped reduce misalignments during start up by improving communication between process units and the tank field.

Following the TAR, users of the programme gave feedback which was used to develop a set of recommendations to improve future use of the programme, including improvements to the handover checklists. Details of the programme, learnings, and recommendations were compiled and passed on to other sites to aid in future TARs. The programme was also presented at an Operating Practices Symposium in 2016.

Effectiveness of training

Using a participative approach of walking with workers through complex procedures can be beneficial for all. Human factors issues can be highlighted and worked through, and sustainable solutions found. The approach can be used in many areas where there are multi-step activities to carry out.

Applications in healthcare

Maintenance in complex systems relies on the effective performance of the team of personnel to have the system set up properly. This is highly dynamic and demanding to achieve without a systematic process. A similar programme could be used in healthcare in areas that rely on reinstating complex systems post maintenance or post event. This could include non-clinical HVAC systems, automated laboratory processing systems or imaging equipment.

Design

21. Reducing musculoskeletal injuries

Sector: Manufacturing

Context: Workplace design

Physical discomfort in the workplace is often a combination of the effect of the design of a specific product and 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 can ensure that work is as comfortable and as safe as possible.

The challenge

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 Human Factors professionals, there were a total of 19 musculoskeletal injuries that were reportable to the Health & Safety Executive.

The manufacturer asked Human Factors 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.

The response

The company supported implementation of a Human Factors programme with the staff. They identified a Human Factors champion and created a robust reporting system. Tailored Human Factors training packages were developed and delivered to train staff in basic Human Factors concepts, identifying and quantifying physical risks and implementing solutions to reduce risk. This programme was then implemented on the shop floor.

Following the Human Factors training, staff identified several 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 Human Factors 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.
- Production lines that 'ended nowhere' causing poor workflow.
- Line managers not empowered to make changes on their own lines.

The impact

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 Human Factors 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 practice-based, taking place at the workstations.

- Line managers were empowered to make relevant changes on the lines to reduce Human Factors risk.
- 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 Human Factors champion presented the participatory 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. (Based on insurance premium savings and projected absence from RIDDOR reportable injuries.) Project payback period was five months.

Effectiveness of training

The process of identifying a Human Factors champion and implementing a training programme to improve work practices and decrease injury is applicable to most workforces and can bring about many improvements for staff and for the organisation.

Applications in healthcare

In addition to visible clinical tasks that occur within a hospital, there are many 'behind the scenes' areas where repetitive tasks occur. Such areas include the processing of specimens in laboratories (e.g. microtome or manual pipetting), the manual cleaning of endoscopes, pot washing in a kitchen or the sorting of linen in a laundry. The intervention described above can be applicable to many workplace settings where repetitive tasks occur daily.

Acknowledgements

We are grateful to the following who provided comment, original case studies and other information:

- **Stephen Barraclough**, Chartered Institute of Ergonomics & Human Factors
- **Tina Worthy**, Chartered Institute of Ergonomics & Human Factors
- **Fran Ives**, University Hospitals Birmingham
- **Lauren Morgan**, Oxford University
- Chris Attoe, Maudsley Simulation, South London & Maudsley NHS Foundation Trust
- **Greenstreet Berman Ltd**
- **Dr Alex Lang**, University of Nottingham
- **Professor Sue Hignett**, Loughborough University
- National Patient Safety Agency/Helen Hamlyn Trust
- Danielle Carey, University Hospitals Birmingham
- **Trevor Dale**, Atrainability
- Dr Patrick Mitchell, Newcastle Upon Tyne NHS Foundation Trust
- **Mark Hellaby**, Alder Hey Hospital
- **Dr William Green**, University of Leicester
- **Beverley Norris**, Jonathan West & Oliver Anderson
- **Ian Rowe Associates Ltd**
- Siemens Rail Automation in partnership with London Underground
- **Russell Fife**, Attwood Leighs
- **Simon Monnington**, BP
- **Nigel Heaton**, Human Applications Ltd
- **George Petrie**, TOTAL E&P UK
- The Energy Institute

CIEHF members denoted in bold

Reference

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