Human Factors Integration (HFI) in UK Healthcare:
a route map for 1 year, 5 years, 10 years and 20 years

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Abstract. This paper reflects on Human Factors Integration (HFI) to consider how Human Factors/Ergonomics has influenced Defence activities, and could influence safety and performance in Healthcare activities. A workshop with 16 Chartered Institute of Ergonomics & Human Factors members was held in July 2016 to discuss and propose a Route Map for HFI in the UK National Health Service. The results set out achievable targets for 1, 5, 10 and 20 years culminating in mandatory HFI to achieve a resilient system for safety culture and work load.

Keywords. Healthcare, Safety, Human Factors Integration

1. Introduction

'*First, do no **NET** harm*' (Sokol, 2013).

How has healthcare safety gone so wrong? At least 10% of patient admissions may result in some form of harm (Kohn, Corrigan, and Donaldson, 2000; Department of Health, 2000). Sokol (2013) revisited the Latin phrase '*primum non nocere*' (*First, do no harm*), suggesting that a revision to '*no net harm*' would be a more accurate expectation. For many clinical procedures there will be a level of harm, e.g. chemotherapy and surgery, but the '*clinician's hope is that the benefits will outweigh the harms*'.

In the UK National Health Service (NHS) there was relatively little management focus on safety until the 1990s. A change in the law, the removal of Crown Immunity from prosecution (Seccombe, 1995), meant that the NHS had to comply with safety legislation. For example, hospitals and other care locations were now places of work under the Health and Safety Act, 1974, (Hignett et al., 2016). The interest in safety moved from staff to patients after the Bristol heart scandal (Department of Health, 2002) but has continued to suffer dysfunction and artificial dichotomy. For example, where staff or occupational safety may be managed by one Executive Director, e.g. Operational Services or Human Resources, and patient safety by another, usually clinical, Nursing or Medical. The latter is often subsumed within the NHS tradition of quality improvement (Hignett et al., 2015).

In the UK Ministry of Defence (MOD), Human Factors and Ergonomics has been present since the 1940s (Newman et al., 2008, Waterson, 2011). Human Factors Integration (HFI) in UK Defence activities has been discussed, implemented, reviewed and improved since the 1980s based on the US MANPRINT (Manpower and Personnel Integration) programme (MOD, 1989) and through significant collaboration between international allies to compare best practice.

HFI is defined by the MOD as '*the systematic process for identifying, tracking and*

resolving human related issues ensuring a balanced development of both technological and human aspects of capability' (MOD 2015)*.* The integration refers to:

1. The integration and management of Human Factors with other engineering disciplines;
2. Between Human, Machines and Organisations;
3. Across 7 HFI domains (Manpower, Personnel, Training, Human Factors Engineering, System Safety, Health Hazards; Social & Organizational (MOD, 2015a&b);
4. Within the system acquisition process (Newman et al., 2008).

Most recently, two directive and guidance documents for HFI have been published (MOD 2015a&b) as Joint Service Publications (JSPs) to provide the '*policy requirements and comprehensive practice guidance for undertaking HFI'.* MOD staff are directed to include HFI in all Defence acquisition projects including *'technology demonstrators, upgrades, software intensive, collaborative, non-development item solutions and projects dependent up on off-the-shelf items';* and to ensure that the HFI activities are carried out '*effectively, efficiently and at appropriate times in a project'.* The intended use is both for MOD staff and for '*other parties, such as the Solution Provider'.* There is a clear description of successful achievement of the directive where '*satisfactory integration of the Defence Capability, Equipment Component and Human Component will be realized when the solution:*

1. *Makes best use of human capabilities (physical, cognitive, psychological, and social characteristics)*
2. *Recognizes and provides for human needs*
3. *Provides mitigations for human limitations*
4. *Applies to all people (end users) involved in the operation of the system*
5. *Utilises people in ways that maximize system safety*
6. *Utilises people cost-effectively*
7. *Controls through-life cost'.*

There is also clear guidance about Human Factors (and Ergonomics) expertise as the '*Suitably Qualified and Experienced Person (SQEP)'* to undertake HFI activities with specific reference to a minimum requirement for Technical Membership of the Chartered Institute of Ergonomics and Human Factors (CIEHF). This applies to those managing Human Factors work, with requirements set for SQEP within specific areas e.g. air platforms, to conduct and sign off Human Factors work. Broadly, where SQEP requirements have been set, they are at Chartered practitioner level i.e. equivalent to a Chartered Engineer. For example, Dstl, who conduct Independent Test Evaluator activities for Lightning II, require Chartered practitioner status as a part of the SQEP for that role.

Over the last 30 years there have been many appeals for cultural change in the NHS with some success '*in changing some of the surface manifestations of medical culture … [but] less successful in penetrating the deeply entrenched values and beliefs (and power bases) that underpin clinical practice'* (Davies, Nutley and Mannion, 2000). It is likely this will continue with new initiatives at least every 5-10 years to restructure at national and local levels. However, despite pockets of good practice there seems to have been relatively little progress in embedding safer practice, technology and changing culture (Bagian, 2012; Shekelle et al., 2013; Dixon-Woods et al., 2014). This includes a lack of engagement with safety scientists (including Human Factors/Ergonomics specialists) in contrast to other safety critical industries when tackling entrenched safety challenges (MOD, 2008; Office for Nuclear Regulation, 2014; Office of Rail and Road,

2008).

This paper presents the results of a workshop with 16 CIEHF members in July 2016 to discuss and propose a Route Map for HFI in the UK National Health Service.

2. **Method**

At the CIEHF Annual Conference in 2016 it was said that '*there's no forum for Healthcare and Defence to meet' (KT)* and that there were opportunities for knowledge transfer between the MOD and Department of Health to improve healthcare safety.

CIEHF members were invited to a workshop at Loughborough University if they had relevant experience in healthcare and HFI in Defence and other industrial sectors. Introductory presentations outlined the current challenges in healthcare (SH; Hignett et al, 2015; Hignett, 2015) and how HFI has been developing in Defence (WT), and other sectors such as nuclear, including the most recent directive and guidance from the MOD (2015a&b).

As a practitioner workshop, the data collection was less robust than a more formal research approach but the intent was to discuss practitioner experiences and reflect on the best way forward for Healthcare i.e. in line with reflective practice as defined by Schön (2011). The discussion was recorded with field notes using post-its and flip charts. The results were reviewed by all participants with an opportunity to augment and/or edit the outputs.

3. **Results**

The results are reported as target achievements at four time intervals; 1 year (Figure 1), 5 years and 10 years (Figure 2), and 20 years (Figure 3).

By the end of year 1 the target achievements include: addressing perceived obstacles e.g. relationship between CIEHF and Clinical Human Factors Group; establishing the HFI framework, using MOD example; and engagement of key stakeholders. This would provide the platform to discuss and agree the vision (a clear message and aim) and plan for the way forward. The suggested success criteria at 12 months are defined domains and terms (MOD, 2015b).

The defined domains could include '*all aspects of human behavior, capability and limitations… e.g. from interactions with the physical environment to understanding cultural differences in groups. Importantly the HFI domains are related to each other and should not be considered in isolation. Any decision in one of the domains can easily affect any other domain. For example, where the level of automation is increased, there may be a change required in staffing levels and vice versa'* (MOD, 2015b, p4).

1. CIEHF – Clinical Human Factors Group (CHFG) to agree Service Level Agreement
2. MOD HFI Framework as Goal Statement
3. Determine key stakeholders as both consultation and endorsement roles including CHFG, Care Quality Commission, NHS Litigation Authority, NHS Improvement, Health Education England, NHS Scotland, Medical & Health products Regulatory

Agency
4. Determine clear message and aim
5. Determine plan for way forward
6. Show examples (case studies and safety cases)
7. Competency matrix
   a. Suitably qualified/experienced person (HFE knowledge / experience)
   b. Who can do what?
8. HFI success criteria: to have:
   a. defined domains
   b. defined terms

Figure 1. HFI principles for Healthcare: Target achievements at Year 1

At 5 years, assuming appropriate support e.g. from the National Centre for Human Factors Integration in Healthcare, the proposed target achievements would have embedded HFI in incident investigations to stop the identified reactive approach to human failure (Care Quality Commission, 2016). HFI and quality improvement projects and initiatives would be linked (Health Education England, 2016) with the HFI delivered by SQEP.

1. HFI applied systematically in incident reports
2. Stop reactive approach to human failure
   a. Change to proactive – early in cycle
3. HFI and Quality Improvement firmly linked at professional level [in healthcare]
4. HFI involved in incident analysis (including root cause analysis)
   a. HFI as part of Coroners response
5. HFI success criteria analysis
6. HFI included in Care Quality Commission inspections
7. Interim HFI tool kit – linked to suitably qualified and experienced person/personnel (SQEP)
8. Investigate key tasks/ roles for HFE
9. HFI in staff training (start from 5 years and continue)
10. CIEHF position on workload in healthcare
    a. Impacts on quality of care?
11. Requirements for resilient healthcare system

Figure 2. HFI principles for Healthcare: Target achievements at Year 5 (and continuing to Year 10)

These targets would continue to Year 10 when it is proposed that the final tool kit (see Figure 2 (7)) should be available, including HFI linked to (and where appropriate, embedded within) quality improvement measures. The toolkit could include a range of HFI activities (MOD, 2015b, p.28) including: Task Analysis; Workload Analysis; Link Analysis; Information Flow Analysis; Allocation of Function, human-human and human-machine; Human Performance Analysis; and Human Reliability Analysis. This would be accompanied by: design activities e.g. modelling, simulation; software and

hardware design; workplace and organization design; trials and experiments; training needs analysis, training design and delivery; and contributions to safety cases.

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1. HFI mandatory in processes for audit, procurement etc.
2. HFI as uniform approach across all Trusts, sectors (primary, secondary, mental health, ambulance, community & home care)
3. HFI competency matrix – clear, embedded and audited
4. HFI capacity to deliver improved safety
    a. Resilient system for safety culture and work load

Figure 3. HFI principles for Healthcare: Target achievements at Year 20

At 20 years HFI should be mandatory in processes for audit, procurement etc. as it is currently in Defence, with a uniform approach across all healthcare providers e.g. JSP (MOD 2015a). The role of HFI providers (SQEP) will be clearly defined, embedded and auditable e.g. by CIEHF, to provide assurance in the same way as other professional regulators such as the General Medical Council, Nursing and Midwifery Council, General Pharmaceutical Council.

Achieving these targets would enable healthcare to define and respond to specific challenges in a robust and systematic way. For example, the MOD (2015b) gives examples of Single Statements of User Need (SSUN) where a capability need or gap is identified from a capability audit. The SSUN provides the scope of the User Requirements Document and summarises the description of HFI need for management purposes (Figure 4).

Future Integrated Soldier Technology (FIST)	*FIST is to deliver the technology to support an Integrated Soldier System with a coherent and ergonomic ensemble of clothing, personal protection, load carriage, personal weapons, target acquisition systems and Command, Control, Communications, Computers and Intelligence (C4) linked to a wider network, served by an integrated power management system, designed to minimise impact on agility, while maximising operational effectiveness in order to maintain battlefield superiority in Dismounted Close Combat in all environments out to 2035.*

Figure 4. Statement of User Need; summarizing the description of HFI need (MOD, 2015b)

4. Discussion and Conclusion

Defence has had over 30 years to develop, discuss, embed, integrate and review HFI. Healthcare is only just starting on this journey so there will be challenges to reducing net harm. The first step has already been taken with 16 healthcare agencies signing a statement '*that a wider understanding of **Human Factors** principles and practices will contribute significantly to **improving the quality** (effectiveness, experience and safety) of care for patients*' (National Quality Board, 2013).
By Year 5, the involvement of SQEP in Human Factors for incident investigation

should be routine. It will answer and respond to the criticism by Peerally et al. (2016) on the failure of healthcare to utilise professional expertise but instead rely on root cause analyses for serious untoward events (including death) '*typically conducted by local teams, not the expert accident investigators who are proficient in systems thinking and human factors, cognitive interviewing, staff engagement and data analysis that are characteristic of other high-risk industries*'.

We expect that HFI in healthcare will be complex but the need to improve safety and reduce harm is a priority for everyone involved in this sector e.g. patients, staff, visitors, contractors, NHS policymakers, board members, commissioners. The next step is a review and development of this Route Map through CIEHF and NHS collaboration at the Human Factors Exchange (https://hee.nhs.uk/hee-your-area/east-midlands/our-work/attracting-developing-our-workforce/human-factors-exchange).

Acknowledgements

References

Bagian, J. (2012). Health Care and Patient Safety: The Failure of traditional Approaches – How Human Factors and Ergonomics can and MUST help. Human Factors and Ergonomics in Manufacturing & Service Industries. Special Issue: Patient Safety, 22, 1, 1-6

Care Quality Commission. (2016). "Briefing. Learning from serious incidents in NHS acute hospitals. A review of the quality of investigation reports". http://www.cqc.org.uk/content/briefing-learning-serious-incidents-nhs-acute-hospitals

Davies, H.T.O., S.M.Nutley, R. Mannion. (2000). Organisational culture and quality of health care. Quality in Health Care. 9, 111–119

Department of Health. (2000). An Organisation with a Memory: Report of an Expert Group on Learning from Adverse Events in the NHS. London: Department of Health.

Department of Health. (2002). Learning from Bristol. The Department of Health's response to the report of the Public Inquiry into children's heart surgery at the Bristol Royal Infirmary 1984-1995. London: TSO.

Dixon-Woods, M., R. Baker, K. Charles, J. Dawson, G. Jerzembek, G. Martin, and I. McCarthy et al. (2014). Culture and behaviour in the English National Health Service: overview of lessons from a large multi-method study. BMJ Quality & Safety. 23:106-115.

Health Education England. (2016). Improving Safety through Education and Training. http://www.hee.nhs.uk/sites/default/files/documents/FULL%20report%20medium%20res%20for%20web.pdf (accessed 22 April 2016)

Hignett, S., Miller, D., Wolf, L., Jones, E., Buckle, P., Catchpole, K. (2015). What is the relationship between Human Factors & Ergonomics and Quality Improvement in Healthcare? In Sharples, S., Shorrock, S & Waterson, P. (Eds) Contemporary Ergonomics 2015; Proceedings of the Annual Conference of the Chartered

Institute of Ergonomics & Human Factors. London: Taylor & Francis. 213-219

Hignett, S., Knopp, R., Bowie, P., McKeown, C., Woodward, M., Tapley, S., Lang, A., Ives, C., Pickup, L., Raistrick, C., Fray, M. (2016) More Holes than Cheese. What prevents the delivery of effective, high quality, and safe healthcare in England? Ergonomics
DOI 10.1080/00140139.2016.1245446

Kohn, L.T., J.M. Corrigan, and M.S. Donaldson. (2000). To Err Is Human – Building A Safer Health System. Washington DC: National Academy Press.

MOD (1989). Defence Standard 00-25. Human Factors for Designers of Equipment. Part 12: Systems. UK: Ministry of Defence.

MOD. (2008). Human factors for Designers of Systems. Part 0: Human Factors Integration. Def Stan 00-25. Glasgow: Defence Procurement Agency.

MOD (2015a) JSP 912. Human Factors Integration for Defence Systems. Part 1: Directive.
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/483176/20150717-JSP_912_Part1_DRU_version_Final-U.pdf

MOD (2015b) JSP 912. Human Factors Integration for Defence Systems. Part 2: Guidance.
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/483177/20151030-JSP_912_Part_2_DRU_version_Final-U.pdf

National Quality Board. (2013). Human Factors in Healthcare. A Concordat
http://www.england.nhs.uk/wp-content/uploads/2013/11/nqb-hum-fact-concord.pdf (Accessed 25th August 2014)

Newman, P., Bruseberg, A., Lowe, M., Borras, C., Tatlock, K. (2008) Improving HFI within systems acquisition: methods, tools and future directions. Cogn Tech Work, 10, 173-180

Office for Nuclear Regulation. (2014). Human Factors Integration.

http://www.onr.org.uk/operational/tech_asst_guides/ns-tast-gd-058.pdf

Office of Rail and Road. (2008). Understanding Human Factors: A Guide for the Railway Industry http://www.rssb.co.uk/Library/improving-industry-performance/2008-guide-understanding-human-factors-a-guide-for-the-railway-industry.pdf

Peerally, M.F., S. Carr, J. Waring and M. Dixon-Woods. (2016). The problem with root cause analysis. BMJ Quality and Safety Published Online First: [23 June 2016] doi:10.1136/bmjqs-2016-005511

Schön, D. A. (2011). The reflective practitioner: how professionals think in action (Reprinted). Farnham: Ashgate.

Seccombe, I. (1995). Sickness absence and health at work in the NHS. Health Manpower Management 21 (5): 6 – 11.

Shekelle, P.G., R.M. Wachter, P.J. Pronovost, K. Schoelles, K.M McDonald, S.M. Dy, K. Shojania et al. (2013). Making Health Care Safer II: An Updated Critical Analysis of the Evidence for Patient Safety Practices. Comparative Effectiveness Review No. 211. AHRQ Pub. No. 13-E001-EF. Rockville, MD: Agency for Healthcare Research and Quality. www.ahrq.gov/research/findings/evidence-based-reports/ptsafetyuptp.html

Sokol, D. (2013). "First do no harm" revisited: Following the dictum means balancing moral principles. BMJ, 347, f6426 doi: 10.1136/bmj.f6426

Waterson, P. (2011). World War II and other historical influences on the formation of

the Ergonomics Research Society. Ergonomics, 54, 12, 1111-1129.