Lloyd's Register Marine

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The Human-Centred Approach

A Best Practice Guide for Ship Designers

Continuous Improvement of the Human Element
Public document

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Contents

1. Introduction

1.1 Purpose of this guide

Lloyd's Register has developed this guide as a statement of best practice in taking a human-centred approach to help ship designers and builders to build 'usable ships', i.e. ships that support safe and effective performance, and are good places to live and work. The system quality to be achieved is *Human-Centred Quality*[1]. In order to avoid novel terminology this document will use the term "*operability*". In practical terms, achieving *operability* means following the principles of **Human-Centred Design** (HCD), and carrying out a set of activities to address *human element issues*.

This approach is in accordance with the IMO 'human element vision, principles and goals' (IMO Resolution A.947(23)). In particular it is aimed at helping to "*significantly enhance maritime safety and the quality of the marine environment by addressing human element issues to improve performance*". It also embraces the IMO principle that "*the human element is a complex multi-dimensional issue that affects maritime safety, security and marine environmental protection*", and that it "*involves the entire spectrum of human activities performed by ships' crews, shore-based management, regulatory bodies, recognized organizations, shipyards, legislators, and other relevant parties*".

This document provides a reference of best practice to support an examination of the extent to which human element issues are considered through the organization, from corporate strategy to technical design activities. The focus on assessment allows ship designers and builders to take a continuous improvement approach to revising the orientation and scope of their activities with respect to the human element.

This guide provides pointers to relevant design guidance. These are detailed in a companion document entitled '*Human Centred approach to ship and equipment design: Guide to Resources*' also available from Lloyd's Register.

1.2 Background

To raise awareness of the crucial contribution of the human element to maritime safety and quality, Lloyd's Register has supported the Nautical Institute in publishing the award-winning **Alert!** bulletin. The best practice presented in this document supports the next step - a transition from awareness to effective action.

Lloyd's Register has taken a leading role in the codification of best practice in addressing *human element issues* through research, consultancy and the publication of international standards.

The background to this guide is set out in the companion white paper '*The Human centred approach – best practice in ship and equipment design*'. Reading (some of) the white paper is probably necessary background to reading this guide.

1.3 Benefits

Use of this guide provides evidence that a ship designer or builder is responsive to *human element issues*. We believe that the assurance provided by this evidence will encourage the industry to address the issue of 'human error' in shipping and to improve seafarer working and living conditions.

[1] Human-centred quality is the outcome of applying human-centred design and has the following components: usability accessibility, user experience, freedom from risk and agreement on solutions (within and across user groups). Lack of knowledge about the operability of an interactive system represents a range of risks (safety, reputation, financial, legal, etc.) but in particular: system risk (not achieving / maintaining expected operability in context); project risk (not meeting targets for operability); and organisational risk (return on investment, through life cost and regulatory compliance).

Human element issues are associated with the vast majority of accidents and incidents. We believe that the ability to demonstrate that this major source of risk is being addressed will be of interest to clients, charterers and insurers.

For the shipping industry as a whole, use of this guide will demonstrate that it is acting in accordance with the IMO Human Element Vision, Principles and Goals.

1.4 Scope

The scope of *human element considerations* is set out in the summary checklists on the next two pages – the "tablemat". They have been broadly divided into 'delivering people' (human resources) and 'delivering *systems*' (*human-centred* design). The shipyard is more directly concerned with delivering systems, but the indirect effects of human resources considerations need to be examined. For example, considering who is going to work in a compartment, use an item of equipment, when, and what training they are likely to have had.

1.5 How to use this guide

This guide is expected to inform three distinct types of use:

1. Overview or getting started

The guide provides an overview of the need to manage the human element across all aspects of ship design, including the drivers and benefits. It will enable a company that has not previously integrated management of the seafarer viewpoint into its practices to start doing so.

2. Implementation of human element management

The guide will enable a company that recognises the value of managing the human element, but is unsure how best to do so, to integrate it into its practices.

3. Assessment/review of best practice

The guide will support a review by Lloyd's Register of whether the practices in place in an organisation represent best practice. This independent check provides confirmation of the benefits of best practice already in place, and guides continuous improvement where the potential is identified. This may be of interest to a company that is already managing the human element, or to a potential client. At the present time, such clients are likely to be in a specialist sector, such as offshore or naval.

The following key applies to the figures:

	Activities, processes or procedures.
	Drivers for improvement changes. Items or practices to consider changing.
	Aims to be achieved by improvement

	Resources for continuous improvement – methods or sources of information. Factors to consider during change

Table 1 Key to figures.

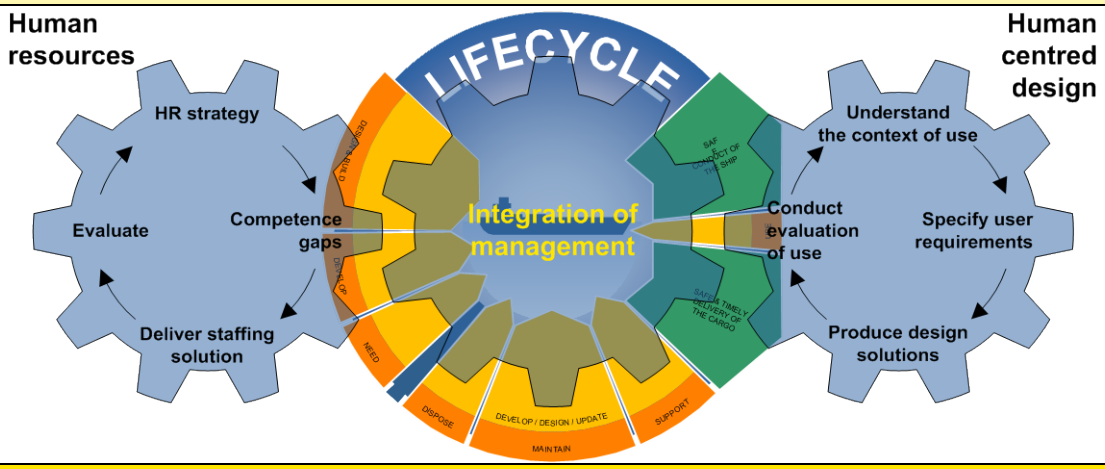
Terms highlighted in *italics* within the document are defined in the glossary. It should be noted in particular that the term "crew" is intended to include the master, officers and the ratings, and "staff" is used to refer to both ship and shore workers, and to staff in the design or build organisation. The terms 'organisation' and 'company' are used to refer to the relevant entity involved with that aspect of design and/or build; this may be the yard, a design company, an equipment manufacturer or other part of the supply chain.

Human resources considerations

Personnel
Understanding the correct mix of people onboard to operate and maintain the ship and its systems

Manning
Understanding that ships have the number of people required for the safe operation and security of the ship and for the protection of the marine environment in both normal and emergency situations

Training
Identifying training needs to ensure personnel are competent and familiar with the ship and its systems



Human factors considerations

Habitability
Company ensures accommodation, washing and toilet facilities, messrooms, group meeting and exercise areas are comfortable, clean (or cleanable) and convivial for all seagoing personnel.

Manoeuvrability
Company ensures its ships have the most appropriate manoeuvring capabilities

Workability
Company ensures its ships and systems are appropriate for the proposed work situation (*context of use*), and that limits will be readily understood by the crew.

Maintainability
Company ensures operational maintenance tasks are rapid, safe and effective to allow equipment and systems to achieve a specified level of performance

Controllability
Company ensures appropriate integration of people with equipment, systems and interfaces

Survivability
Company ensures that there are adequate firefighting, damage control, lifesaving and security facilities to ensure the safety and security of crew, visitors and passengers

Occupational health and safety
Company ensures appropriate consideration of the effect of work, the working environment and living conditions on the health, safety and wellbeing of workers

System safety
Company ensures appropriate consideration of the risks from people using (or misusing) the system

Human resources considerations

Personnel
- Nationality and language
- Selection
- Training
- Physical *characteristics* for the tasks to be done
- Terms & conditions of service
- Expected competencies
- Experience levels
- Payment arrangements
- Disciplinary process
- Leave, travel arrangements

Manning
- Tasks, duties & responsibilities
- Numbers, grades & capacities
- Watchkeeping patterns
- Hours of work & rest
- Required competencies
- Retention
- Continuity at handover
- Succession planning
- Teamworking
- Promotion paths

Training
- Required knowledge, skills & abilities
- STCW requirements
- System-specific training
- In-house/onboard training facilities
- Management/leadership training
- Technical training
- Safety & security training
- Induction
- Onboard familiarisation, safety drills and continuation training

General considerations

- International conventions/regulations
- Crew nationality
- Working language
- Size, shape & gender
- Strength & stamina
- Posture
- Religious & cultural differences
- Welfare facilities
- Intended role
- Ship's operating pattern
- Tours of duty
- Watchkeeping patterns
- Environmental stressors
- Impact of fatigue/stress
- Degree of automation
- Cleanability
- Surface coverings
- Shipboard maintenance policy
- Tripping/falling/bumping/crushing hazards
- Signage
- Understandable operating instructions & procedures
- Company culture

Human factors considerations

Habitability
- Religious & cultural differences
- Need for privacy
- Bathroom facilities
- Messing arrangements
- Facilities for personal recreation & study
- Need for natural light
- Storage space for personal effects
- Furnishing, interior design & decoration

Manoeuvrability
- Potential weather conditions
- Communications
- Minimum/maximum/manoeuvring speed
- Propulsion/manoeuvring systems
- configuration
- Critical system redundancy
- Available harbour services
- Through life costs
- Protection of the environment
- Fuel economy

Workability
- The users
- Tasks
- Fitness for task
- Equipment
- Accessibility
- Communications
- Signage
- Protective equipment

Maintainability
- Through-life support
- Onboard expertise
- Accessibility
- Provision & location of tools
- Location of heavy spare parts
- Bench space
- Removal routes
- Noise protected communications
- Policy for onboard spares
- Storage of spare parts and supplies
- Handling of heavy parts
- Disposal of parts & equipment

Controllability
- Control room, workstation, display screen layout
- Computer dialogue design
- System integration
- Communications
- Alarm philosophy & management
- Direct & peripheral vision
- Daytime/night-time vision
- Dazzle
- Controls & switches
- Reflection
- Glare

Survivability
- Availability of manpower
- Emergency response systems & procedures

Ship layout and equipment fit

Occupational Health and Safety
- *Occupational Health & Safety* policy
- Safe working practices
- Development of a safety culture
- Permit to work
- Health awareness – mental & physical
- Medical screening
- Medical support
- Balanced diet
- Drug and alcohol policy
- Provision, maintenance, access & use of Personal Protective Equipment
- Short/long term hazards to health
- Recording, reporting & feedback procedures

System safety
- Hazard identification
- Potential for human error
- Risk analysis
- Management of risks
- Operating instructions & procedures
- Communication/working language
- Business imperative
- Training & familiarization
- Potential for environmental damage & pollution
- Recording, reporting & feedback procedures

Figure 1: "tablemat" of Human Element considerations

2. The Human-Centred approach and use of this guidance

2.1 The Human-Centred approach

The background to the human-centred approach is discussed in the companion white paper[2]. The human element affects many aspects of equipment design.

We believe that the key to improving design is to develop those areas of **management and technical practice** where all of the **human element issues** in the preceding table can be addressed. This **best practice** guide aims to promote **continuous improvement** in these **key areas** of management and technical practice by enabling these areas to become more **human-centred.** Applying the best practice in this guide will enable **balanced action on the human element,** with an **overall benefit to safety and performance.**

A human-centred approach provides a structure for the consideration of human element issues. The principles of Human Centred Design (tailored) are:

- An explicit description of the operational concept that reflects the context of use.
- Early, continuing, effective crew input.
- Continuous improvement, learning from experience, trials or prototypes.
- The matching of systems to people and tasks, encompassing the user experience.
- Multi-disciplinary teamwork.

A ship design developed using Human-Centred Design (HCD) to address human element issues is almost certainly safer and more productive place to work and live.

2.2 Guidance for management and technical practices

The guidance has been drawn from good practice in a number of sectors where it has been found to contribute to safety and good employment. It has been written in a way that allows an assessment to be made of the extent to which the practices are performed.

The model of good practice has a number of components that make up the organisation. These are represented graphically below in Table 2, together with informal definitions.

The model as a whole is shown below in Figure 2.

[2] *The Human Centred approach - best practice in ship and equipment design*: White paper on the LR approach to the human element, Lloyd's Register report 2013

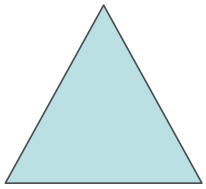
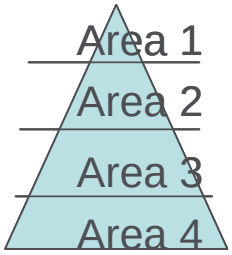
Key \Component	Organization	Area	Process	Activity
Graphic				
Description	The company or organization is the entity aiming for improvement. It might or might not include subsidiaries and subcontractors	Areas of the company; broadly split into two levels of corporate management and two levels of technical work.	Informally defined as "a collection of related responsibilities". NOT a step-wise procedure or method. Key to "making things happen" are an owner and outcomes.	Activities may be closer to methods, procedures. These are the specific "things to be done".

Table 2 Components of the model. Note that formal definitions are given in the Glossary.

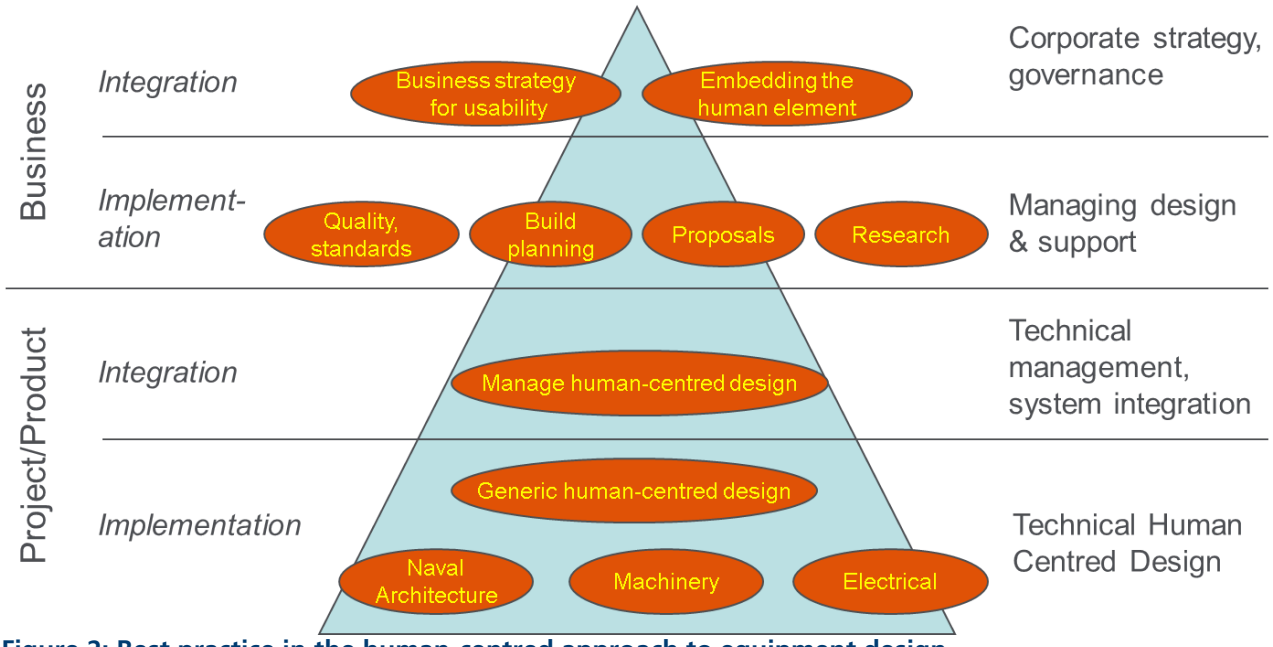


Figure 2: Best practice in the human-centred approach to equipment design

The areas of activity presented are summarised as follows. They may map to organisational functions:

Area 1 addresses "Corporate strategy, governance" for the human element, i.e. the practices of the company at a corporate and strategic level:

– 1.1 Business strategy for *operability* (human-centred quality)

– 1.2 Embedding the human element

Area 2 addresses "**Managing design and support**", i.e. what the company management does about the human-system issues on an ongoing basis:

– 2.1 Quality, Standards

– 2.2 Build planning

– 2.3 Proposals

– 2.4 Research

Area 3 addresses "Technical management, system integration" and comprises

– 3.1 Manage HCD

Area 4 addresses "**Technical Human-Centred Design**", and is based on addressing human-system issues in each area of design. The section describing Area 4 firstly presents the generic HCD processes as 4.1 to 4.4 and then lists the specific technical issues for ship design:

– 4.1 Understand and specify the context of use

– 4.2 Specify the user requirements

– 4.3 Produce design solutions

– 4.4 Evaluate the designs against the requirements

– 4.5 Naval Architecture

– 4.6 Machinery

– 4.7 Electrical.

2.3 The approach to addressing the human element

As can be seen from the 'tablemat' in Fig. 1 above, the human element affects many aspects of ship design. The Lloyd's Register approach is based on established best practice, and applies the following concepts:

– **Why**: A very broad objective, encompassing the 'ilities' in the tablemat, termed Human-centred quality, and generally referred to in this guide as '*operability*' or safe and effective operation.

– **What**: The principles of Human Centred Design (see Section 2.1 above) as central to achieving the objective;

– **How**: The idea of a 'process' as a collection of related responsibilities, rather than a mechanical procedure, together with Continuous Improvement of these processes as the means of ensuring a Human-Centred approach is implemented.

2.3.1 Continuous improvement in the human element

This guide provides a framework for the assessment of a yard or ship designer's ***capability*** to address *human element issues*. The human element guidance defines best practice in ship design through the life cycle (from concept to operation) and in management practice (e.g. risk management). It describes management practices that enable a ship designer or builder to resolve *human element issues*, and **integrate** the human element into the operation of the company. The supporting technical practices of applying human centred design to different aspects of design are also defined.

Using the guide will help ship designers and builders to improve their consideration of the human element by adjusting the *orientation* and *scope* of their management practices in a staged manner. The change in ***orientation*** gives greater emphasis to identifying *human element issues* and to acting on them. The change in ***scope*** is to integrate *human element issues* into the way that existing practices such as purchasing, risk management etc. are carried out.

2.4 The key components of the improvement cycle

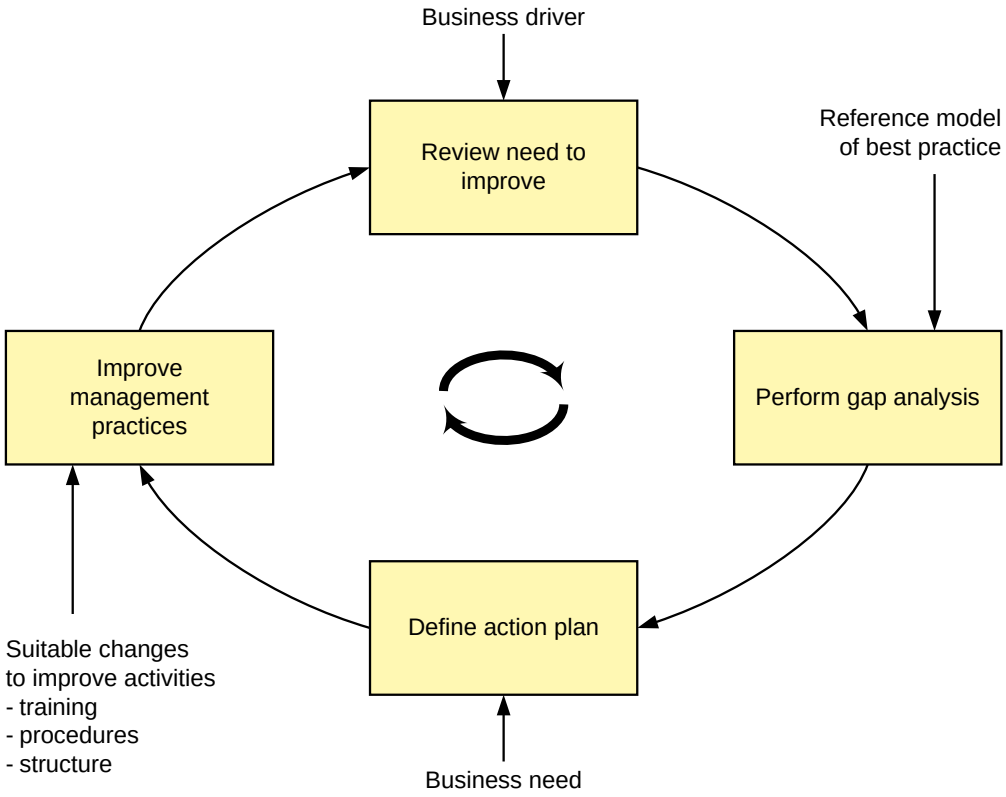


Figure 3: The continuous improvement cycle

It is not realistic to expect an organisation to become human-centred overnight – the more practical approach is the continuous improvement cycle, shown in Figure 3 above.

The need to improve the consideration of *human element issues* is stimulated by a business driver such as competition pressure, regulatory needs or a recovery plan. Performing a *gap analysis* identifies shortfalls against a reference model of best practice. Improvement actions are identified and prioritised in an action plan. Improvement activities are then put in place. These can include training and awareness raising, changes to procedures or changes to company structure and communications. Progress is reviewed against the external requirements, and a new *gap analysis* undertaken.

The guidance provided here illustrates the progression towards managed HCD in the form of a number of levels of capability, shown in Figure 4 below.

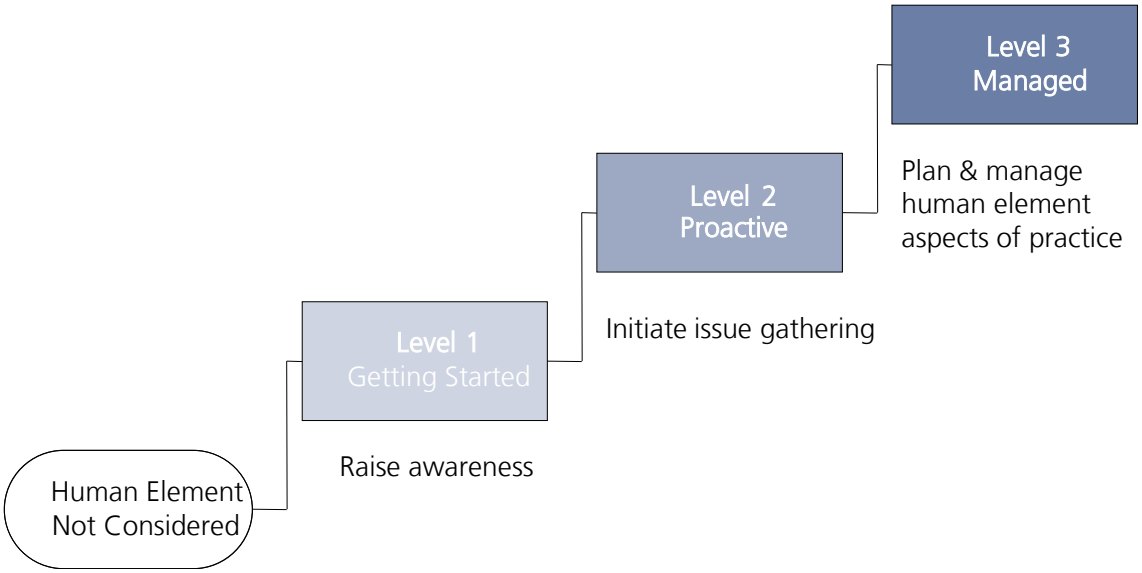


Figure 4: Levels of capability in addressing human element issues

The levels are:

N/A: No consideration of the human element. Human element issues are not addressed.
Level 1, Reactive – getting started: Feedback on human element issues is gathered, the company listens to issues, reviews them and acts on them. The achievement of Level 1 may involve a change in *orientation*. It represents a major step from a compliance-driven technical culture. The company takes some first steps – mostly to test organisational change.
Level 2, Proactive – active human-centred approach: The ship designer seeks out human element issues, takes action to gather data, and then acts on it. Good practice is identified and used. Human-centred methods are used. Achieving Level 2 is likely to require a change in the *scope* of company practices.
Level 3, Managed: Human element issues are addressed as part of a plan, and there is a managed programme of work considering them. Achieving Level 3 is likely to involve some changes in both *scope* and *orientation*.

2.5 Structure of best practice

The guidance is structured as follows:

Each area is described as follows:

- Title: identifies the area of management or technical practice where consideration of the human element is to be addressed.
- Purpose: defines objectives and outcomes to be achieved by effective consideration of the human element in that area of management or technical practice.
- Benefits: The benefits to be obtained to the company, or to other stakeholders.
- Outcomes: the internal and external outcomes that result from carrying out this area of management or technical practice.
- Motivation, strategy: The levers/influences that might be brought to bear to get started or to improve this area of management or technical activity.
- Principles: How the area relates to the principles of Human-Centred Design, and any other principles specific to the area.
- Resources: Standards, guides etc. that are aimed at that area. These are detailed in a companion document "The Human Centred approach - best practice in ship and equipment design: Guide to Resources" available from Lloyd's Register.

Each process is described as follows:

- Title: identifies the area of management practice where consideration of the human element is to be reviewed.
- Purpose: defines objectives and outcomes to be achieved by effective consideration of the human element in that area of management practice.
- Benefits and outcomes: the benefits and outcomes for the organisation that fully considers the human element in that area of management practice.
- Life at each level: a summary of what might be seen in a company operating at each level within that area.
- For the technical HCD area, a set of generic HCD processes are described (Processes 4.1 to 4.4). Then, for each type of specialist design (Processes 4.5 to 4.7) the scope is outlined, together with typical human element considerations, issues and design drivers.

3. Activities for addressing the human element

3.1 Area 1 "Corporate strategy"

Purpose

This area is concerned with governance and corporate strategy. All initiatives need encouragement from the top, and the human-centred approach is no different.

The purpose is to establish awareness to user aspects of design, to make *operability* part of the company's strategy. Activities here are presented as two processes, one essentially outward-looking (1.1 Business strategy for *operability*), and the other inward-looking (1.2 Embedding the human element).

Benefits

The benefits to the company are:

- The ability to claim operable designs.
- Easier tailoring of designs to meet specific customer requirements.
- Enhanced relationships with operators.

The benefits to ship owners are:

- Ship with greater *operability*.
- Support to Maritime Labour Convention (MLC) risk assessments.
- Assurance of reduced risk of claims, fines, detentions arising from human error or poor living/working conditions.

The benefits to other stakeholders, such as those financing ship purchase or concerned with loss prevention are:

- Assurance of reduced risk of claims, fines, detentions arising from human error or poor living/working conditions.

Outcomes

Successfully addressing this group of activities will mean that a business-based human-centred approach is integrated from the top of the organisation and its supply chain.

Outcomes with external visibility (of being able to provide assurance of a human-centred approach) are:

- The usability of the organization's systems in the market is seen to be at a competitive level.
- The corporate vision of usability as an asset is recognized.

Outcomes within the company include the following:

- The appropriate resources will be made available to enable this.
- Human element data will be used to develop company procedures, and
- Human element issues will be a crucial consideration in the production of company standards.

In summary, *operability* is treated as a corporate asset or value across the company.

Motivation, strategy

Getting started and subsequent improvement might be motivated by concerns that include the following:

- Ease of use is found to be a worthwhile asset to customers, and helps to move the company boundary with customers.

- The human-centred approach is used as a valuable element in business change, such as:
  - Using *lead users* as a source of ideas for innovation.
  - *Customer development* for new products.
  - Becoming more agile, resilient, 'outside-in'.
  - Moving the business model, e.g. towards provision of services
- Reacting to incidents, and wanting to demonstrate that lessons have been learned.
- Going beyond a compliance culture.
- Coping better with the skills shortage and lack of marine experience among staff.

Principles

The human element is addressed at the level of corporate governance in ISO/IEC 38500 (Corporate Governance of IT) Principle 6 Human Behaviour - "IT policies, practice and decisions demonstrate respect for Human Behaviour including the current and evolving needs of all the "people in the process".

The Principles of Human-Centred Design are annotated below:

- An explicit understanding of the operational concept that considers the context of use. This area of activities is concerned with enabling the organization as a whole to gain such an understanding. Setting out a clear vision in this regard is important.
- Early, continuing, effective crew input. Leading by example is simple, cheap and effective.
- Continuous improvement, learning from experience, trials or prototypes. Enabling iteration to happen requires considerable change and needs good policy support. A policy lead is needed with regard to any contractual implications of evaluation.
- The matching of ships and systems to people and tasks, encompassing the user experience. This needs to be part of the 'vision' both internally and externally.
- Multi-disciplinary teamwork. Practical leadership here may be needed to break down silos/stovepipes.

Resources

Alert 26 HSEQ

Alert 24 on shipyard training, HSI etc.

Alert 5 centrespread

Alert 3 as background

Alert 2 centrespread - man and machine aspects.

Alert 1 centrespread as frontispiece

3.1.1 Process 1.1 Business strategy for Operability

The **purpose** is to take account of ship *operability* in the organization's business strategy.

The **benefits** of successfully addressing the human element in this area are:

- Senior management require that *operability* has an appropriate role in design and development projects;
- *Operability* goals are set and resources are made available to address Human-centred issues.
- HCD techniques and resources are applied in a cost-effective manner.

Successfully addressing the human element in this area achieves the following **outcomes**:

– A corporate vision of *operability* as an asset is established
– A strategic objective for the *operability* of the organization's equipment in the marketplace
– Marketing takes account of *operability*
– Investment decisions consider *operability* and human performance risks and opportunities
– Senior management support for the improvement of infrastructure related to equipment *operability*
– The extent to which HCD needs to be incorporated in aspects of equipment design is known.
– There is a plan that adapts to emerging *human element issues*, with allowances for feedback loops.

The **activities** involved in business strategy for *operability* are:

– Consider *operability* as a potential asset for the organisation
– Relate *operability* issues to business benefits for the organisation
– Set generic *operability* objectives for key products or services.
– Analyse trends in equipment use from a human-centred point of view
– Take account of *operability* in financial management.
– Follow the competitive situation in the market place

Life at each level

Level 1 – Start to develop ways of finding and using the benefits of a *human-centred* approach. Identify forms of business benefit (e.g. possible margins, new clients etc.).

Level 2 – Define usability as a competitive asset. Track competitive advantage in the market place.

Level 3 – Set usability objectives for equipment developments. Track cost-benefits of a human-centred approach.

3.1.2 Process 1.2 Embedding the human element

The **purpose** is to ensure acceptance of a human-centred approach in the organization for each project / product line as appropriate.

The **benefits** to the company of successfully addressing the human element in this area are:

– Reduced cost of a human-centred approach over time, as resources develop.
– Greater likelihood of achieving full managed HCD and formal recognition.

Successfully addressing the human element in this area achieves the following **outcomes**:

– The organisation has a human-centred approach to ship design
– Ship design and support meets users' needs and expectations
– The principles of human-centred design are applied in development of ship and equipment designs
– Ships are accepted by the market
– The organisation is responsive to changes in seafarers and other users

The **activities** involved are:

– Champion a human-centred approach;
– Establish and communicate a policy for *operability* in the organisation;
– Include human-centred elements in support and control procedures;

- Define and maintain human-centred infrastructure and resources;
- Increase and maintain awareness of *operability*;
- Develop or provide staff with suitable human-centred skills;
- Promote acceptance of human-centred activities in the organization;
- Ensure planners consider a human-centred approach in setting out systems strategy.

Life at each level

Level 1 – Draft an internal vision/policy document for the company human-centred approach and test response.

Level 2 – Try out 'championing' activities such as awards. Maintain staff's focus on human-centred approach. Promote acceptance of human-centred activities and outcomes.

Level 3 – Have a company policy for the human-centred approach. Include human-centred approach in staff competencies. Develop human-centred infrastructure (authorise funding, resources).

3.2 Area 2 "Managing design and support"

Purpose

This group of areas is where the company's commitment to the human element translates into management practices. It is concerned with ensuring that the human element is considered within everyday management activity.

The purpose of this area is to provide the organization with an appropriate HCD capability through life (i.e. from research to end of warranty), ensuring that policies are in place and implemented.

Benefits

- The benefits to the organization concern cost and repeatability, arising from making the human-centred approach part of normal business.
- The benefits to external stakeholders relate to the business advantages of supplying or operating usable systems.

Outcomes

- The internal outcome of this area is that a human-centred infrastructure is established, promoted and maintained, and that human element considerations form part of business activity.
- Usability, health and safety are an inherent element in the acquisition and supply of ships and systems
- Trade-off and risk management explicitly include usability in mitigating risks
- Information exchange and communication regarding human element issues is supported.
- Reusable data and information necessary for the organization to carry out human-centred design is supported
- Usability considerations are part of each project's business plan
- Strategies for achieving usability are set and implemented
- Appropriate procedures for achieving usability by human-centred design activities for equipment design are developed and maintained.
- The external outcome of this area is that business stakeholders find they are doing business with an organization that treats human element considerations seriously.

Motivation, strategy

Making progress in this area can be seen as a way of gaining maximum benefit from any competitive advantage provided by the human-centred approach. It secures any gains made by building them into e.g. company standards and procedures. It also prevents ship design being let down by a supply chain that does not consider *operability*.

Principles

The principles of HCD are listed below with comments on their impact for this area:

- An explicit understanding of the operational concept that considers the context of use. This will require changes to documentation internally, with the client (particularly at the proposal stage) and with the supply chain.
- Early, continuing, effective user input. Arranging for this in the context of build planning will require careful thought. Extending the organisation's 'research' function to embrace this will reduce the demands on the build schedule.
- Continuous improvement, learning from experience, trials or prototypes. This is directly linked to activity in the organisation's quality function.
- The matching of systems to people and tasks, encompassing the user experience.
- Multi-disciplinary teamwork. The need for teamwork extends beyond the technical teamwork addressed in Area 3, to the need for working between technical and commercial staff. This impacts all aspects of this area.

Resources

ISO 17894 process principles may be helpful for systems development.

ISO 25060 series CIF, SQuaRE information items, ISO 9241-210 or 9241-220 Annex B checklists

Alert 22; MLC article

Alert 12 – "what's new" on resources

Alert 11 - issues and integration centrespread, energy institute link, Neil Chaplin article

Alert 7, 8 – especially the centrespreads

ISO 9241-210 'planning, long term monitoring' processes may be helpful.

Standards for service management (ISO/IEC 20000) may also be helpful (if there is an organisational fit).

3.2.1 Process 2.1 Quality & Standards

The **purpose** is to take account of equipment operability in the development of company infrastructure and resources.

The **benefits** of successfully addressing the human element in this area are:

- Gains made in HCD are secured, and not subject to individuals or initiatives.
- The cost of taking a human-centred approach reduces as procedures and resources are developed and made part of the company.
- The human-centred approach becomes scalable.

Successfully addressing the human element in this area achieves the following **outcomes**:

- Suitable tools and methods are used to address *operability* for existing products and for development projects.

- *Operability* competencies are made available.
- HCD is a documented part of the equipment design and development process, with at least as much detail as other system development activities. Examples include:
  - The plan for HCD forms part of the overall system development project plan.
  - Procedures are defined for integrating HCD activities with other system development activities.
  - The methods and techniques that are expected to be used are documented, with criteria for when they would be appropriate.
  - Accepted process practise is provided and maintained in suitable format(s) for use by project stakeholders.
  - Accepted regulations, standards, guidelines and other information related to *operability* are provided and maintained in suitable format(s) for use by project stakeholders.
- There is a basis for tailoring the scope of HCD methods to mitigate the risk of not meeting the needs of success-critical stakeholders.
- Potential risks arising from Human-centred issues related to the system and its context are identified.
- HCD costs (e.g. personnel and training costs), effectiveness (e.g. human performance) and risks are known.
- Human-centred design practice and capability are reviewed in order to build organisational knowledge.

The resources for this process include the HCD standards, good human-centred design and human factors practice, and relevant maritime good practice, e.g. from the MLC, and IMO requirements, such as preventing single human error.

The Activities for this process are:

- Integrate human-centred design into the overall system development project plan.
- Define and plan a system strategy for *operability*.
- The methods and techniques that are expected to be used are identified, with an indication of when they would be appropriate.
- Contribute to the business case for products and projects.
- Develop and use a common terminology for human-centred issues with the organisation
- Establish feedback and communication
- Facilitate personal and technical interactions related to human-centred issues developing effective procedures for establishing feedback and communication on human-centred design activities as they affect other design activities and trade-offs, and methods for documenting these activities;
- Assess and improve human-centred capability in processes which affect usability, health and safety
- Seek and exploit expert guidance and advice on Human-centred issues
- Follow good practice
- Whatever the design process and allocation of responsibilities and roles adopted, a human-centred approach should follow the principles of human-centred design.
- Support active user involvement.
- Use appropriate tools and methods
- Customise tools and methods as necessary for particular projects/stages
- Use appropriate skills

– Deploy appropriate personnel to implement the proposed usability engineering activities determined
– Identify the specialist skills required and plan how to provide them
– Develop or provide staff with suitable HCD skills identifying the individuals and the organization(s) responsible for the human-centred design
– Develop and re-use human factors data
– Have a policy for human factors data management
– Perform research to develop human factors data as required
– Produce coherent data standards and formats
– Define rules for the management of data

Life at each level

Level 1 – Conduct awareness-raising activities such as case studies, exercises in the human-centred approach.

Level 2 – Develop company guidance on the human-centred approach. Deliver training. Investigate how to include the human element in investment appraisal, cost-benefit analysis, pricing. Try forms of usability expert input. Develop documents and methods to support inter-disciplinary interfaces and teamworking.

Level 3 – Develop and use standard company terminology, report formats. Develop and use company procedures that include the human-centred approach where necessary. Provide a set of recommended guides, standards, documents. Provide tools and resources, e.g. for CAD design (standard parts libraries etc.) and for walkthroughs (e.g. animation, mannekins). Manage process improvement of human-centred approach internally.

3.2.2 Process 2.2 Process 2.2 Build planning

The purpose is to ensure that a human-centred approach is taken to planning ship design and build activities.

At first sight, this poses obvious difficulties e.g. iteration is not normally a part of the build process, which is normally conducted as swiftly as possible. However, iteration could be conducted across separate builds in the light of crew input and feedback. Given proper planning, design and build activities can be scheduled to include human-centred activities. A human-centred approach to planning needs to include:

– time for iteration.
– real user input.
– use of incident data.
– risk/issue identification, management.
– identification of two-way dependencies with engineering activities.

This process needs to consider planning at a corporate level across projects and site resources. Sets business risk appetite for planning within a project (Process 3.1). The impact on build strategy needs to be considered. User involvement needs to be addressed at a strategic or business level here (to support the technical user involvement in Process 3.1).

Where a human-centred approach is being pursued to support technical innovation, it may be helpful to consider it as part of customer development.

The benefits to the company of successfully addressing the human element in this process are:

– Ways of finding affordable human-centred activities can be planned and resourced.

Successfully addressing the human element in this process achieves the following **outcomes**:

- The life cycle plan (e.g. build strategy) adapts to emerging human element issues. There is sufficient iteration in the life cycle to achieve system usability over a known period.
- The need for user involvement is identified and accepted by the organisation. Representative users are selected and made available in sufficient numbers and in a timely fashion. User involvement is widespread and effective. Resulting changes to the system are reported back to the users.
- Planning documents include the work products from human-centred activities.
- Resources and staff are adequate to address human element issues. Project resource is allocated on the basis of an explicit assessment of threats to human-centred quality.
- The business risks and benefits associated with operability are understood.
- Potential conflicts between human-centred quality and other risks and issues are traded-off or otherwise reconciled.

The **activities** involved with this process are:

- Develop a plan to achieve operability.
- Manage business risks and opportunities associated with operability. Manage hazards associated with the human element. Trade-off or reconcile any potential conflicts between human-centred quality and other risks or issues.
- Manage stakeholders affected by operability.
- Allocate project resource to mitigate threats to operability. Identify HCD specialist skills required and plan how to provide them.
- Manage life cycle plan (e.g. build strategy) to address human element issues.
- Define a strategy and plan for user involvement.

Life at each level

Level 1 – Include some (resourced) opportunities for user input/feedback and other human-centred activities in plans. Identify areas of good practice that offer potential business benefit.

Level 2 – Include user input and other human-centred activities in plans. Identify human-centred resources, including ways of making possible design solutions more concrete to users. Develop plans that encourage multi-disciplinary teamwork. Include human-centred options for design solutions. Identify business risks, opportunities, drivers for human element issues. Understand the scale of potential benefit or threat from human element issues.

Level 3 – Tailor the design and build process to increase opportunities for human-centred activities. Include human-centred activities as part of routine planning, including dependencies, resources, reporting, iteration cycles. Manage business risks and opportunities arising from human element issues. Maintain business plans for user input and feedback from lead users and the more general user community. Give feedback to users on how their input was used.

3.2.3 Process 2.3 Proposals

The **purpose** is to take account of ship operability in proposals for ships and ship designs.

The **benefits** to the company of successfully addressing the human element in this process are:

- Competitive advantage is obtained by addressing a topic important to the client.
- The ease of operation may simplify integration, test and acceptance.
- Unnecessary or over-specified items may be eliminated.

– Reduced litigation risk.
– Innovative solutions are perceived as lower risk because their operation is more easily understood.
– The potential for business model innovation is increased.

The **benefits** to the operator and seafarer of successfully addressing the human element in this process are:

– The ship has some assurance of improved ship and personnel safety.
– The ship has some assurance of improved effectiveness.
– The ship is likely to be retention-positive.

Successfully addressing the human element in this area achieves the following **outcomes**:

– The offer is easier to relate to operational need.
– The implications for initial operation are easier to plan.
– The offer gives some assurance of supporting safe and effective operation.

The **activities** involved in human-centred aspects of a proposal include:

– Reporting the degree of assurance of operability, e.g. the standards, good practice used, the extent of user input and feedback.
– Identifying areas with low assurance and measures being taken to provide assurance.
– Reporting the match between the context of use evaluated to date with that proposed by the client, and measures proposed to fill any gaps.
– Reporting the manning and training aspects of the ship for the proposed operations.
– Stating opportunities for crew input and feedback during design and build.
– Stating any formal assessment or acceptance testing made in the offer.
– Reporting risks, opportunities and hazards.
– Collating documentation on how the ship would be operated, e.g. System Operational Concepts.

Life at each level

Level 1 – Include areas of good ergonomic practice in the offer. Identify some benefits to seafarers and the operator.

Level 2 – Analyse the context of use to identify issues. Address issues in proposed design where possible. Include some of the following in the offer:

– Information on MLC risk assessment.
– Information on the ease of operation for items on the makers' list.
– A statement of key user requirements.
– Opportunities for user input.

Level 3 – Offer makes contractual commitment to meeting key user requirements. Acceptance is to include usability testing. Offer includes a concept of operations that matches the context of use for the operator. Offer includes statements on manning, training requirements. Proposed design provides assurance of using good practice, with statement of risks and issues to be managed by operator. Offer includes plan for user input.

3.2.4 Process 2.4 Research

The **purpose** is to take account of ship operability in the organization's research.

The **benefits** of successfully addressing the human element in this area are:

– The ability to offer ships with assurance of safe and effective operation without undue delays to build programmes.

Research activity can be conducted 'offline' and help to minimise the impact of a human-centred approach on programme. It is likely to involve gathering feedback on existing ships and systems, and looking forward to future designs. The forward looking research is typically in support of technical innovation, legislative change, and competitive advantage.

Typical outputs are contributions to ship design, the makers' list and risk assessments.

Successfully addressing the human element in this area achieves the following **outcomes**:

– An improving basis for design and build, with increasing use of good practice, and an improved assessment of risks, opportunities and hazards.

– An improving relationship with the user community.

The **activities** involved in research are:

– Identify the human element issues and aspects of ship and equipment design that require user input.

– Define a strategy and plan for user involvement in research and feedback.

– Select and use the most effective method to elicit user input.

– Take account of user input and inform users.

– Maintain contact with users and the client organization through the definition, development and introduction of a system.

– Tests that current or future ship and equipment designs meet the requirements of the users, the tasks and the environment.

– Analyse feedback on the design post-delivery and inform the organisation of emerging issues,

– Identify sources of guidance and good practice to support future design and build activity.

Life at each level

Level 1 – Start to build list of issues to investigate. Map out contexts of use. Find ways of communicating with users. Find ways of evaluating usability of equipment. Identify aspects of design to change. Start to consider usability in makers' list.

Level 2 – Use different contexts of use to identify users, operational situations to investigate. Develop requirements that address usability for internal use and for purchasing Apply methods for user input as regards ship design, equipment design, future needs, and for feedback on existing designs. Discuss usability with candidate suppliers. Propose items for makers' list on grounds of usability.

Level 3 – Include usability (and usability risk) in selection of equipment for makers' list. Have a business plan for involving users and lead users for different business needs (current designs, future needs). Understand the risks of not involving users.

3.3 Area 3 "Technical Management, System Integration"

Purpose

This area is the key technical management set of activities. It is likely that the wide-ranging activities necessary to *integrate* human-centred design into ship design will be undertaken by an individual, or a small team at most, and so they have not been broken down into separate topics. [The activities necessary

to *implement* HCD will be undertaken by a range of people, as part of their technical work – presented in Area 4].

This group of areas is where the company's commitment to the human element translates into technical management practices. It is concerned with ensuring that the human element is considered within everyday technical activity.

The purpose is to ensure that HCD technical activity is carried out in an achievable manner that matches human, financial and technical resources, and assigns these in accordance with company priorities.

This area is also responsible for upward reporting and for communication with corporate management activities (Areas 1 and 2).

Benefits

- The benefit to the company is that management commitment to a human-centred approach is achieved in an affordable manner.
- The benefit to the ship operator is that the ship has achieved the maximum gain in *operability* possible within the constraints of time, cost etc. Where the operator's own seafarers have been involved in the design, then it is likely that there will be benefits in both initial and continuing operation.

Outcomes

- The internal outcome is that HCD technical activity is carried out and documented in accordance with company aspirations and policies.
- In addition, senior management has visibility that human-centred design is being carried out in accordance with company aspirations and policies.
- The external outcome is that the company is able to offer assurance that the design has been undertaken in a human-centred manner, and that human element issues have been addressed.

The risk associated with this area/process is underestimating the amount of activity that may be required. For example:

- Introducing automation, or electronic displays, may increase the effort required to design and test the user interface, rather than decrease it.
- The range of relevant contexts of use is easy to underestimate initially.
- It is easy to underestimate the scope of design shortfalls reported by users when first asked.
- Some requirements only emerge once a prototype or initial design is presented.

Motivation, strategy

In a company with top-level commitment to human-centred design, the strategy here would be to look for 'quick wins' to demonstrate some early success and help to build continuing commitment.

For companies where human-centred design is being led at a senior technical level, the activities in this area are vital to survival. The motivation here is similar, to obtain visible success and growing commitment.

Principles

The principles of human-centred design are:

- An explicit understanding of the operational concept that considers the context of use.
- Early, continuing, effective crew input.
- Continuous improvement, learning from experience, trials or prototypes.
- The matching of ships and systems to people and tasks, encompassing the user experience.

– Multi-disciplinary teamwork.

The activity in this area is driven by these principles. The principles can be used for internal review of progress, and as a basis for re-assigning technical work, and re-directing activity in this area.

Life at each level

Level 1 – The preferences and needs of the crew are captured, but based on anecdotes rather than a formal review when developing specifications. Address known problems and issues. Gather feedback on problems e.g. during warranty. Find ways of identifying problems in operation. Specific complaints and any history of maintenance problems, for example from a sister ship or previous use of the same item of equipment, will be considered. Initiate activities that will enable design staff to see or experience the user viewpoint. Try simple methods on real, well-bounded topics or issues. Identify hazards. Attempt simple identification of possible human errors – mostly as learning exercise.

Resources at this level might typically include:

LR introduction to the human element, introduction to human centred design.

ABS Guides to Ergonomics and Bridge Ergonomics

ILO publication "Barefoot ergonomics".

SCAMPER for human error identification

Level 2 –Feedback from an existing sister ships is obtained where applicable. Prototype surveys and human reliability analyses are carried out. Find ways of gathering feedback or input where possible to drawings, operational use, items on the makers list. Input is collected from crew carrying out real tasks in a realistic environment. Identify scenarios from contexts of use with potential benefit to seafarers, operators, and the yard. Identify risks and opportunities for particular operating conditions, types of user, contexts of use. Identify and address important human element issues. Identify and try out feasible methods and tools. Identify internal and external stakeholders (e.g. marketing, technical staff from the company, crew organisations, insurers, owners) and engage them in the design and the design process.

Resources at this level might typically include:

TEA (Petersen),

LR Introduction to context of use analysis.

Level 3 – Work to a plan. Identify methods, procedures, reporting, resources, dependencies, milestones, and ways of achieving user input. Manage a register of risks, issues, opportunities, including tracking progress, making trade-offs. Match activities, resources and business need. Specify requirements related to usability for suppliers. Conduct user reviews/evaluations of systems, equipment, compartment and ship layout.

At this level, continuing evaluation and monitoring of use is appropriate.

3.3.1 Process 3.1 "Manage Human Centred Design"

The purpose is to take account of ship *operability* in ship design technical activity including the *integration* of ship design from an operational point of view.

The benefits of successfully addressing the human element in this process are:

– Evidence that human element issues have been addressed in a prioritised and cost-effective manner.

– HCD activity is managed in a way that matches the constraints from programme, resources etc.

– Owners will be able to claim that particular risks have been mitigated (e.g. for MLC risk assessment).

Successfully addressing the human element in this area achieves the following outcomes:

– The resulting design will have assurance that known issues, risks and opportunities have been addressed.
– The state of unresolved issues, risks and opportunities is known.
– The design can claim to have "honoured the seafarer", taken seafarer input and good HF design practice into account.

The management of human-centred design comprises four inter-related **activities**, and a more detached activity, as shown in Figure 5 below. The activities are:

– Maintain HCD plan.
– Manage human element risks, issues, opportunities.
– Resource planning and management.
– Manage scope of HCD.
– Manage user involvement

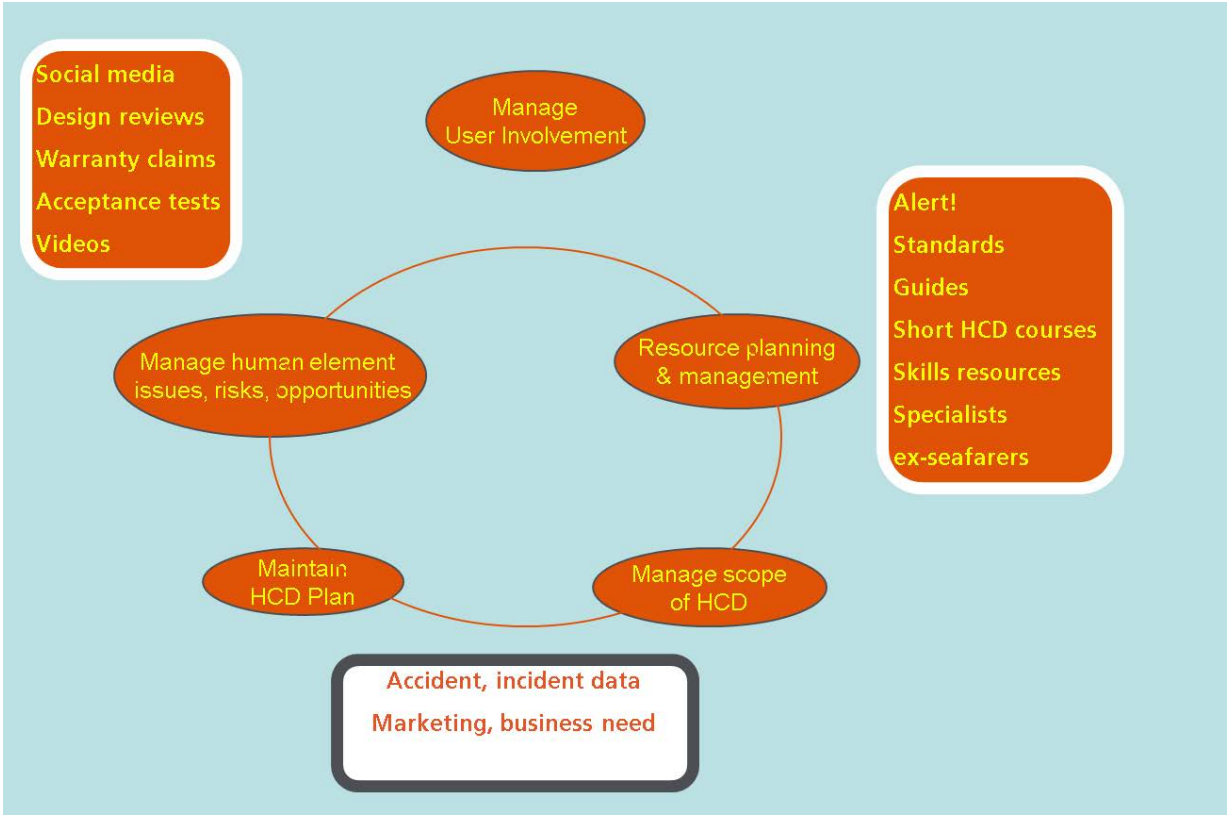


Figure 5 Technical management of HCD

Maintain HCD plan.

Maintaining the planning of HCD activities is likely to require considerable re-planning when starting out or at a low level of capability. The use of this guide and the equipment guide as a source of material for self-assessment and reporting on continuous improvement may be valuable. Co-ordinating the activities of technical specialist is likely to be demanding, as is facilitating multi-disciplinary interactions on human element topics.

Manage human element risks, issues, opportunities.

This activity more or less follows a standard cycle of identifying, tracking and mitigating risks and opportunities.

Resource planning and management.

Resource planning and management is as much about resource development as it is about management. It can draw from the following options:

- Raising awareness and enabling people to find useful resources e.g. from the Alert! website;
- Developing in-house staff, perhaps including ex-seafarers;
- Use of training courses;
- Use of external specialists.

The use of technical resources such as Human Factors good practice is important at low levels of capability, particularly finding material that is easy for non-specialists to use, or translating material into a form that is.

Manage scope of HCD.

The scope of HCD needs to be matched to the business need and opportunity e.g. for a minor update vs. the start of new design concept. It may be focused on a particular business driver. HCD may also be in support to a particular campaign e.g. to reduce slips, trips, falls risks. The scope of HCD activity needs to match available resources and resource development, and may need revising as work proceeds. The scope also needs to be maintained in light of user feedback, and experience from iteration. For example, really positive feedback early on may lead to an increase in scope.

Manage user involvement

Corporate aspects of user involvement, and any implications as regards contracts, responsibilities, liabilities etc. is undertaken as part of Process 2.4, Marketing, Customer Support.

User involvement activity here is concerned with the practical matters of finding sources of user input and feedback and making best use of them. Practical issues such as time and travel costs for users may need to be addressed, and can be difficult to resolve. Not all users are equal, and the concept of *lead users* may be important. For user involvement, the local outcomes are:

- The need for user involvement is identified and accepted by the project.
- Representative users are selected and made available in sufficient numbers and in a timely fashion.
- User involvement is widespread and effective.
- The resulting changes to the system are reported back to the users.

4. Area 4 Technical Human-Centred Design

4.1 Generic processes

Purpose

This group of areas is where the company's commitment to the human element translates into technical design and development activities. It is concerned with ensuring that the human element is considered within everyday technical activity. The purpose of the activities in this area is to enable ship designers to take a human centred approach.

Benefits

- The benefit to the company is that the design is more likely to be popular with seafarers, and that the assurance from a capability evaluation may help win orders. The use of HCD methods may enable the company to meet owner-specific requirements in a managed, cost-effective manner, even without a crew standing-by.
- The benefit to a ship operator is that the design is more likely to support safe and effective operation, and that there is a technical basis for risk management (e.g. MLC risk assessments).
- It is very easy for design teams to make assumptions about user needs; these frequently turn out to be erroneous, and sometimes expensive to implement. It is much better to base requirements on a known rationale.
- There are sources of good ergonomic practice that can be used to place requirements, giving confidence that the design will be usable, and can be justified on the basis of good practice e.g. for risk assessments by the operator.

Outcomes

- Internally, implementing the activities in this area will change the scope of work (not necessarily an increase). Human-centred methods are built into work activities. Human element issues are addressed. Designers communicate with users.
- Externally, technical design activity is communicated to users, who may be involved in requirements or evaluation activities.

Motivation, strategy

For mainstream designs, user input may find cheaper and better ways of designing or building a product. For software-intensive parts of a ship, it can counter-balance the expensive drive for 'creeping featuritis' to find the '*happy user peak*'.

For innovative designs, user input is an essential part of building a successful product. Human-centred design is part of the activities necessary to find affordable solutions for new design tasks.

The design team may find that seafarer input (and other user input e.g. maintainer) is a rewarding part of their work – particularly given the frequent shortage of marine experience.

Principles

The principles of human-centred design are listed below. All of the principles have a major day-to-day impact on activities in this area:

- An explicit understanding of the operational concept that considers the context of use.
- Early, continuing, effective crew input.
- Continuous improvement, learning from experience, trials or prototypes.

- The matching of ships and systems to people and tasks, encompassing the user experience.
- Multi-disciplinary teamwork.

Resources

ISO 17894 product principles

ISO9241-110 interaction principles

ISO18529

MLC, Class (including Control Stations, Alerts), ATOMOS project checklists, MSC Circ. 982 Guidelines on ergonomic criteria for bridge equipment and layout, MSC Circ. 834 Guidelines for engine room layout design and arrangement.

Alert 19 - retention positive design, fatigue bit at back

Alert 13 - fatigue

Alert 17 - slips trips falls

Alert 15 - automation

Alert 14 - signage

Alert 11 - comfort

Alert 3 - anthropometry

Alert 1 AIS fit

ISO 9241-210,

ISO/IEC 25000 SQuaRE series (quality framework), ISO 25060 CIF,

ISO 16982

ABS guides to ship and bridge ergonomics.

IACS Rec 71: Guide for the development of technical manuals.

Generic technical HCD processes

The processes of HCD are shown below in Figure 6. The processes are summarised in the following sections.

Figure 6: Technical Human Centred Design – generic processes

4.1.1 Process 4.1 Understand and specify the context of use

The purpose of this process is to identify, clarify and communicate the characteristics of the user of the ship or system under consideration their goals and tasks and the technical, organisational and real physical environment in which the system will operate.

The outcomes of this process are:

- The characteristics of the actual or intended users, their goals and their tasks, including user interaction with other users and other systems, are identified.
- The real operational environment of the system, including the factors that affect the performance of users, is described in sufficient detail to support the design activities.
- Information about the context of use and its implications which are available throughout the life cycle of the interactive system.

The activities involved in this process are:

- Define the scope of the context of use for the system.
- Analyse the tasks and *work system*.
- Describe the characteristics of the users; differentiate between different groups of users.
- Describe the cultural environment, organisational, management regime.

– Describe the characteristics of any related equipment external to the system and the working environment.
– Describe the location, workplace equipment and ambient conditions.
– Analyse the implications of the context of use.
– Present these issues to project stakeholders for use in the development or operation of the system.

Life at each level

Level 1 - Develop some personas and scenarios for communication to/by design staff to raise awareness. Develop some scenarios for design reviews.

Level 2 - Identify the types of user (operator, maintainer etc.), and indicate the range of users of each type. Identify design drivers e.g. particular environmental requirements. Identify consistency requirements e.g. from other equipments, other parts of ship. Check the context of use with users. Use context of use to inform requirements, analysis, reviews, tests.

Level 3 - Conduct adequate context of use analysis. Maintain effective links to design and test. Develop links to training (e.g. change in context of use from current). Check that the analysis is useful and being used.

Resources

LR guide to context of use

ISO/IEC 25063

LR System Operational Concept

4.1.2 Process 4.2 Specify the user requirements

The purpose of this process is to establish, clarify and communicate the requirements of the users of the system.

The extent of user requirements specification relates to the risk of poor *operability*, either because of shortfalls in current designs, because of technical change, or new types of operation. Such an approach is compatible with say the 'Manifesto for Agile Software Development'.

The outcomes of this process are:

– Relevant groups of users and their task needs are identified and analysed.
– The requirements of the users of the system are defined.
– User criteria for the performance of the work system against operational and functional objectives are stated.
– User requirements are addressed in the system design.

The activities involved in this process are:

– Set and agree the expected behaviour and performance of the system with respect to the user.
– Develop an explicit statement of the user requirements for the system.
– Analyse the user requirements.
– Generate and agree measurable criteria for the system in its intended context of use.
– Present these requirements to project stakeholders for use in the development and operation of the system.

Life at each level

Level 1- Try adopting some good practice requirements to support compliance, or to go beyond it (on a business or safety basis). Develop some critical user requirements for operation or maintenance to communicate safety or business needs.

Level 2 - Start to use requirements in tasking, in reviews. Start to use requirements for conformance to good practice (standards, guides etc.) internally and with suppliers.

Level 3 - Place requirements for conformance to good practice on the basis of safety or business requirements. Use user requirements to place measurable criteria for key aspects of safety and effectiveness. Resolve trade-offs between requirements e.g. security, safety, maintainability. Prioritise requirements based on value and cost. Manage the agreement of requirements with client, suppliers etc. Maintain requirements e.g. updating.

Resources could include the use of SMART requirements, and perhaps a methodology such as RESCUE.

4.1.3 Process 4.3 Produce design solutions

The purpose of this process is to incorporate user requirements and human factors data into the design solution and to identify and mitigate potential *operability* defects before implementation of the system (e.g. before committing to manufacture).

The outcomes of this process are that:

- Issues are considered in the trade-off between design options.
- *Operability* is traded-off against other design criteria.
- All user aspects of the system (for example, staffing, jobs, roles, documentation) are designed.
- User input (direct and/or as feedback from evaluations) is incorporated in the design.

The activities involved in this process are:

- Distribute functions between the human, machine and organisational elements of the system best able to fulfil each function.
- Develop a practical model of the users' work from the requirements, context of use, allocation of function, and design constraints for the system.
- Produce designs for the user-related elements of the system that take account of the user requirements, context of use and HF data.
- Produce a description of how the system will be used.
- Revise design and safety features using feedback from evaluations.

Life at each level

"*Designers shooting for usable is like a chef shooting for edible*". - Aarron Walter

The human centred approach to ship o equipment design uses an understanding of the human tasks to inform the technical design, rather than have technical design lead to task design by implication. Thus human traffic flow is a consideration in ship layout rather than solely a result from a technical approach to design; the allocation of function to members of the crew should affect the location of equipment or control positions on the ship. The human centred approach to automation does not take the view that because something can be automated it should be, and is aware that automation is not a cure-all for 'human error'. The most visible area where the human centred approach is apparent is the design of user interaction, where the interface is determined by task considerations rather than convenience of build or installation. Evacuation and the design of access and protection are topics where a human centred approach is particularly important.

In terms of risk to the seafarer, designing out hazards is the most effective mitigation measure (from the sequence Design – Remove – Guard – Warn – Train).

The level of understanding of the design from the user point of view needs to progress in line with the technical design decisions being made e.g. the understanding to support the preliminary design (say information architecture or hardware layout) needs less detail than for detailed design e.g. alert messages.

See the FAQ 4.6 in the white paper on the role of specialist usability input to design.

Level 1 - "*A change in perspective is worth 80 IQ points.*" Alan Kay

Communicate how the design will be used (who, where, when, how), make the design more concrete from a user point of view (focused on their tasks, not technical or interface features). Revise the design in the light of user feedback. Start to use good practice in design.

Resources

Tthe principles for interaction design in ISO 9241-110.

'The High Performance HMI Handbook' by PAS.

'Usability Engineering' by Jakob Nielsen.

ABS guides on ergonomics and bridge ergonomics.

Level 2 - Communicate the design to users and other stakeholders, and respond to their input. Incorporate good practice into the design process. Communicate an analysis of user tasks and organisation for normal, emergency and fallback operation.

Resources at this level could include the LR System Operational Concept.

Level 3 - Base the allocation of function (who does what, what is done by automation etc.) on the System Operational Concept. Use the task analysis as an input to training needs, and to safety assurance. Link the design activity to human element issue tracking. Make informed trade-offs against operability.

4.1.4 Process 4.4 Evaluate the designs against the requirements

The purpose of this process is to help to select an appropriate design solution, to identify *Operability* defects, and to prove that the system meets the user requirements.

The outcomes of this process are:

- New risks, issues are identified by formative evaluation. *Operability* defects are identified before implementation. The organisation has information on which to base a decision regarding human element issues.
- Overlooked user requirements are identified before implementation. Incompleteness and misinterpretations in specifications are identified.
- Fulfilment of user requirements is demonstrated by summative evaluation.
- The design is tested with real users.

The activities involved in this process are:

- Plan the evaluation.
- Identify the intended outcomes of the evaluation.
- Identify needs for inspection-based evaluation, and user-based evaluation.
- Agree appropriate methods for the evaluation.
- Identify and analyse the conditions under which a system is to be evaluated.

– Check that the system is fit for evaluation.
– Carry out and analyse the evaluation.
– Understand and act on the results of the evaluation.

Life at each level

"*When the chef tastes the soup that's formative. When the customer does, that's summative*" Robert Stake.

Formative evaluation provides design information, and updates the understanding of risks and issue s. Summative evaluation demonstrates the fulfilment of user requirements.

User-based testing involves users attempting to perform representative tasks in the space or with a system. Inspection-based evaluation involves assessing the design against good ergonomic practice; this can complement user-based testing, and make the user-based testing more productive.

Level 1 - The user viewpoint (e.g. based on the conditions of use, or some scenarios) is used in evaluation exercises. Walk-throughs from the user point of view (e.g. "a day in the life") are conducted, perhaps using the CAD model, wireframe diagrams. Simple mock ups are evaluated against scenarios of use. Some inspection-based evaluation is tried. Good practice checklists are used against the design.

Level 2 - Formative evaluation is used to probe potential issues. Criteria are set for summative evaluations. Results are reported to designers in a manner that they will be able to use. Designers are engaged in the evaluation. When making evaluations, there is a judgment about the difference between the test conditions and the real conditions of use. This judgment is used in interpreting evaluation findings.

Level 3 - Evaluation is included in the HCD plan. Select tools and methods to match design decisions and feasible resources. Human-centred evaluation is linked to design decisions and milestones. Evaluation is linked to issue tracking and updating of requirements. Shortfalls against user requirements, good practice, hazards are identified. User input is incorporated into the design process.

4.2 Specialist Processes

In the following sections each design speciality is discussed with some typical issues and design drivers identified. When starting a human-centred approach, these examples might prove helpful expansions of the 'tablemat' set of human element considerations.

4.2.1 Process 4.1 Naval Architecture

The purpose of this process is to take account of ship Human-centred quality in Naval Architecture technical activity including integration of ship design from an operational point of view.

The scope is outlined below with a selection of likely issues and design drivers.

Seakeeping, stability, and controllability

The nature and extent of ship motion may affect provision of features such as hand holds, the orientation of bunks etc.

Seasickness and motion induced limitations need to be considered in the general hull design and in the general arrangement.

The design of features such as fo'c'sle and weatherdeck doors needs to reflect expected sea conditions.

The physical environment is an important aspect of the context of use. Requirements arising from analysing it need to be placed with other specialist designers.

The context of use here includes aspects of operation such as berthing, use of tugs etc., and consideration of *controllability* issues. Any limits to operation need to be presented to the crew in a form that they will see and use. Consideration of human error is also important to *controllability*.

Structure and arrangement

General arrangement; deck and superstructure, compartments, stores, holds, tanks, machinery spaces, voids.

Ensuring adequate sightlines is an early activity, along with traffic flow and work flow. Access requirements (not just for inspection) need to be addressed; good design practice needs to be available to designers in a form they can use.

Te context of use will need to consider operations such as tank cleaning, cargo hazards etc. as applicable.

The users here may include stevedores, maintainers and other non-crew personnel.

Accommodation design benefits from a human-centred approach e.g. location on the ship, relative to sources of noise and vibration etc. Design to reduce fatigue is an important topic here. The accommodation requirements will need careful consideration of the whole ship concept of operation in the light of MLC requirements e.g. for seariders.

Compartment outfit; control rooms, offices, accommodation, catering, sanitation, workshops, HVAC.

The design of working and living spaces is an obvious topic for a human-centred approach. HVAC requirements will need to reflect the context of use, and the system requirements and design may require a detailed understanding of usage.

Outfit – Manoeuvring, anchoring & mooring, deck outfitting, closures, access, masts, lifesaving, firefighting, surfaces and labelling, hull piping, ballast, spares and stores.

Coatings and other design features to prevent slips, trips and falls (STF) need to be addressed. This is perhaps the principal preventable hazard onboard.

The operational design of the parts of ship and associated systems here is important from a safety point of view; many ships have shortfalls here that could be remedied at little or no cost with a human-centred approach.

Applying good Human Factors to labelling on an offshore platform more than paid for itself in reduced commissioning costs.

Cargo handling- cranes, ventilation, refrigeration, heating, etc.

A human-centred approach here is likely to yield operational benefits as well as safety improvements.

The benefits of successfully addressing the human element in this area are:

– A ship that supports safe and effective operation.
– MLC compliance, improved seafarer retention.
– Reduced risk of 'human error' by reducing 'latent errors'.

4.2.2 Process 4.2 Machinery

The purpose is to take account of ship QOU in the design and installation of ship machinery.

The scope is indicated below, together with some typical user issues and design drivers.

The integration of machinery, its installation within the ship structure, its pipework and cabling, and its control (typically by software) inevitably requires multi-disciplinary teamworking – for example, minimising

nuisance alarms. Ensuring that user requirements are placed into contracts (e.g. for usable manuals) requires teamworking between technical and commercial staff.

Technical innovation and increasing complexity are typically sources of problems for users, but offer opportunities for taking a human-centred approach when considering technically-driven change. The increasing reliability of machinery has had an impact on skills and training requirements for crew and maintenance staff. Changes to 'the job to be done' onboard will continue, and *human resources considerations* warrant examination in a human-centred approach.

Propulsion

Issues include maintenance access, access for servicing e.g. replacing filters, removal routes, space and facilities for working on systems.

Machinery is a potential source of noise and vibration issues. The best way to deal with these is at source; propulsion designers need to work with other specialists to provide a cost-effective risk mitigation, bearing in mind that hearing protectors are a last resort. It should be noted that compliance with maritime regulations for noise exposure falls well short of European shore-based requirements.

The potential health hazards of modern lubricants and other such materials warrant checking.

The selection of machinery can benefit from a good understanding of the context of use e.g. times at different power settings, duty cycles.

Auxiliary systems

Ease of operation and maintenance for auxiliary systems can almost certainly be improved on starting a human-centred approach. Studying the context of use from a business point of view may identify opportunities for improved operability with business benefits. Identifying potential human errors can assist with the effectiveness of operation as well as improve safety. Good layout of systems can improve operation with reduced manning.

Environmental control systems (oily waste, ballast water, SOx and NOox etc.)

The IMO guidelines for ballast water treatment include requirements for ease of operation and maintenance. Claims by manufacturers on these aspects should be checked. Ease of operation and maintenance cannot be achieved by equipment selection alone, and requires a 'systems approach' that includes ship design and installation aspects, documentation, training etc.

Ship/shore interface, power supplies

The integration of technical systems, procedures, ship and port staff need to be checked here. The consideration of safety hazards should include examination f human error potential.

The benefits of successfully addressing the human element in this area are:

- Systems meet operational needs.
- Systems support safe operation and reduce the potential for human error.
- Health hazards can be shown to have been mitigated.

4.2.3 Process 4.3 Electrical

The purpose is to take account of ship operability in the selection, design and installation of electrical and electro-technical systems. The major issues here are concerned with system integration, the design of user interaction and its fit to user tasks, and the design of automation i.e. issues of 'supervisory control'. The scope for system improvement may be constrained at any one time, but a prioritised treatment of issues has the potential to make improvements as opportunities arise.

The **scope** of this aspect of design is outlines below with typical issues and design drivers.

Automation, lighting, power generation & distribution

An important issue here is support to diagnostics and fault finding; a combination of complex systems, alarm cascades, poor documentation and a lack of type-specific training can result in problems worsening rather than being solved.

Automation is now the biggest hazard in civil aviation; the issues of 'supervisory control' are well-understood but rarely resolved in complex control systems.

Lighting systems have been revolutionised with the introduction of LEDs. There is now the opportunity to provide really adequate task lighting (rather than a compliant solution). This will require an understanding of user tasks.

Transfer of technology from 'smart buildings' is likely; this brings with it some potential for operational improvement, and also a great many opportunities for further user confusion, frustration and error. For all systems that have been designed for non-marine use and then adapted, a check on usability problems is worthwhile e.g. zoning on fire detection systems.

Navigation, communications, office systems

Human element aspects of bridge system design are essential to navigation safety. There are obvious shortfalls on many bridges e.g. spurious alarms, poor dimming, poor system integration. Providing the bridge team with the ability to understand the state of ship and navigation systems would improve safety.

Office systems are likely to be client supply but frequently suffer from poor usability.

The **benefits** of successfully addressing the human element in this area are:

- Reduced human error potential.
- Improved system effectiveness.
- Better fit to tasks and jobs with reduced manning.
- Better fit between ship tasks and offboard tasks.

5. Addressing the human element through the system lifecycle

This section presents snapshots of the state of the human element at each major milestone in a ship lifecycle, together with notes of how HCD activities might be tailored particularly to that stage.

There are four versions of the lifecycle to consider:

- Standard design
- Bespoke design
- Tailoring a standard design
- Extending a standard design e.g. to new types of operation, operating areas, regimes

The standard design is necessarily generic, aimed at a fairly broad context of use. Given that the design phase is under less time pressure than responding to an enquiry. Once in operation, a standard design evolves; this evolution could be guided by feedback from seafarers.

High levels of HCD capability can give big returns for bespoke designs and tailored responses; the knowledge of 'what works' and the managed ability to tailor a design to specific user requirements is likely to give the yard a significant advantage in responding to an enquiry.

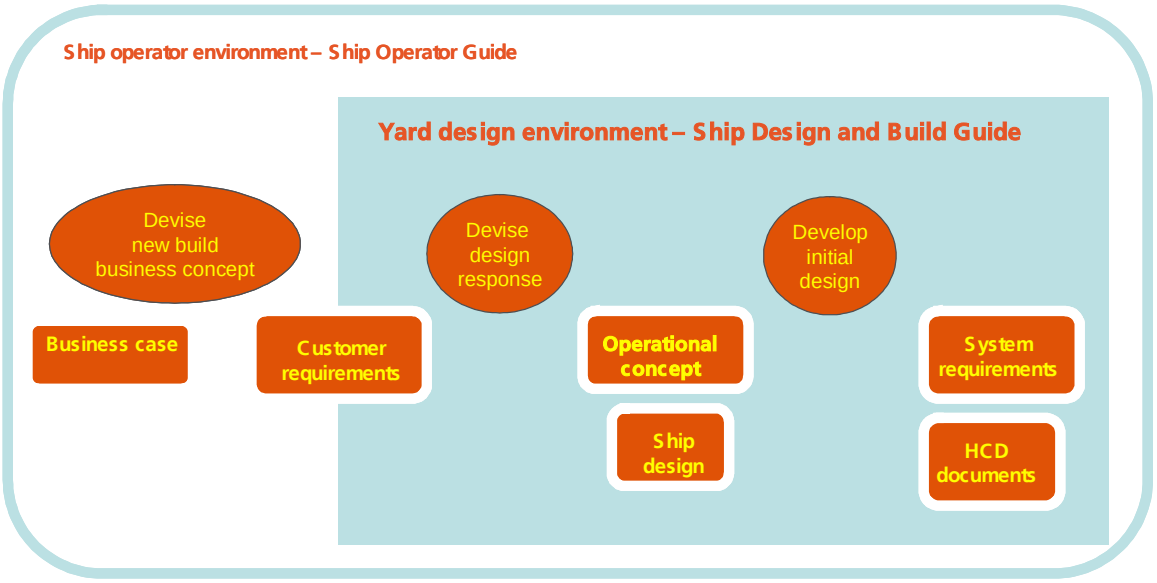


Figure 7 – the translation from a business case to system specifications

The different levels of capability can perhaps be illustrated in 'extending a design'. At the reactive level, the design change can accommodate known issues. At the proactive level, the design can address human element issues identified for the purpose. At a managed level, a satisfactory design can be achieved in a predictable manner. At the optimised level, the design can be shown to be appropriate.

5.1 Initial concept

The initial design concept needs to be linked to the operational concept.

To the extent that previous research has generated candidate design solutions, these can be used. A review of a draft concept from the seafarer point of view may identify further research questions to be answered before the design can proceed with acceptable risk. .

5.2 Operational concept

A Concept of Operations report provides information with regard to describes the ship's intended service in terms of purpose and function. It includes information on crewing, operational situations, temperatures, motions, arrangements under reasonably foreseeable, normal and abnormal conditions, and other information pertinent to the design of the ship.

The human-centred approach bridges design and operation. The divide between design and operation is much deeper in shipping than in other sectors. The Operational Concept is intended to form the bridge between the owner/operators needs and the design of the ship and its systems.

A System Operational Concept report demonstrates that the system's architecture, configuration and criticality meet the requirements defined by the concept of operations and the designer's assumptions or intent in regard to the operation of a system comprising multiple items of equipment and sub-systems. It details the intended configuration for different operations and modes of operation and conveys intent regarding the criticality of system features and/or equipment.

5.3 Technical Specification

The technical specification can use all '3Ps' to ensure usability. Standards and guides can be cited where appropriate.

A System Design Description report details the system's capability and functionality under all normal and reasonably foreseeable abnormal operating and fault conditions, defined operating and emergency conditions.

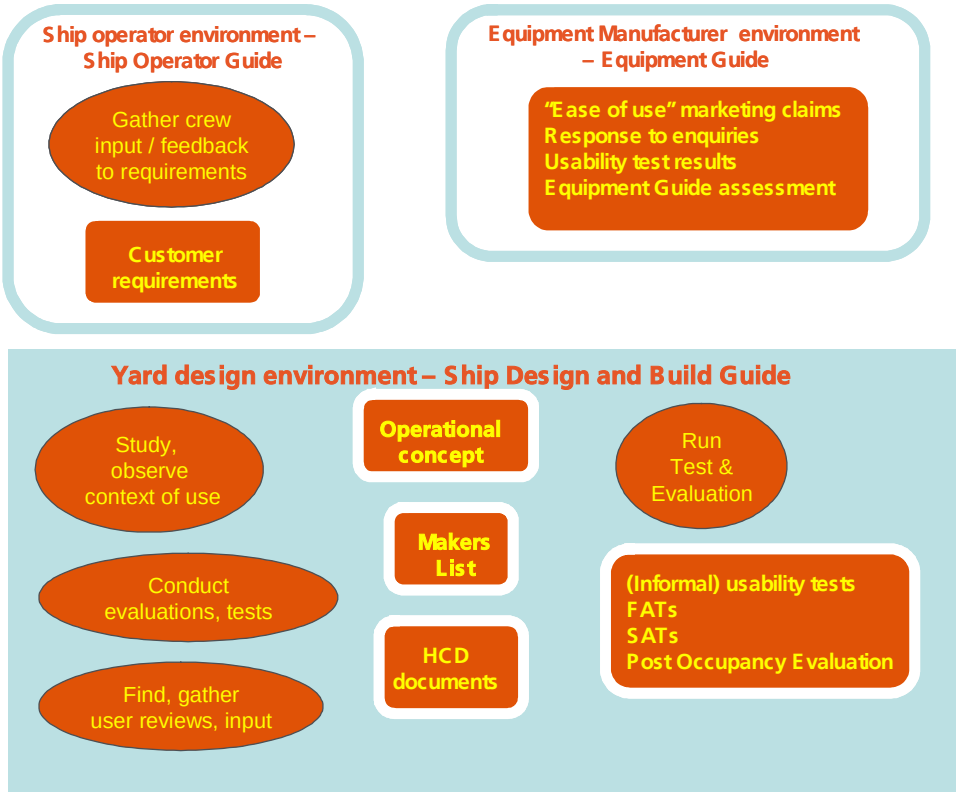


Figure 8 Documents during acquisition

5.4 Makers List

The makers list is a key document to achieving usable ships. Research can help to assess and improve the usability of the items on the list.

Potential equipment for the makers list can be assessed with varying degrees of formality and scope. User feedback on equipment on the existing list could be obtained. Expert user reviews, heuristic reviews, specific use cases could be tried on exhibition stands. More formal usability testing could be performed. Manufacturers could be contacted for assurance.

Research can also examine potential suppliers. The potential suppliers for the makers list may make informal marketing claims of 'ease of use', which are of limited value. Suppliers may be able to make stronger assurance claims based on the Equipment Guide, or may have a form of assurance of their system usability based on standards, assurance of manual readability based on good practice etc. They may be able to offer some degree of assurance based on informal applications of the HCD principles e.g. in response to a Pre-Qualification Questionnaire.

The scope of supply needs to consider manuals and documentation, training, support. Where usability has led to reduced operating demands or costs (such as training costs) then it may be appropriate to present options..

5.5 Proposal

A timely response to an enquiry can only address operability if adequate research has been done ahead of time. The outcome of the research can be included in the proposal to provide assurance of the various '–ilities' in the tablemat.

The proposal should state the extent to which a human-centred approach will be adopted during design and build. Assumptions, dependencies (and benefits) should be identified.

Claims concerning operability performance should be given where possible, together with a statement of the degree to which the claim can be substantiated.

Specific design features that are likely to enhance operability should be given.

The extent to which operability aspects form part of the contractual matter should be identified.

5.6 Plan Approval

Prior to freezing the design, a human-centred approach would conduct an extensive design review, and log any issues arising into the issue tracking system. Topics would typically include:

- Design against good practice 'product' characteristics e.g. deckhead, control and display positioning,
- Traffic flow in a range of normal and emergency scenarios, checking for bottlenecks, difficult routing, hazards such as slips trips falls.
- Compartments in use; walk-through of compartments with a 'day in the life' and any relevant emergency scenarios.
- Lighting can be checked using CAD tools. The assumptions and performance of the HVAC and noise levels can be checked against scenarios for operation.
- Systems in use; walk-through of system operation – possibly separate high level and detailed reviews.
- Manning review e.g. to see if a specified manning meets the IMO Guidelines on Minimum Safe Manning.
- Design for safety e.g. to check against MLC safety requirements and risk assessments.
- Design for fatigue e.g. to ensure good arrangement for sleep (darkness, freedom from intermittent noise etc.).

Documentation would typically follow in-house review practice: Issues tracking system; Access to good practice guidance; Documents on scenarios and use cases.

A documentation audit might be advisable, checking that requirements arising from the Operational Concept have been incorporated into the design and into specifications.

5.7 Test and Commissioning

Factory Acceptance Tests need to be used to maximum advantage. Where the contract has called up good practice or specific usability requirements, these need to be incorporated into the test plan. Where this has not been possible, then some informal user reviews may be achievable and still useful.

Testing the installed systems at the yard by a crew standing by was an important part of traditional shipbuilding. To the extent that this can be revived, then this can be incorporated into the programme. Some benefit can be obtained by extending the technical test programme with tester who have received some awareness training and are supported by good checklists and test procedures.

Obtaining real seafarer input to test and commissioning is inevitably difficult. Planning and discussion well in advance are necessary to achieve a worthwhile result. Funds may also be required.

Documents comprise extensions or additions to the main test documentation. Usability testing has been defined in considerable detail in standards, which are listed in the project white paper "The human centred approach, best practice in ship and equipment design".

5.8 Sea Trials

Sea trials are normally far too hectic and focused on technical matters to address human element issues as well without a significant change. Without such change, all that is achievable is gathering issues as they are identified.

In the longer term, one could envisage formal testing of safe and effective operation being a key feature of sea trials or initial operation, as is done in other sectors.

5.9 Guarantee Period

The guarantee period offers an opportunity to gather feedback. It may be necessary to set clear dividing lines between snagging as part of the contract and feedback as information gathering. A human centred approach would include the following:

- Informal feedback gathering.
- More formal evaluation of the ship and its systems e.g. *Post-Occupancy Evaluation*.
- There are developments in the building industry to move the life cycle further into operation, and include *Post Occupancy Evaluation* within the contract period. An example of a changed life cycle is the '*Soft Landings*' initiative.
- Documents for this stage would typically include:
- Human element issues register.
- Feedback gathering arrangements.
- Arrangements for communications with owner, suppliers, crew.
- Evaluation documentation (e.g. plan, pro-formas, procedures).

5.10 Operational feedback in service

Manufacturers in most safety-related sectors are obliged to monitor usage e.g. to identify "human errors". Gathering operational feedback from ships is the cheapest and simplest way to start the human-centred approach, and to improve the safety and effectiveness of ships in real-world operation.

For the in-service stage, the human centred approach would put the following in place:

- Links to ship operators, and/or to crews of ships from the yard.
- Means of gathering feedback, ideally tailored to the operator or crew (e.g. bandwidth constraints, links to Masters' conferences). Potential hazards may need specific treatment.
- Ways of highlighting improvements made as a result of feedback.
- Documents would include a human element issues register.

6. Assurance Case

For high-value or high-criticality ships such as warships where an assurance case for operability can act as part of a set of safety cases the generic framework for assurance cases provided in ISO/IEC 15026 provides a generic case structure to describe claims, justification and evidence based on Process, Product, Performance and Build.

7. Origin of best practice

The best practice set out here has been based on international standards as discussed in the companion white paper.

There is considerable agreement with the best practice set out in the international standard and a wide range of regulatory and statutory requirements. The best practice set out here will assist in meeting a number of statutory requirements. However, the Human Element Gap Analysis (HEGA) is offered as a discretionary service, and no undertakings of statutory compliance can be made by Lloyd's Register Group or the shipping company using the service.

The HEGA methodology draws on the successful *gap analysis* methodology used by the Lloyd's Register Group.

HEGA draws on the same theoretical background as the OCIMF quality initiative, TMSA, but the two methodologies tackle different topics.

7.1 Feedback to Lloyd's Register Marine

7.1.1 Improving the Best Practice

Lloyd's Register is committed to improving this statement of best practice. The ISO standard underpinning it is subject to a periodic review cycle, which may prompt an update. It will be updated as new best practice emerges and in the light of practical application and feedback. The contact point for feedback is Jonathan Earthy (jonathan.earthy@lr.org), Group Technology Centre, Southampton, UK.

7.2 Bibliography

7.2.1 Regulatory

IMO Resolution A.947(23) *Human Element Vision, Principles and Goals for the Organisation* 2003. This acknowledges the need for increased focus on human-related activities in the safe operation of ships, and the need to achieve and maintain high standards of safety and environmental protection for the purpose of significantly reducing maritime casualties.

ILO Maritime Labour Convention, 2006

IMO International Safety Management (ISM) Code, 2010

7.2.2 Non-regulatory

Alert! *– The International Human Element Bulletin*, **www.he-alert.org**. A four-monthly bulletin, published by the Nautical Institute, aimed at improving the awareness of the human element in the maritime industry.

ISO PAS 18152:2003 *A specification for the process assessment of human-system issues*. This is the standard that provided the basis for the best practice guide.

ISO/IEC 15504[3] *Process assessment* defines the requirements for process assessment and process improvement frameworks.

OCIMF, *Tanker Management and Self Assessment* (TMSA), second edition, 2008. This quality management tool takes a similar continuous improvement approach.

The Human Centred approach - best practice in ship and equipment design: White paper on the LR approach to the human element, Lloyd's Register report 2013, available from Jonathan.Earthy@lr.org

Human Centred approach to ship and equipment design: Guide to Resources, Lloyd's Register report 2014, available from Jonathan.Earthy@lr.org

[3] This series of standards is being revised and updated to the ISO 33000 series.

8. Glossary of key terms and phrases

Unless otherwise stated, all terms used should be considered to accord with the definitions applied in ISO 9001:2008 and ISO 14001. Other terms listed here have been used with the meaning given for the purposes of this guide.

3 Ps: The combination of characteristics used to specify and verify a system's performance e.g. as regards operability. They are Product characteristics (say colour), checked by inspection, Performance characteristics (say task completion time), checked by a test, and Process characteristics (say iterative prototyping), checked by an audit.

Anthropometrics: The comparative study of human body measurements and properties. Standards for this topic are developed by ISO/TC 159/SC 3. Standards cover static and dynamic aspects, and computer manikins and body templates.

Best practice indicator (BPI): Observable signs of the successful implementation of a management practice at a specific level. When used as part of a measurement *system*, they determine the quality of the processes and the degree to which the aims and objectives are being achieved.

Capability: The ability of a process to achieve a required goal. At a company level, capability refers to its ability as an organisation to achieve goals in a specific area, e.g. to deliver consistent performance that meets customer or regulator requirements.

Characteristics: Distinctive features of a person, object or *system*, which define its limitations and requirements.

Competence: Ability to perform *procedures* to operate systems. This is affected by factors such as a person's education, training, aptitude, knowledge and experience, as well as temporary influences such as fatigue.

Context of use: The work situation, i.e. users, tasks, equipment (hardware, software and materials), and the physical and social environments in which a product is used.

Controllability: Integrating people with equipment, *systems* and interfaces.

Crew: All onboard staff engaged in the routine operation of a ship, including the master, other officers and ratings.

Culture: A pattern of shared basic assumptions that the group learned as it solved its problems of external adaptation and internal integration, that has worked well enough to be considered valid and, therefore, to be taught to new members as a correct way to perceive, think and feel in relation to those problems. Schein (1992)

Customer Development: A four-step framework developed by serial entrepreneur and business school Professor Steve Blank for discovering and validating the right market for your idea, building the right product features that solve customers' needs, testing the correct model and tactics for acquiring and converting customers, and deploying the right organization and resources to scale the business. **http://market-by-numbers.com/customer-development/**

Effectiveness: Accuracy and completeness with which users, processes, equipment or systems achieve specified goals.

Efficiency: Resources expended in relation to the accuracy and completeness with which users achieve goals.

Ergonomics, human factors: Scientific discipline concerned with the understanding of interactions among human and other elements of a system, and the profession that applies theory, principles, data and

methods to design in order to optimize human well-being and overall system performance [ISO 26800:2011]

Gap analysis: A review of how a management *system* or *procedures* has addressed, or plans to address, a set of requirements. The assessment does not result in certification, but reports on gaps within a *system* and identifies what needs to be done to close them.

Habitability: Comfortable, clean (or cleanable) and convivial accommodation, washing and toilet facilities, messrooms, group meeting and exercise areas.

Happy User Peak; The sweet spot between inadequate functionality and confusing excessive features. "*Give users what they actually want, not what they say they want. And whatever you do, don't give them new features just because your competitors have them!*" (Kathy Sierra)
http://headrush.typepad.com/creating_passionate_users/2005/06/featuritis_vs_t.html

Hard costs: A traditionally measured and recognised expense such as equipment, subcontracts or rent. There will often be a tangible result. Reductions in hard costs will often have immediate measurable financial savings. (See also soft costs.)

Human-centred: An approach that is characterised by the active involvement of users, and a clear understanding of user and task requirements, an appropriate allocation of function between users and technology, iterations of design solutions and *multi-disciplinary* design.

Human element: "A complex multi-dimensional issue that affects maritime safety, security and marine environmental protection. It involves the entire spectrum of human activities performed by ships' crews, shore-based management, regulatory bodies, recognized organizations, shipyards, legislators, and other relevant parties, all of whom need to co-operate to address human element issues effectively." [Source: IMO Resolution A.947(23)]

Human element consideration: An aspect of the work situation or employment that may affect safe and effective operation or quality of working life. Table 1 in the introduction to this document illustrates the range of human element considerations. They can be divided into human resources and human factors considerations. That is to say, they relate to the people, i.e. users and other *stakeholders*, and to their involvement in or interaction with a ship and its *systems* at any time in the *lifecycle* of the ship or its *systems*.

Human element data: Information about the crew or support staff, or the operation of the ship and its *systems*, or more general information about seafarers and other *stakeholders*.

Human element issue: A *human element consideration* where there is a potential mismatch between the user need and the current or proposed work situation or employment arrangements. Unresolved issues can become *risks* or hazards. The potential mismatch may be expressed as a need, want, constraint, limit, concern or factor.

Information design: 1) The practice of presenting information in a way that fosters efficient and effective understanding of it. The term has come to be used specifically for graphic design for displaying information effectively, rather than just attractively or for artistic expression. (Wikipedia); 2) The field of information design applies traditional and evolving design principles to the process of translating complex, unorganized, or unstructured data into valuable, meaningful information. The practice of information design requires an interdisciplinary approach which combines skills in graphic design, writing and editing, instructional design, human performance technology, and human factors. [stcsig.org]

Instructional System Development (ISD): See Systems Approach to Training.

Iterative: An approach to design, which applies to the design of policies and methods of operation as well as ships and equipment. Iterative design involves a series of repeated cycles where, in each cycle, the design is elaborated, refined, and tested, and the results are fed into the design focus of the next cycle.

Active user involvement therefore becomes critical. Iteration provides an effective means of minimising the *risk* that a *system* does not meet user and organisational requirements (including those requirements that are hidden or difficult to specify explicitly).

Lead User, Lead User Methodology: Lead users are users of a product or service that currently experience needs still unknown to the public and who also benefit greatly if they obtain a solution to these needs. Because lead users innovate, they are considered to be one example or type of the creative consumers phenomenon. (von Hippel) **http://en.wikipedia.org/wiki/Lead_user**

Lifecycle: The stages and activities spanning the life of a ship and its *systems;* from initial concept through to disposal.

Maintainability: Operational maintenance tasks are rapid, safe and effective, to allow equipment and *systems* to achieve a specified level of performance.

Manoeuvrability: The most appropriate manoeuvring capabilities.

Minimal Manual: Minimalism in the context of technical communication is a research-based theory of learning and instruction developed by John M. Carroll and first published in Carroll's book 'The Nurnberg Funnel'. Minimalist documentation is the practical application of this theory to the process of authoring technical documentation, with the goal of producing user guides that function according to minimalist theory. The theory comprises the following simple principles:

- Anchor instruction in the job domain: Don't teach how the system works; instead, teach how to solve your domain goals by using the system. Focus on doing their job rather than learning your system.
- Less is more: Provide only hints and tips that guide exploration, rather than exhaustive detail.
- Eliminate sequence: Design topics to be read in any order so that they cannot be read in the "wrong" order and thereby cause the reader to become lost or to overlook important information.
- Expect user error and provide recovery instructions: The "RTFM" mentality assumes that readers actually follow instructions to the letter and in the prescribed sequence, thereby avoiding errors. This is fallacy even in traditional sequenced documentation, but of course if one of your design principles is to eliminate sequence then this principle becomes especially important.

Multi-disciplinary: A means of providing the wide range of skills and viewpoints required to produce and maintain safe and effective ship operations. A multi-disciplinary team can be small, dynamic and temporary. Examples of the range of skills which may be required, depending on the *system*, include: operator, user, maintainer, purchaser, business analyst, trainer, marketeer, visual designer, domain expert, technical author, ergonomist, human resources or health and safety practitioner, systems analyst, programmer and logistics. It could also take inputs from different shipboard departments, e.g. deck, engine, electrotechnical or hotel.

Occupational health and safety (OHS): The effect of work, the working environment and living conditions on the health, safety and wellbeing of the person.

Operability: Another term for *Human-centred quality*.

Operational concept: An input to the overall *system* requirements, specifically covering its fitness for purpose in relation to the needs and expectations of the users. The operating concept relates to the capabilities that the users will require the *system* to have, rather than the possibilities that the hardware could provide them with.

Orientation: The focus of an organisation's management practices.

Policy: A programme of actions, or a set of principles, which establishes practices to follow or rules to adhere to. It is authorised and available to all those who are affected by it. A *strategy* may be required to define how to implement it.

Post Occupancy Evaluation: The process of evaluating buildings in a systematic and rigorous manner after they have been built and occupied for some time. (Peiser et al 1988).

Procedure: A declared way of formally conducting a course of action to achieve a technical or managerial outcome. It is authorised and established.

Process: A set of interrelated activities, which transform inputs into outputs. [ISO 8402:1994]

Process assessment: A disciplined evaluation of an organization's processes against a Process Assessment Model. [ISO/IEC 15504-1:2004, 3.29]

Process improvement: Actions taken to change an organization's processes so that they more effectively and/or efficiently meet the organization's business goals. ISO/IEC 15504-1:2004, 3.40

Quality In Use: The degree to which a product or system can be used by specific users to meet their needs to achieve specific goals with effectiveness, efficiency, freedom from risk and satisfaction in specific contexts of use. ISO 25010 (2011)

Human-centred quality: Human-centred quality is the outcome of applying human-centred design and has the following components: usability accessibility, user experience, freedom from risk and agreement on solutions (within and across user groups). Lack of knowledge about the operability of an interactive system represents a range of risks (safety, reputation, financial, legal, etc.) but in particular: system risk (not achieving / maintaining expected operability in context); project risk (not meeting targets for operability); and organisational risk (return on investment, through life cost and regulatory compliance).

Representative seafarers: People with similar practical experience, *competence* and outlook to the crew affected by the activity. Recent relevant operational experience is particularly important, given the pace of change.

Risk: A combination of the probability, or frequency, of occurrence of a defined hazard and the magnitude of the consequences of the occurrence.

Risk management: The process whereby decisions are made to accept a known or assessed risk, and/or the implementation of actions to reduce the consequences or probability of occurrence. The formal risk assessment exercise is only one of many contributions to risk management. Much more important are flexibility and responsiveness to a dynamic environment and its dangers. The organisation must ensure that it is sensitive to the signals provided by internal audits, routine reporting, company and masters' reviews, accident reports, etc., and that it responds promptly and effectively.

Satisfaction: Attitudes related to the use of the interactive system, and the emotional and physical experiences arising from use. [ISO WD 9241-11]

Scope: The range of issues that are considered within management practices.

Seafarer representatives: People who present the views of serving crewmembers for consideration by the company, in formal or informal ways. They do not necessarily have to have been to sea themselves to perform this role.

Service: Means of delivering value for the customer by facilitating results the customer wants to achieve. [ISO/IEC 20000-1:2011]

Service Design: Addresses the functionality and form of services from the perspective of the user. It aims to ensure that service interfaces are useful, usable and desirable from the client's point of view, and effective, efficient and distinctive from the supplier's point of view (Birgit Mager). See also **http://www.service-design-network.org/intro/** and **http://www.servicedesigntools.org/**

Servitization: The shift from selling products to supplying an integrated offering of products and services that delivers value in use. Typical services include training and consultancy. The shift can also include a

change in business model – the classic case being "power by the hour" **http://knowledge.wharton.upenn.edu/article/power-by-the-hour-can-paying-only-for-performance-redefine-how-products-are-sold-and-serviced/** See also **http://value-basedservicesystem.blogspot.co.uk/2011/07/5-myths-of-servitization.html**

Ship operator: (Term used with the same meaning as "company" in SOLAS IX/1) The owner of the ship or any other organisation or person such as the manager, or the bareboat charterer, who has assumed the responsibility for operation of the ship from the owner of the ship and who on assuming such responsibility has agreed to take over all the duties and responsibilities imposed by the International Safety Management Code.

Soft costs: Costs that may not have a tangible output against them, but can still have a large impact on profitability. They can include productivity, absenteeism, legal conformity, management and support costs. In contrast to hard costs, savings in soft costs will often not realise a cash benefit immediately, but will lead to savings over the longer term.

Soft Landings: A building procurement initiative developed by BSRIA and the Usable Buildings Trust where designers and constructors stay involved with buildings beyond practical completion. This will assist the client during the first months of operation and beyond, to help fine-tune and de-bug the systems, and ensure the occupiers understand how to control and best use their buildings.

Staff: Company workers involved in the activity in question. This may include people who work on the ship and/or in the company ashore, permanent and/or temporary workers, and employees and/or contract workers. May also refer to workers in a ship yard, design office or equipment manufacturer.

Stakeholder: An interested party having a right, share or claim in the ship and its *systems* or in its possession of qualities that meet that party's needs and/or expectations. Examples include the crew, charterer, inspectors, etc.

Strategy: A means of implementing a *policy*. It may help to bridge the gap between *policy* and practice by specifying the constraints and risks to achievement.

Survivability: Adequate firefighting, damage control, lifesaving and security facilities to ensure the safety and security of crew, visitors and passengers.

System: A combination of interacting elements organised to achieve one or more stated purposes. The elements can be both human and machine, including the workplace, physical equipment, computer software, documentation, manuals, human tasks and organisational or management *procedures*.

Systems approach: Looks at the two-way interaction between a *system* and its environment. It also examines the properties of the *system* that emerge from the interaction of its component parts.

Systems Approach to Training (SAT): The systematic approach and development model goes by many names; however, Instructional System Development (ISD) has remained the standard. This model takes into consideration audience characteristics, the nature of the knowledge, skills, job, and tasks to be learned, and environmental constraints. ISD is a field that takes many of its concepts and principles from various disciplines. For example, as an applied discipline, ISD uses learning theory from psychology to determine how a person learns (learning style) and how to best address their learning need. Instructional theory uses that person's learning style to determine how to best design instruction. The five-phases of the ISD model are Analysis, Design, Development, Implementation, and Evaluation (ADDIE) or Control (ADDIC) and may be pictorially represented as a linear model, but the approach involves continuous iterations. Decisions made in one phase affect actions and plans in other phases.

Trade-off: A decision-making activity which balances *risk* control actions to be taken with the level of *risk*, typically using the ALARP principle (As Low As Reasonably Practicable). A typical management trade-off will consider varying any or all of time, money and quality, with the positive and negative impacts that will

result weighed up in the decision. This document addresses the inclusion of human-*system* issues in such studies.

Usability: The extent to which a product (ship, *system* or equipment) can be used by a specified crew to achieve specified goals with *effectiveness*, *efficiency*, safety and satisfaction in a specified *context of use*. The phrase 'safe and effective operation' is broadly equivalent to usability.

User: An individual interacting with a *system*.

User experience (UX): 1) the overall experience of a person using a product such as a website or a computer application, esp. in terms of how easy or pleasing it is to use. Oxford English Dictionary. 2) A person's perceptions and responses that result from the use and/or anticipated use of a product, system or service. ISO 9241-210:2010

Workability: Equipment and *systems* are appropriate for the work situation, including the physical and social environment of use.

Work system: System comprising one or more workers and work equipment acting together to perform the system function, in the workspace, in the work environment, under the conditions imposed by the work tasks. [ISO 6385:2004]

Lloyd's Register Marine

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