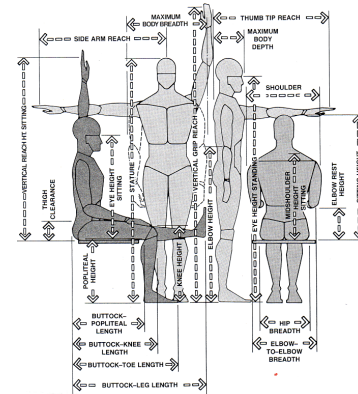
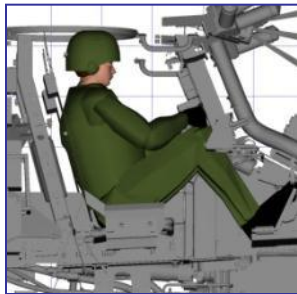


INCOSE UK HCSE WG update and Human Factors Integration (HFI): Current Challenges and Thoughts for the Future



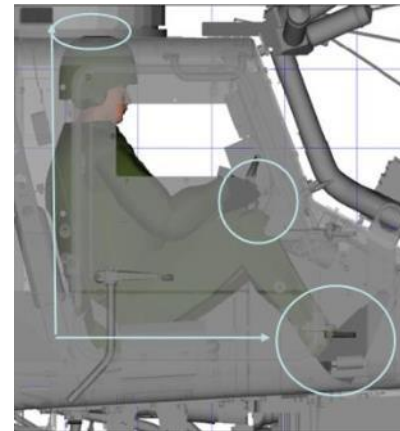
Mike Boardman

DE&S Engineering Group (EG) HFI Team and Dstl

Presentation Aim

To provide:

- INCOSE UK HCSEWG Update
- Brief overview of the UK MOD Approach to HFI
- Current Context and Drivers for HFI Development
- Thoughts on Terminology, HCD and the ISO9241 approach
- Some thoughts for the coming days



INCOSE UK HCSE WG Update



An Update on INCOSE UK's Human Centric Systems Engineering (HCSE) Working Group

Michael Boardman on Behalf of Rupert England (Chair: HCSEWG)

Presentation to HSI Workshop,
INCOSE UK: Human Centric Systems Engineering Working Group
Prepared by Rupert England (Chair: HCSEWG)
Email: rupert@thinkwell.training

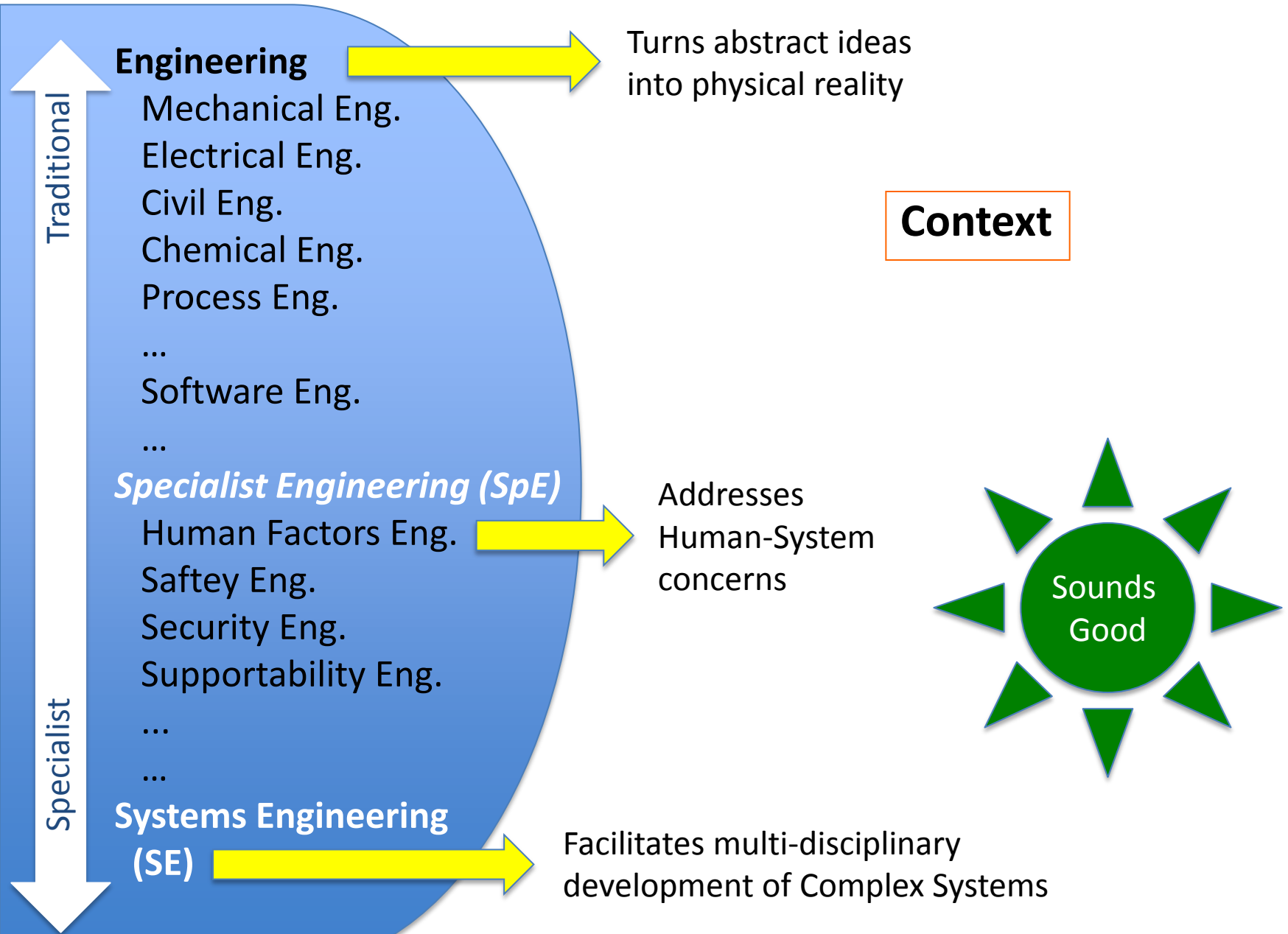


INCOSE UK: Human Centric Systems Engineering Working Group

Coming Up

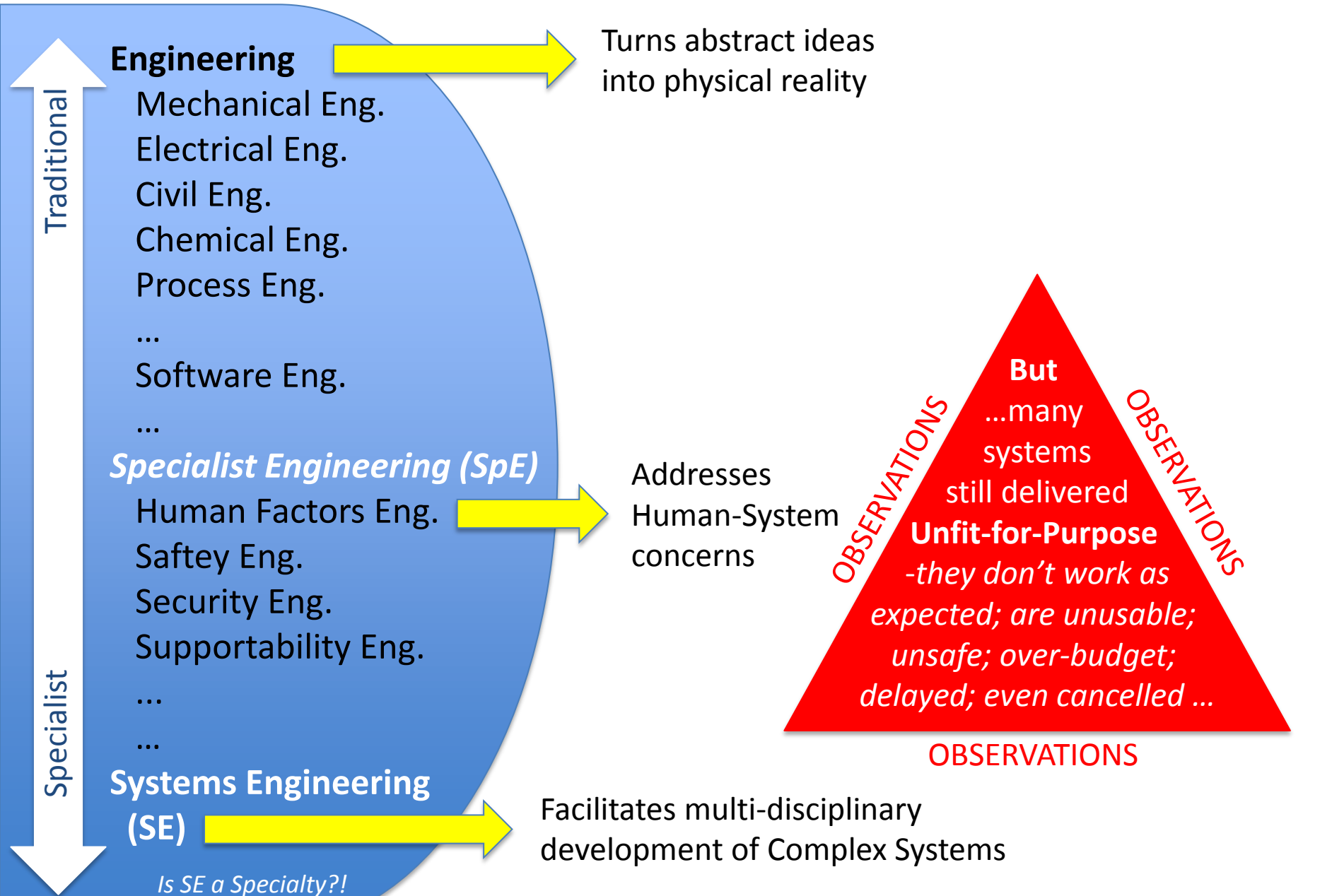
- Context
- Current SE Practices, Concerns and Opportunities
- HCSEWG Strategic Ambitions
- Key Objectives
- History
- Activities & Progress

INCOSE UK: Human Centric Systems Engineering Working Group





INCOSE UK: Human Centric Systems Engineering Working Group



INCOSE UK: Human Centric Systems Engineering Working Group

Current Practices, Concerns & Opportunities



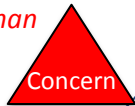
INCOSE UK: Human Centric Systems Engineering Working Group

Current Practices, Concerns & Opportunities

Real World SE Practices Varied and Inconsistent

- Every nation, culture and business is unique, so every instantiation of SE is different
- All subject to business dynamics
- Some do SE better than others;
All can do better!

Differences also apply to related Specialist Engineering (SpE) processes, e.g.: US Human Systems Integration (HSI) & UK Human Factors Integration (HFI)



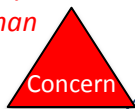
INCOSE UK: Human Centric Systems Engineering Working Group

Current Practices, Concerns & Opportunities

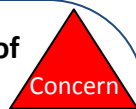
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Maturity / Immaturity of SE Best Practice



- SE consensus *still developing (ask what constitutes SE Research and diversity of views evident...)*
- **Incomplete Guidance / Standards** (*Some 'Whats' but little How, Who, Why, etc.*)
- Inconsistent use of terms (e.g. Architecture: Views & Viewpoints)
- Much 'standardised' SpE Best Practice available (*HFI over 20yrs old*)
- Most poorly integrated into SE, so under-utilised
- Lack of parity between PM and SE Lead

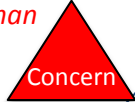
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Relationship of SE to SpE

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- SpE seen as less important than SE
- SpE inclusion in SE often to chance
- SpE equated to extra cost & delay

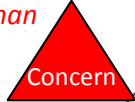
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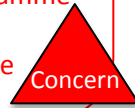
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- Risks mitigated by SpE poorly understood by SE Leads, SE Practitioners and Programme Managers (PM)
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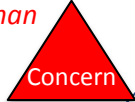
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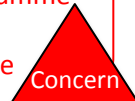
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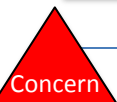


Systems Engineering Observations



INCOSE SE Vision 2025

- INCOSE desire to broaden SE applicability into new Sectors (non-traditional SE);
- Requires new SE Approaches, Tools, Methods, Practices & Behaviours ...



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INCOSE UK: Human Centric Systems Engineering Working Group

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Concern

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Opportunity

Concern

Relationship of SE to SpE

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Conclusion:

Need easier way to ensure human issues accommodated;

Need HF / SpE addressed in SE by default



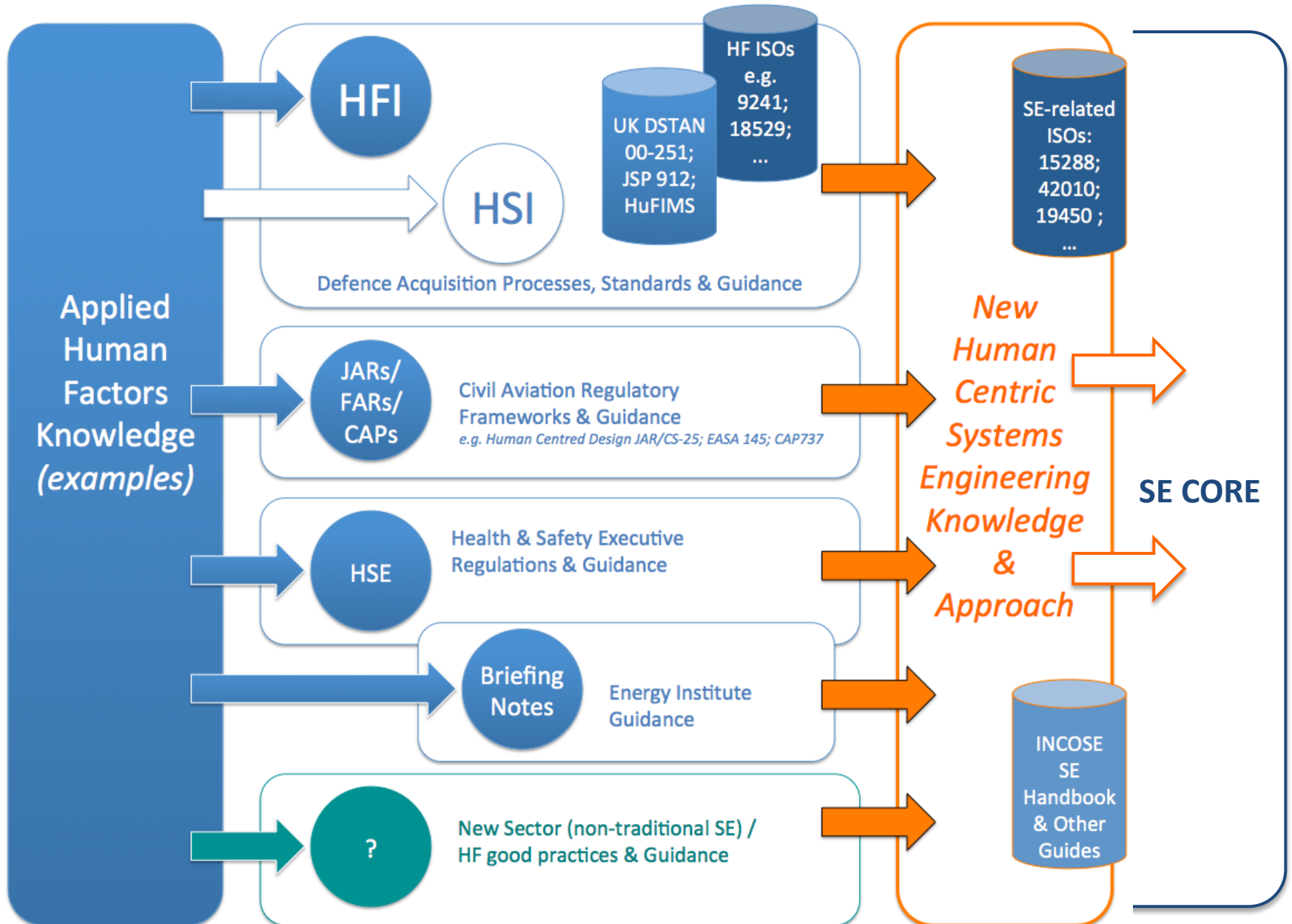
INCOSE UK: Human Centric Systems Engineering Working Group

Strategic Ambitions

- Develop **Comprehensive Coherent HCSE Framework** to ensure human concerns are addressed across the SE lifecycle (from system conceptualisation to end-of-life)
Build on extant HF Applied Knowledge & processes; Incorporate essential SpE influences into mainstream SE activity (i.e. the SE 'Core') to reduce risk from accidental or 'intentional' SpE exclusion: Practice HCSE by default
- Develop **additional mechanisms** to facilitate greater SpE inclusion
Early Systems Architecting and Model-Based Systems Engineering are 2 such avenues; Find and develop others
- Identify **New Best Practice** in non-traditional SE sectors (e.g. health, energy)
Determine which to include in our new universal SE Core and which might constitute more sector-specific 'flavours' to complement it
- **Raise Awareness**, Promote and Guide advocated HCSE Best Practices
Develop INCOSE information / technical guidance products, How-To workshops, etc.

HCSE is a **Pathfinder** we hope may help other SpEs to integrate better with SE, driving the development of a more comprehensive SE Core.

INCOSE UK: Human Centric Systems Engineering Working Group



Key Objectives

- Identify organisations across diverse sectors practicing Human Factors
- Review where possible what approaches, standards, guidance they follow
- Determine what constitutes best practice (develop criteria)
- Consolidate Best Practice findings into core elements of HCSE and sector-specific or sector-cluster 'flavours' of HCSE
- Seek opportunities to formalise HCSE and its Best Practice in relation to a 'universal' lifecycle approach and flavours of enterprise-based development processes
- Raise awareness of the HCSEWG and its HCSE developments:
 - *Information products; workshops; WG website; other outputs and activities*
- Develop cross-linkages with other INCOSE WGs and other Professional Bodies



INCOSE UK: Human Centric Systems Engineering Working Group

Activities & Progress

- Building understanding between 2 core participating member communities:
 - *SE*
 - *SpE (predominantly HF & Safety so far)*
- Identifying key areas of concern, including:
 - *Workshop 2015: New Sectors of interest and anticipated Types of BP*
 - *Workshop 2016: HF and Systems Architecting*
- Information Products in development:
 - *Introduction to Human Factors (INCOSE UK Z-Guide)*
 - *Human Factors Integration (INCOSE UK Z- or Omega Guide)*
 - *INCOSE Preview Article / INCOSE UK ASEC2015 and 2016 Posters*
- Formal / reciprocal links established with external entities:
 - *UK Ministry of Defence-Industry HFI WG*
 - *Energy Institute's Human and Organisational Factors Committee (HOFCOM)*
- INCOSE WG Links:
 - *Architecture, MBSE, Organisational Capability WGs*

We hope to establish stronger links with our colleagues in the HSI WG too!

A question from Rupert for us to think about.....

- In what ways can HSI (and other SpE disciplines) help / drive requirements for HCSE?

More fully stated:

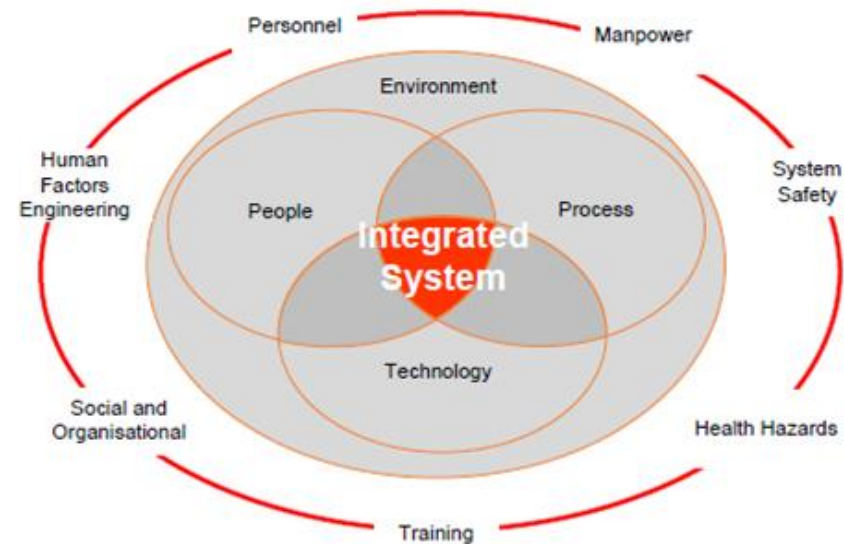
- *In the UK, INCOSE is seeking to develop a Core within SE that will ensure SpEs are considered by default. HCSE, as a pathfinder for doing this, will build on existing SpE capabilities, as well as new / emerging capabilities, to ensure they are addressed effectively. The HCSEWG's initial focus is on SpEs having Human Factors or human-related concerns (many of which are poorly supported by SE). HFI was established as a UK equivalent to HSI over 20 years ago and has now a key role in supporting HCSE. What then of HSI; in what ways might HSI (and the SpEs under its umbrella) help HCSE and drive requirements for HCSE?*

Brief overview of the UK MOD Approach to HFI

Human Factors Integration

Human Factors Integration is the UK MOD's process by which the People Component of Capability is considered during Capability Delivery and Support.

It is a systematic **process** for identifying, tracking and resolving human related issues to ensure a balanced development of both technologies and human aspects of Capability.



Can these personnel with this equipment and training perform their tasks to a specific standard under agreed conditions?

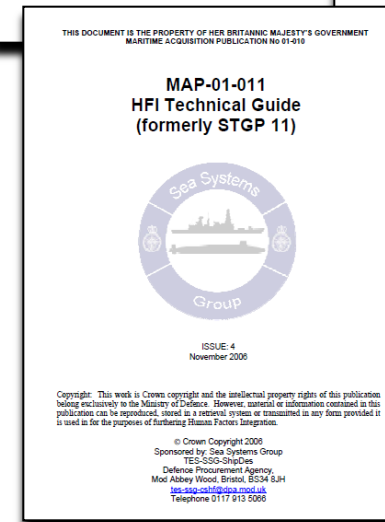
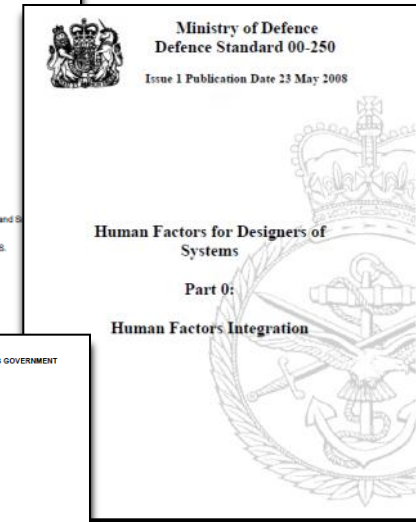
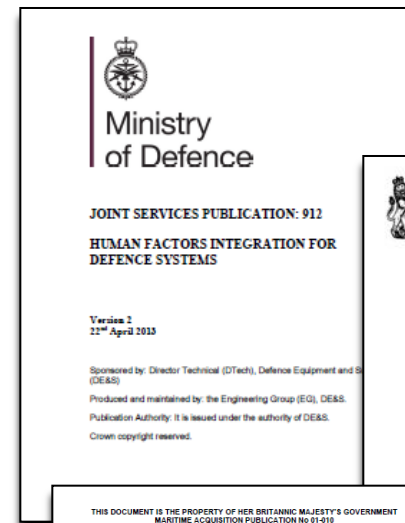
HFI Policy and Standard Development

Rationalisation of HFI Policy, Process & Guidance

- Issues which triggered review:
 - New JSP structure and purpose
 - Inconsistency, conflict between documents
 - Range of documents
 - No documented common HFI process
 - Size: Def Stan runs to 1000+ pages
 - Ability to update Def Stan
 - Structure for accessibility by variety of end users

The Objectives

- Revise MOD HFI Policy & Process and Guidance Material to:
 - Ensure they are fit for purpose
 - Facilitate Contracting
 - Designed for the intended audience(s)
 - Organise to facilitate uptake
- Key Legacy Documents:
 - JSP 912
 - Def Stan 00-250
 - Supporting Guidance material (e.g. Single Service/Tri-Service)
 - JSP 886 & SSE GP2.9 (HFI in ILS)



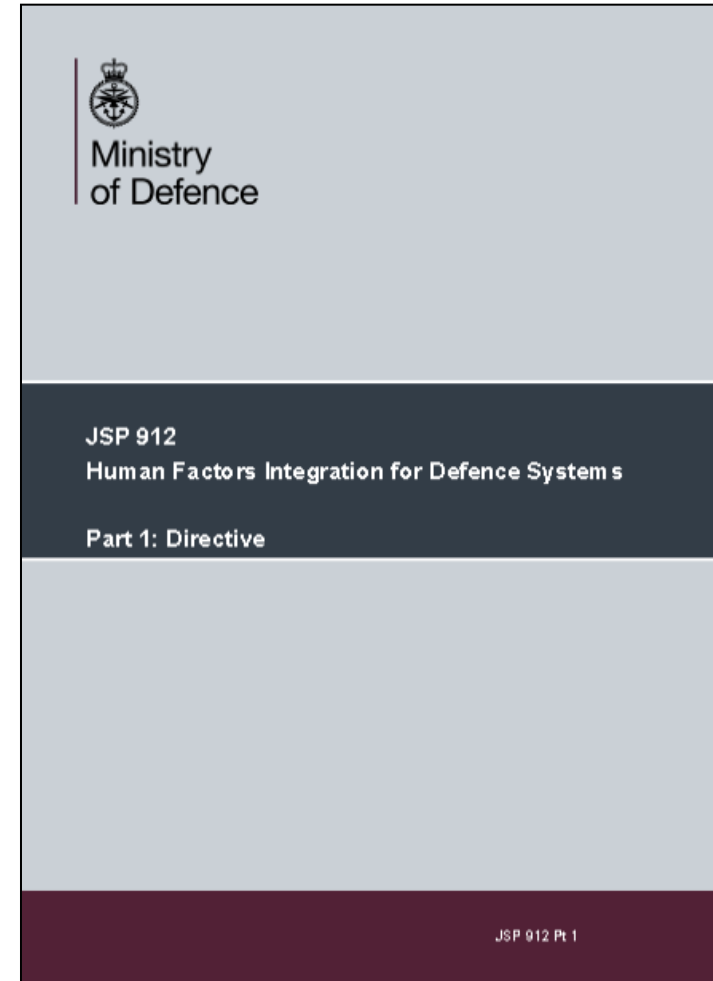
Revised JSP 912

Part 1

- 1.Introduction (Policy, Scope, Applicability)
- 2.MOD HFI Process
- 3.MOD Staff Responsibilities
- 4.HFI Resource Competencies
- 5.References
- 6.Acronyms and Abbreviations

Part 2

- 1.Introduction to HFI
- 2.Overview of HFI Process
- 3.HFI Process: Stages and Steps
- 4.Tailoring the Process
- 5.Roles and Responsibilities
- 6.HFI Resource Competencies
- 7.References



DEF STAN 00-251

Presented as 4 Parts

Part 0

Introduction to HFI, HFI Domains
MoD Contracting Process Using
new HF Process and System
Requirements.

Part 1 - Early Lifecycle HFI Process Requirements

Part 2 - HFI Process Requirements for Solution Provider

Part 3 - HFI Technical Requirements

- Candidate HFURs (5/6)
- Candidate HFSRs (15)



Ministry
of Defence

Defence Standard 00-251 part 0
Draft issue

**Human Factors Integration for
Defence Systems**

**Part 0: Human Factors
Integration**

Technical Guides



Technical Guides

The Technical Guides consist of a suite of Tri-service Human Factors guidance divided into 'New' or 'Interim' (the latter based on the legacy parts of Defence Standard (Def Stan) 00-250 / 251). As shown in the table below, the Guides are grouped into nine Human Factors categories with two additional categories of Platform (10) and Other Practical Guidance (11). In addition to the Tri-service guides, there are a number of domain (Land, Sea and Air) or platform specific guides.

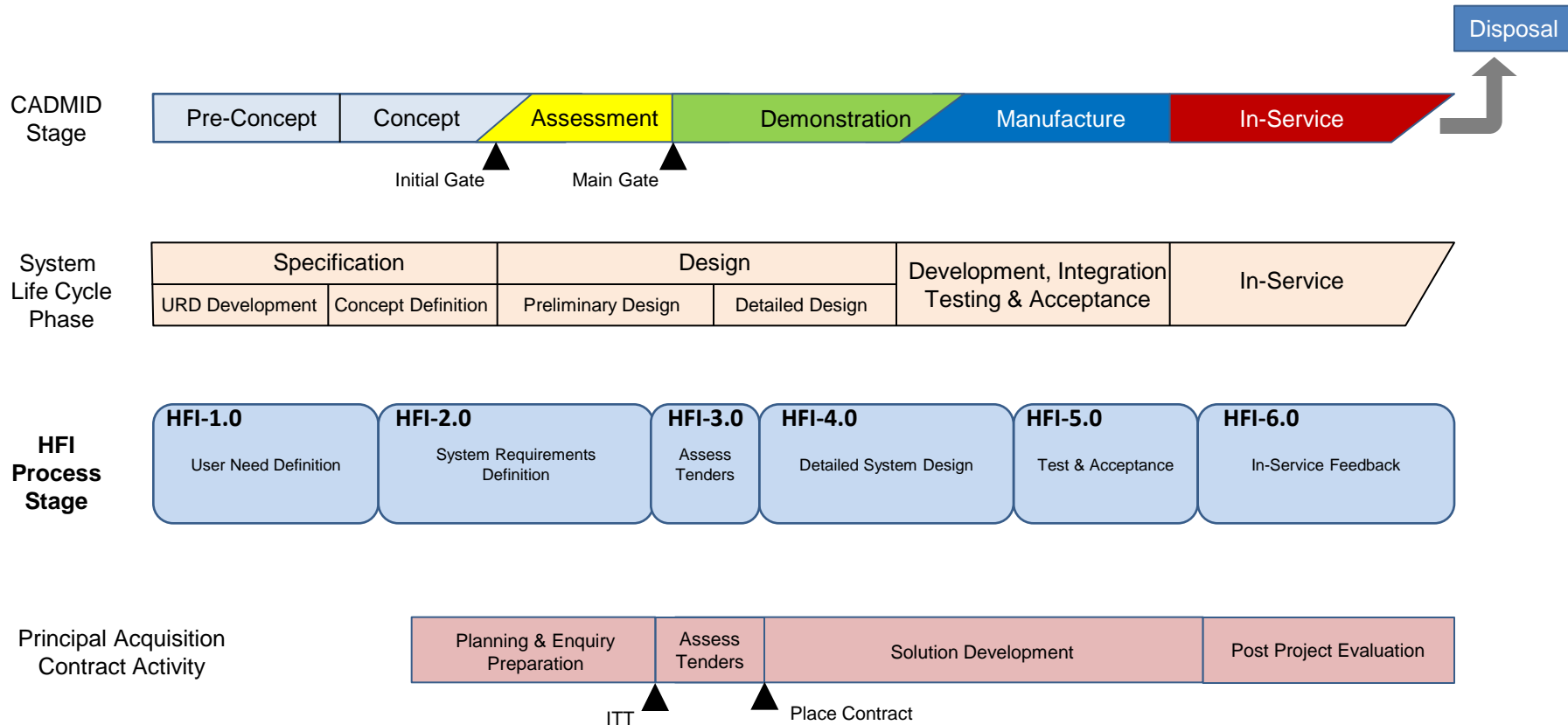
This spreadsheet provides a [mapping between Def Stan 00-250 Part 3 and the new technical guide structure \[65KB XLSX\]](#). It should allow users to identify where to look for information.

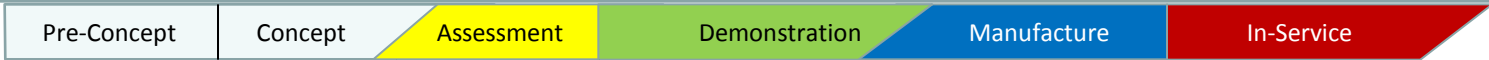
Human Factors Category	Tri-Service New	Tri-Service Interim	Domain Specific
1. People Characteristics	1.1 Anthropometry: People Size [2.48MB PDF]	1.2 Sensory Capabilities and Communication [1.32MB PDF] 1.3 Cognitive Capabilities [414KB PDF] 1.4 Physical Capabilities [1.35MB PDF] * 1.5 Motivation and Emotion	
3. Jobs and Tasks		2.1 Work Design [417KB PDF]	
3. Equipment	3.1 Human Computer Interaction [1.80MB PDF]	3.2 Information Presentation [4.51MB PDF] 3.3 Control Technology [4.76MB PDF] 3.4 Display Technology [1.15MB PDF] 3.5 COTS / MOTS Equipment [290KB PDF] 3.6 Design for Maintainability and Supportability [566KB PDF]	
4. Working and Living Spaces		4.1 Working and Living Spaces [3.74MB PDF]	MAP 01-107 - Part 1 [PDF] [Ⓔ] MAP 01-107 - Part 2 [PDF] [Ⓔ]
5. External Environment		5.1 External Environment [891KB PDF]	
6. Organisation		6.1 Social and Organisational Factors [276KB PDF]	
7. Human Aspects of Safety		7.1 Equipment Health and Safety [263KB PDF] 7.2 Workplace Health and Safety [282KB PDF] * 7.3 Human Contribution to System Safety	
8. Human Aspects of Training		8.1 Individual and Collective Training [298KB PDF] * 8.2 Competency and Retention	
9. Personnel		* 9.1 Manning 9.2 Recruitment and Selection [260KB PDF]	BR 3 Naval Personnel Management [Ⓜ]
10. Platform			High Speed Craft HFE Design Guide [2.18MB PDF] High Speed Craft HFE Design Guide Supplement [8.39MB PDF] * HFI for Land Vehicles
11. Other Practical Guidance			MAP 01-011 HFI Technical Guide [PDF] [Ⓔ]

* Technical Guides that are in preparation, but intended to be published in the near future, are detailed and will be available once published.

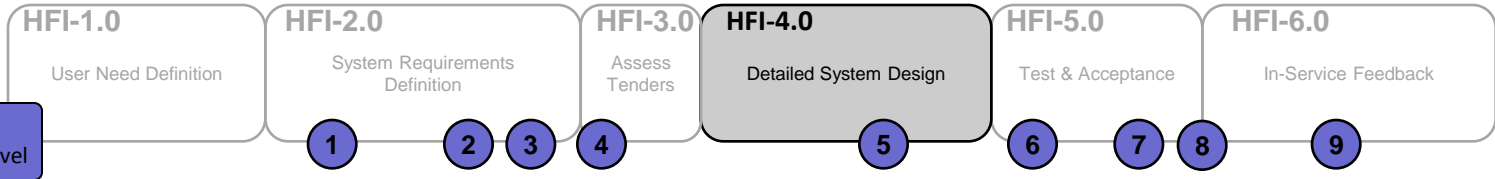
Revised HFI Process (HuFIMS)

Mapping to CADMID Cycle, System Life Cycle Phases and Principal Acquisition Contract Activity





Initial Gate Main Gate



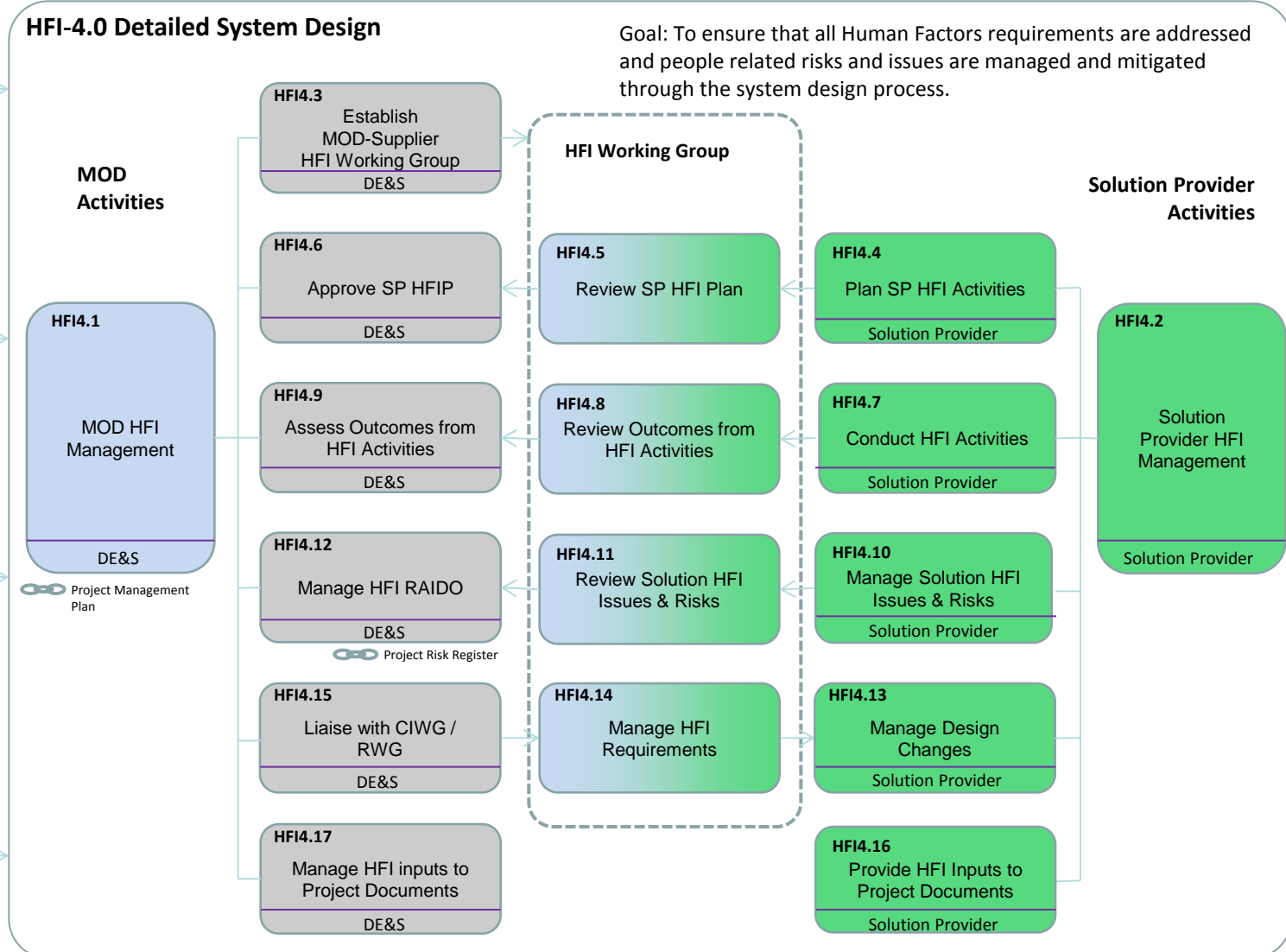
SRL/HFI Maturity Level

FLC Project Inputs
 URD
 CONEMP
 TAD

DE&S Project Inputs
 HFSRs in SRD
 HFPRs in SOW

DE&S HFI Inputs
 MOD HFIP
 HFI
 RAIDO

SP Project Inputs
 Tender Response(s)
 (incl. Compliance Statements)



FLC Project Outputs
 CONUSE

DE&S HFI Outputs
 HFI
 RAIDO

SP Project Outputs
 System Design
 Subsystem Specs
 ITEAP
 Safety Case
 Support Solution
 Training Solution

SP HFI Outputs
 SP HFIP
 HFI Case

Current Context and Drivers for HFI Development

Current Context and Drivers

- Organisational Drivers:
 - Project Cost
 - Project Risk
 - Requirements Driven Acquisition
 - Commercial Aspects of Acquisition
- HFI is MOD Policy JSP912 v3
- As civilian as possible, as military as necessary – Move away from developing bespoke Military Stds when possible
- Development of wider acquisition processes: Guide to Engineering Activities and Review – GEAR and SOSA
- Focus of Acquisition on Equipment and Logistics DLODs - HFI operates in both Acquisition and Integrated Logistics Support, but has wider implications

Current Context and Drivers

Organisational and Strategic

- “Front Door” process and “Hard Charging”
- Assurance (GEAR, SRL, SSdT)
- Performance Assessment of Acquirer – What gets measured drives behaviour
- No strategic “owner” of HFI

Corporate Knowledge, Training and SQEP

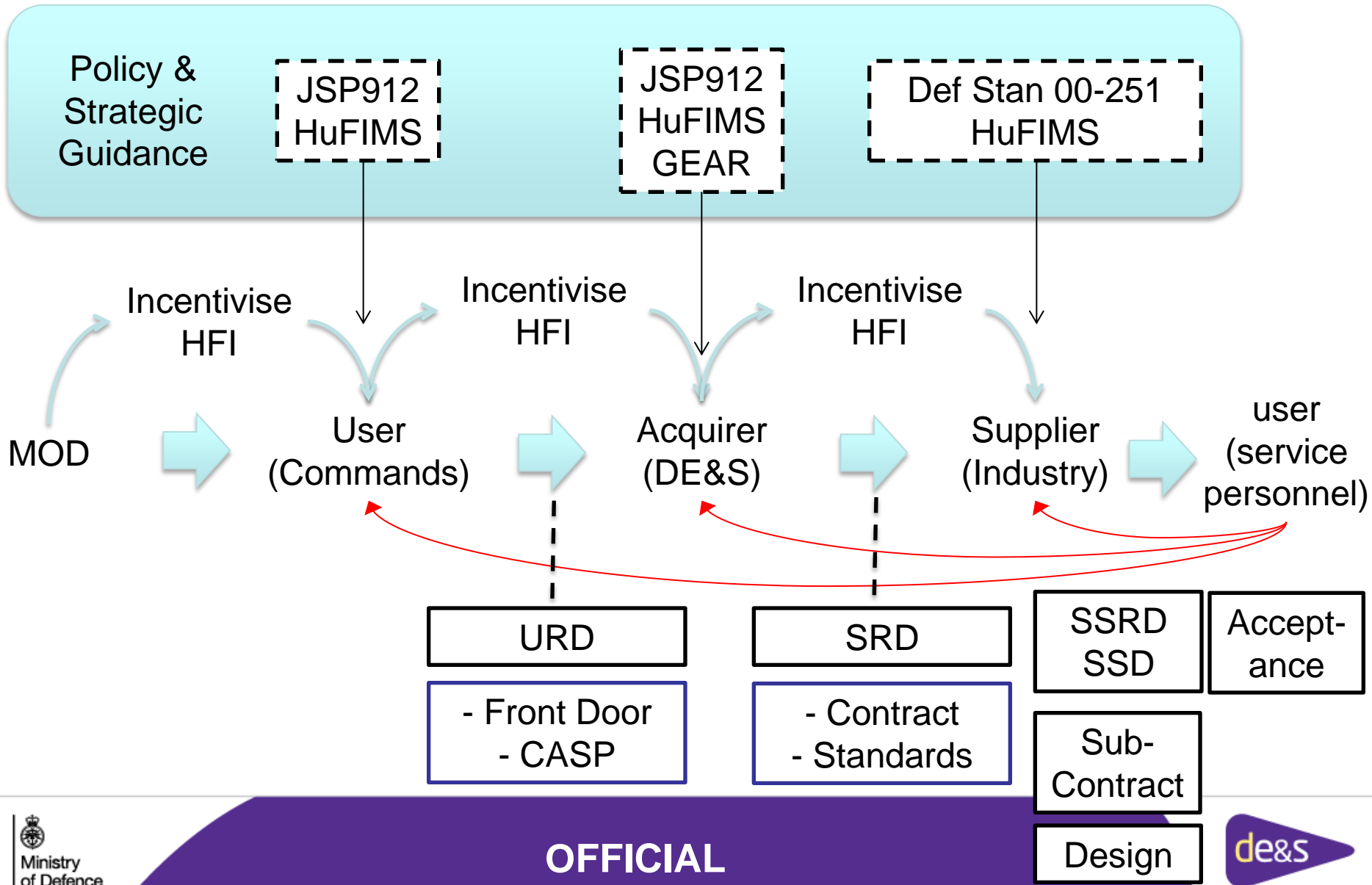
- Lack of HFI posts and SQEP in FLCs

Policy and Guidance Gaps

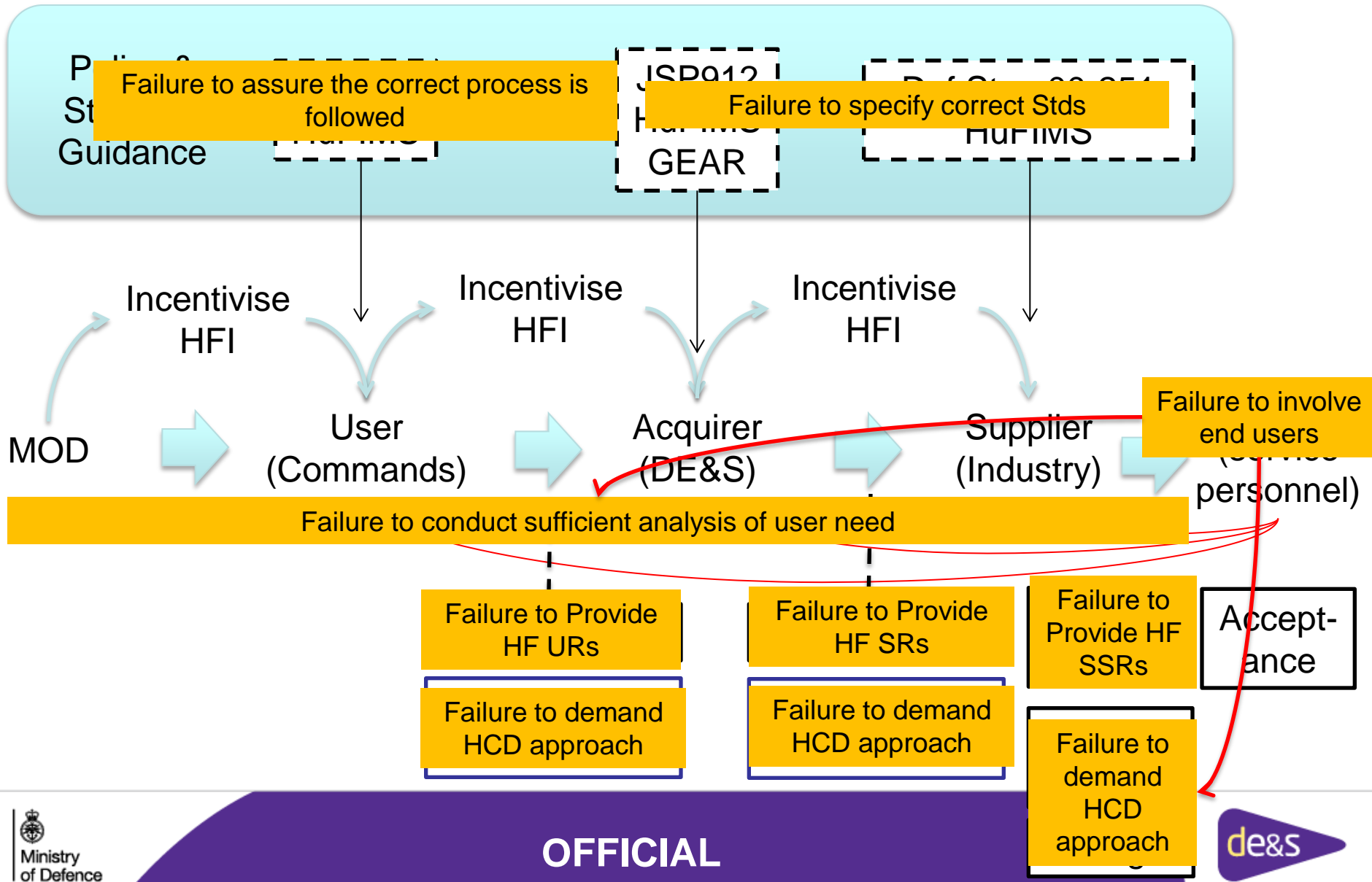
- Lack of HFI guidance for Front Line Commands
- Lack of In-Service process guidance

What’s the incentive to conduct HFI?

Potential Challenges for HFI



Potential Challenges for HFI



HFI - What's the Incentive?

- Duty of Care
- System Performance
- Combat Effectiveness
- Risk (Cost / Schedule / Technical)
- Whole life Cost
- Change Enabler

Thoughts on Terminology, HCD and the ISO9241 approach

Definitions

Glossaries and definitions of common terms reviewed and collated, including:

- MOD Policy and Guidance:
 - HFI process common terms (JSP912, HuFIMS)
 - Risk Management common terms
 - Engineering and Software common terms
 - GEAR – Engineering best practice and review definitions
 - SOSA – glossaries
 - DLODs – Staff Officer definitions
- MBSE Ontology
- ISO 9241 210 and 220
- ISO 27500

Definitions - Initial Thoughts

- 718 Entries
- Differences in definitions between areas – no common definitions in some places.
- MBSE Ontology potentially useful approach for describing importance of HSI within the wider SE approaches

$$\text{Efficiency} = \frac{\text{Effectiveness (task time, completion, errors)}}{\text{Resources Expended (cost, manpower, cognitive effort)}}$$

HFI and the Defence Lines Of Development

- Lines of Development
 - Concepts and Doctrine
 - Organisation
 - Personnel
 - Training
 - Equipment
 - Logistics
 - Information
 - Infrastructure



HFI & HSI Domains

HFI

MANPOWER

PERSONNEL

TRAINING

HUMAN FACTORS ENGINEERING

SYSTEM SAFETY

HEALTH HAZARDS

SOCIAL & ORGANISATIONAL

HSI

MANPOWER

PERSONNEL

TRAINING

HUMAN FACTORS ENGINEERING

SYSTEM SAFETY

HEALTH HAZARDS

SURVIVABILITY

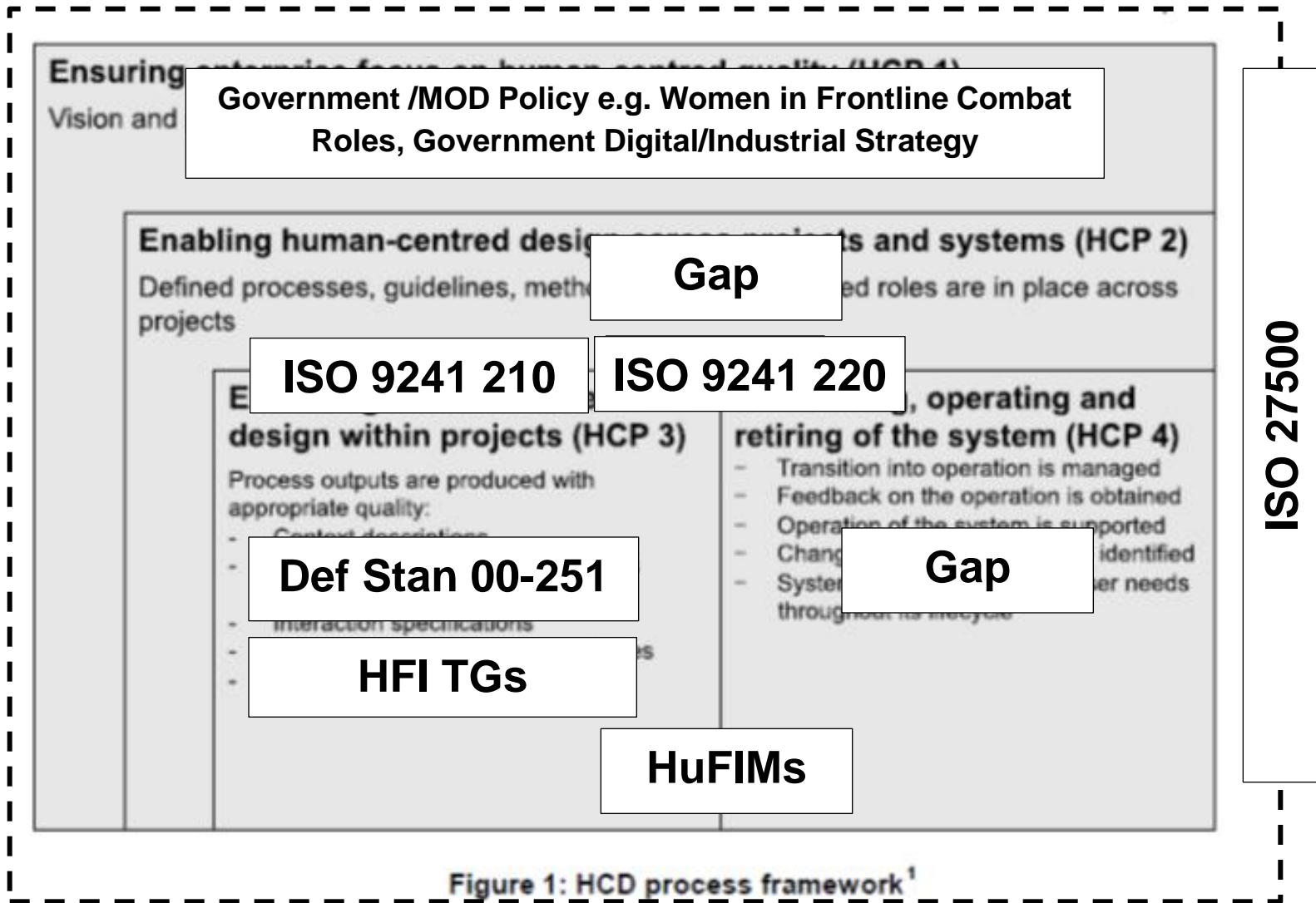
HABITABILITY

ENVIRONMENT (USAF)

HCD and ISO9241 Observations

- HFI principals and processes need to be adaptable to the broad range of both MOD and Industry organisational structures and business processes.
- BS EN ISO 9241 highlights that Human Centred Design approaches can be applied at Organisational, Programme, Project, System / Sub-system levels as well as during the operation and disposal of the system. See FIG
- Currently MOD HFI policy and HCD policy and guidance focuses predominantly on the Project and System Aspects of HCD. Even JSP912, which describes the MOD-wide, overarching policy for HFI, is oriented towards the application of HFI within a specific project context.

HCD and ISO9241 - Levels of HCD



Are HCD and HSI trying to Achieve the Same Thing?

Human Systems Integration Working Group

- **Definition**

Human Systems Integration: interdisciplinary technical and management processes for integrating human considerations within and across all system elements; an essential enabler to systems engineering practice.

- **Charter**

To facilitate embedding Human Systems Integration within Systems Engineering, promoting the benefit of placing the proper focus on the role of people in the development and operation of systems. Our vision is to see Human Systems Integration embedded in Systems Engineering practices, leading to the efficient delivery of effective systems.

- **9241 210 - HCD Definition**

“Human-centred design: approach to systems design and development that aims to make interactive systems more usable by focusing on the use of the system and applying human factors/ergonomics and usability knowledge and techniques.”

“Human-centred design is an approach to interactive systems development that aims to make systems usable and useful by focusing on the users, their needs and requirements, and by applying human factors/ergonomics, and usability knowledge and techniques. This approach enhances effectiveness and efficiency, improves human well-being, user satisfaction, accessibility and sustainability; and counteracts possible adverse effects of use on human health, safety and performance.”

- Human centred design approaches are used to create more usable systems, which are more effective and potentially more efficient.

HSI

- [Human systems integration \(HSI\)](#) is an interdisciplinary technical and management process for integrating human considerations with and across all system elements, an essential enabler to systems engineering practice. Human activity considered by HSI includes operating, maintaining, and supporting the system. HSI also considers training and training devices, as well as the infrastructure used for operations and support (DAU 2010). HSI incorporates the following domains as integration considerations: manpower, personnel, training, human factors engineering, occupational health, environment, safety, habitability, and human survivability.

ISO9241 210

- ISO 9241 210 aims to make the body of human factors/ergonomics knowledge about how human-centred design can be used to support the effective planning and management of hardware and software design and re-design processes to include timely human-centred design activities. The human-centred approach to design described in ISO 9241 210 complements existing systems design approaches and can be incorporated in approaches as diverse as object-oriented, waterfall and rapid application development.
- ISO 9241 210 provides an overview of human-centred design activities and a common framework for human factors and usability professionals involved in human-centred design to apply within projects, it does not provide detailed coverage of the methods and techniques required for human-centred design, nor does it address health or safety aspects in detail. This is because it is intended for use by those responsible for planning and managing projects developing interactive systems and only addresses technical issues to the extent necessary to allow such individuals to understand their relevance and importance in the design process as a whole. The detailed human factors/ergonomics, usability and accessibility issues associated with the design of interactive systems are dealt with more fully in a number of standards including other parts of ISO 9241.

ISO9241 220

- ISO 9241 220 describes processes that represent good practice for human-centred design within and across projects. The primary intended users of ISO 9241-220 are those institutionalising human-centred design in an organization, who need to specify, assess and improve human-centred design in the organization.
- ISO 9241-220 can be used for:
 - implementing human-centred design as part of a system development or procurement process and/or support lifecycle;
 - assessing an enterprise's existing capability to carry out the human-centred processes;
 - improving the application of human-centred design as part of an existing system development process;
 - development of competence in human-centred design;

For executives/top management ISO 9241-220 gives guidance on governance in the area of human-centred quality. Using ISO 9241-220 as the basis gives confidence that interactive systems developed and used by an organization will be usable and accessible.

For managers ISO 9241-220 facilitates integration of human-centred design into the system lifecycle and quality management system. Human-centred activities can be specified, assessed and improved as required for projects.

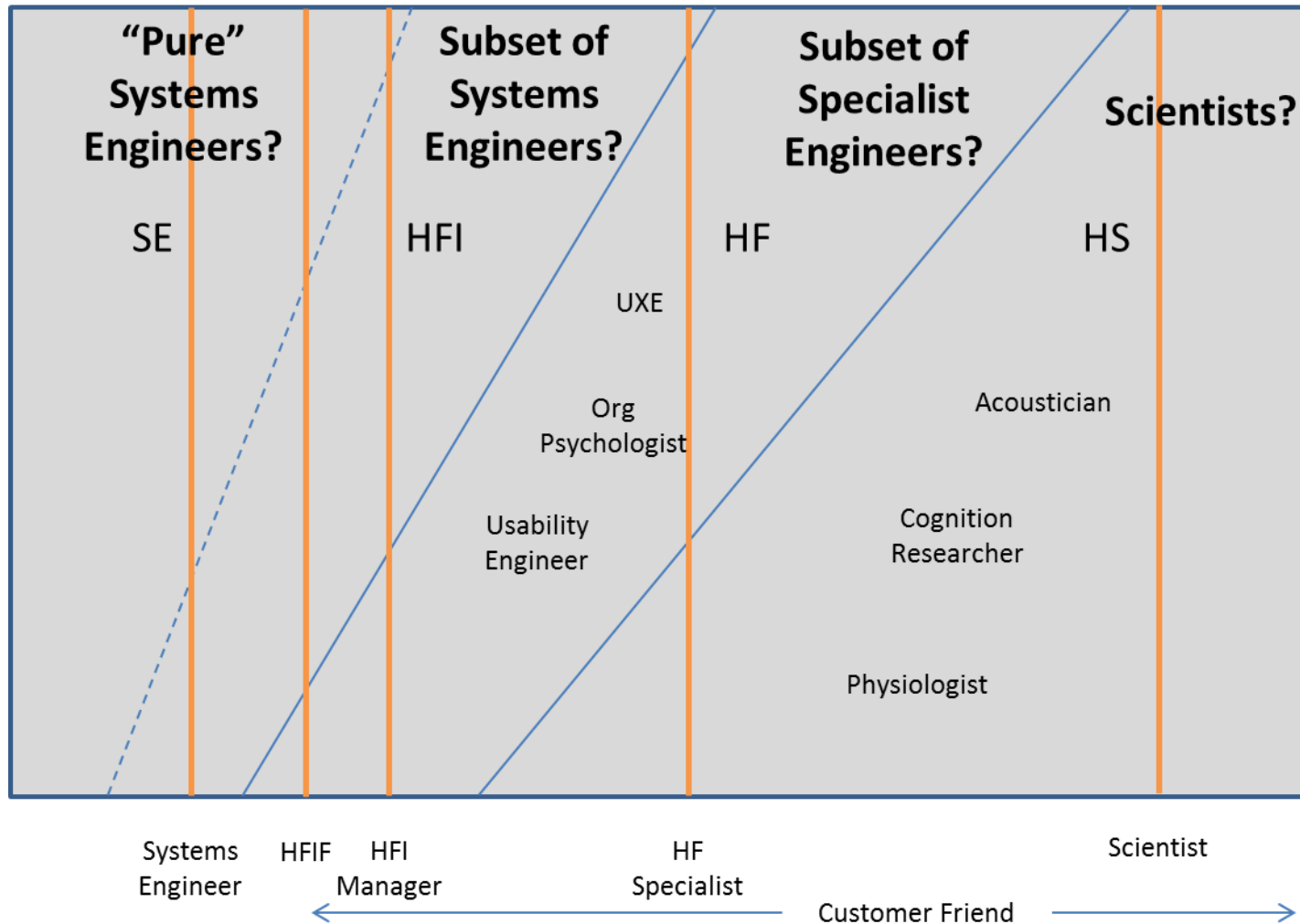
ISO 9241-220 enables efficient interaction between human-centred design and other disciplines. The services and information that technical staff provide to projects are defined so that their value and purpose can be understood.

ISO27500

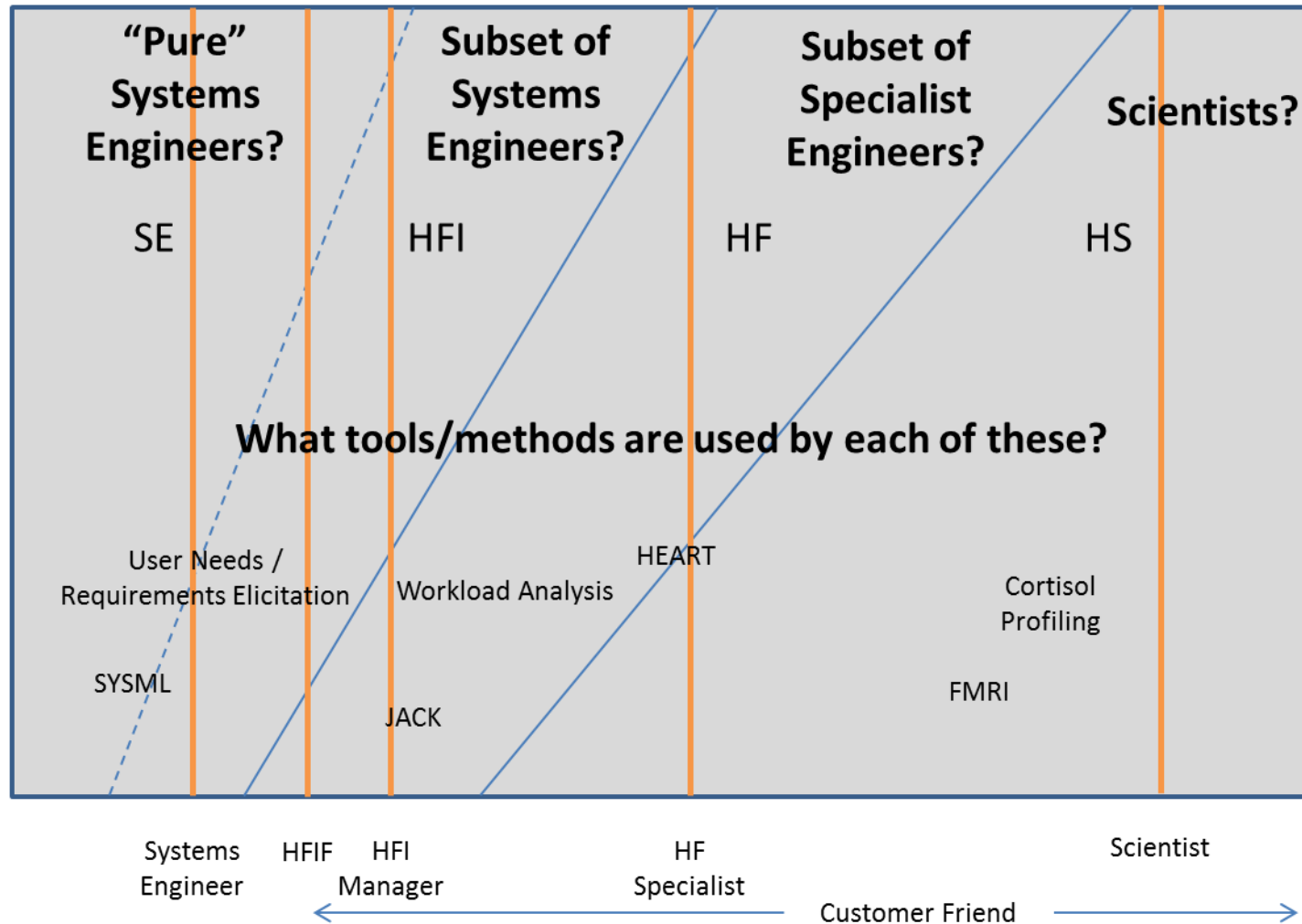
- ISO 27500 is intended for executive board members and policy makers of all types of organizations (whether large or small) in the private, public and non-profit sectors.
- It describes the values and beliefs that make an organization human-centred, the significant business benefits that can be achieved, and explains the risks for the organization of not being human-centred. It provides recommendations for the policies that executive board members need to implement to achieve this. It sets out high-level human-centred principles for executive board members to endorse in order to optimize performance, minimize risks to organizations and individuals, maximize well-being in their organization, and enhance their relationships with the customers. The importance of organizational policy to address human-centredness is emphasized.

Some thoughts for the coming days

HCSE/HCD vs HSI/HFI vs HF vs HS



HCSE/HCD vs HSI/HFI vs HF vs HS



HCSE/HCD vs HSI/HFI vs HF vs HS

Does this suggest a hierarchy?

- **SE**
- **HCSE (HCD)** is a human centric view and subset of **SE**
- **HSI / HFI** are a specific version of **HCSE (HCD)** used by the DoD / MOD
- **HSI/HFI** is made up of **HF Domains** (HFE being the most relevant to equipment design?)
- **HF Domains** apply **Human Factors** methods
- **Human Factors** methods draw on **Human Science** knowledge

Some thoughts for the WG

- Is HSI (as a management discipline) any different from the wider SE technical processes? e.g. HF requirements management is no different, just looked at from a different perspective
- Is there a difference between HCD (ISO9241) and HSI?
- Thinking outside the box – Should we:
 - Collate current HSI best practice and agree a common language and approach
- Or
 - Take a fundamental look again at what HSI is and where it fits within SE more widely.
- Do wider SE methods and approaches include appropriate representation and consideration of the human component?
- How is HSI best served by the guidance that we can provide in the SE Handbook and SEBoK?
 - What level of guidance is appropriate?
 - Stand alone section vs interwoven throughout SE guidance or both?

Some thoughts for the WG

- Who is our target audience?
 - HSI professionals
 - Engineers in other disciplines
 - Key decision makers and policy setters in organisations
- Where is WG effort best targeted?
 - Developing and documenting a common HSI process and language
 - Collating best practice HSI tools, methods and techniques
 - Developing better representation of the human component within existing SE methods and approaches
 - Advocating the embedding of HCD and HSI within the culture of organisations
 - Influencing people of influence at the top level of organisations – selling HSI/HCD to decision makers?
- Do we have all the tools and methods that we need for coming technologies and sociotechnical systems - Should the HSI WG have an academic or applied focus?
- What is the desired end point and how will we know when we've got there?

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