HFI Human Factors Integration

The need for HF to be well integrated has long been recognised by HF Engineers, but as SpE they have struggled to engage effectively within SE, and have sought linkages with other SpEs through their own processes. One way of creating better connectivity with SE activities is by a set of processes known as *Human Factors Integration (HFI).*

UK Defence Standard 00-251 describes the HFI process, essential for large defence acquisition programmes. HFI coordinates 7 HF domains: *Manpower, Personnel, Health Hazards, Training, HFE, Social/ Organisational and System Safety.* Other UK sectors (e.g. Rail, Energy) have adopted a form of HFI.

The US DoD equivalent of HFI is *Human–Systems Integration (HSI)*. It gets a brief mention, late in the INCOSE SE Handbook (v4).

The Future: HCSE?

Human-Centric Systems Engineering (HCSE) seeks better ways to address HF within mainstream SE (e.g. via MBSE) while building on and optimising the coherence of existing best practice. Approaching HF from an SE viewpoint, HCSE aims to develop core SE practices that help engineering organisations adopt the best HF processes for their needs (e.g. draw in HFI, HSI or whatever else).

Additional Material

ISO/IEC 9241 A multi-part HF/Ergonomics standard *(e.g. ISO 9241-210:2010 Part 210: HCD for interactive systems)*
http://www.iso.org/iso/catalogue_detail.htm?csnumber=52075

Sample HF publications (guidance, role of HF, accident report):
http://publicapps.caa.co.uk/docs/33/CAP%20737%20DEC16.pdf

http://www.hf.faa.gov/media/RoleOfHF-FAA.pdf

Glossary

HCD	Human Centred Design
HCSE	Human-Centric Systems Engineering
HFE	Human Factors Engineering
HFI	Human Factors Integration
HSI	Human–Systems Integration
MBSE	Model-Based Systems Engineering
SpE	Specialist Engineering
SSM	Soft Systems Methodology
STSE	Socio-Technical Systems Engineering
SysML	Systems Modelling Language

Wider Concerns

Every 'created STS', like an aircraft, has HF concerns for all its stakeholders (e.g. designers, crew, maintainers). But the SE organisation *creating* the aircraft is also a 'creating STS' with its own set of HF issues. HF concerns in the wider enterprise include organisational development (e.g. leadership, job satisfaction) and extend into the wider environment of issues such as policy, ethics and well-being. This is the context for *Socio-Technical Systems Engineering (STSE).*

About this Z-Guide:

This Z-Guide seeks to raise awareness of HF for SE, of the risks it can address and opportunities it offers.
For more HF-related information please visit:
www.ergonomics.org.uk
www.bps.org.uk
www.hfes.org

Download copies of this leaflet and other Systems Engineering resources: www.incoseuk.org

For further information, advice and links go to:
https://incoseuk.org/Groups/GPG/Main?GNID=16

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Human Factors for Systems Engineers

Human Factors (HF) is a broad scientific and applied discipline. Its knowledge base is derived from empirical evidence in many fields from psychophysics to bio-mechanics, from social resilience to artificial intelligence. Within engineering, it is used to help de-risk and optimise systems. It enables us to make allowances for the diversity of human needs and characteristics.

Relationship with Systems Engineering (SE)

HF plays a leading role in *Human Factors Engineering (HFE)* -aka Ergonomics. HFE integrates human characteristics into system design for optimal human performance. INCOSE views HFE as *Specialist Engineering (SpE)* that supports a range of SE concerns. It works alongside other SpE such as Safety, Security, Support and many others. SE practice must engage SpEs effectively to avoid compromised system development.

Why is HF Important for SE?

SE aims to facilitate the development of complex systems that serve human goals. Humans are the most complex aspect of these systems and HF specialist knowledge and methods are needed to manage human concerns. Issues arise at different levels across the system, from individual people to organisational culture. If SE methods do not address HF they will not address the major source of complexity in the systems they aim to optimise. SE methods must therefore fully engage with HF or risk failure.

Human Systems

If a system comprises interrelated parts contained within a boundary serving one or more functions within an environment, then humans are both systems themselves as well as parts of larger ones.

Humans are *living* systems. This means they have different properties and so need different methods to technical systems engineering.

Humans are social animals with complex communication capabilities who group together for mutual benefit (e.g. share food, values, beliefs). Such groups constitute social systems and become 'Capabilities' or *Socio-Technical Systems (STS)* when they include technology. HF can help make such STS *effective, efficient* and *safe.*

Human Variance

Humans share a common 'species' boundary but within this they exhibit a significant degree of physical and behavioural variance. We can see such physical differences in our unique faces, but internally our physiology and psychology differ too. Such variations influence how we perceive, think, experience and interact with our world. This means so called 'common sense' is different for everyone – i.e. not common! So using common sense for design decisions will not work.

Scope of HF

HF begins with the role of humans in an STS but engineers must consider the whole context. E.g:

Humans

Who are the STS stakeholders? What physical attributes, psychological experiences or skills are required?

Technologies

What technology will people use or be exposed to? Will protective clothing/ equipment affect usability?

Is the STS fit for purpose, usable, maintainable, sustainable, safe? How will teams communicate? Will all stakeholders accept the technologies?

Activity Systems

What tasks/ processes will people be engaged in? Are they within workload limits, prone to error, individual or team-based? How tightly are they coupled? Will planned training be adequate?

Working Culture

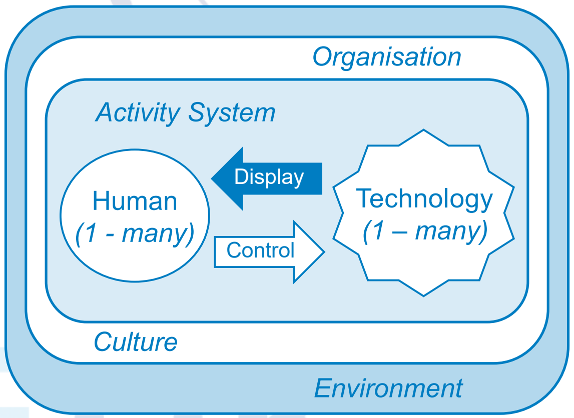
How might attitudes and values of management or peers impact the STS (e.g. its availability, safety or effectiveness)? What can be done to ensure safety is taken seriously? How will this be assessed?

Organisational Context

How does the organisation impact the STS under differing conditions (normal, crisis, war)? Is it supportive or restrictive? Are command and control styles appropriate for all envisaged scenarios?

Environment

Will the STS operate in safe or hostile conditions? Is the STS sustainable in the wider, long term economic environment?



STS Context

Who, When, How & What?

Who?

Engage qualified experts for applying HF in SE. The SpE who do this are HF Engineers. They must interact fully with other SpEs as part of SE to help deliver the effective systems required. Current SE practices rely on the self-organisation of SpE communities (see HFI, Panel 5).

When?

HF can help optimise STS by addressing physical-functional vulnerabilities in their design and use. It is pan-lifecycle but the sooner it begins the more it can help. HF is a critical front-end SE concern that should begin with *Capability Planning.* Costs and programme risks rise the longer HF involvement is delayed. Cost Benefits of HF therefore follow the same pattern as for SE (see Z2 on enabling SE).

How?

Every system has HF concerns, some more than others. A systematic approach is best, starting with understanding the scope and aims of the STS and implications for its proposed systems and stakeholders. Many SE methods / tools can be used for this (e.g. Rich Pictures/ SSM; Systems of Interest; SysML block and activity diagrams) and these should exploit HFE methods such as task analysis and Human Centred Design.

What?

HF activities in SE can cut across many SpEs and may include: early HF-system architectures *(Human Views)*; eliciting human / system requirements; designing and prototyping novel interfaces, simulations (e.g. for maintainability), collaborative control frameworks using artificial intelligence and automation; conducting workload and usability trials; supporting organisational development as well as safety cases and safety management; investigating human reliability, errors, accidents, system failures.