The Human Element in Ship Design

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1 CONTENTS

2 SUMMARY

This report introduces the human element and what this means for a designer of a ship. The human element is a complex multi-dimensional issue that affects maritime safety, security and marine environmental protection. It involves the entire spectrum of human activity performed by ship crews, shore-based management, regulatory bodies, recognized organizations, shipyards, legislators and other relevant parties. All these groups need to co-operate to address human element issues effectively.

For the design spiral activities are added to consider the human element at each stage. For design this means designing for the user by understanding the seafarers and listening to their views, and creating a ship that is ergonomically designed.

Integrating the Human Element is split into human resources and human factors. For human resources the designer needs to design an ergonomically-liveable environment that tends the psychological needs of the seafarer. For recruitment this involves providing the best facilities for seafarers; for manning creating enough room for the safe number of crew to operate the ship; for training this involves designing systems that are easy to use with the smallest training requirement; and for the social organisation this involves creating good areas for the crew to mix with, for example, a gym, IT facilities, and a good size kitchen. Human factors are about habitability, manoeuvrability, maintainability, workability, controllability, and serviceability. This involves designing a ship with the least amount of noise and vibration, taking into account different cultures in design, good areas for crew, and which is easy to manoeuvre, with ergonomic, usable systems and adequate safety, to name a few important points from the Alert! bulletin.

This document also describes some of the regulations to look at with respect to the element and some tools to allow easier design for the human element.

The human element and human-centred design are important to the design of the ship. However, trying to implement them on the tight budgets that ships are built to can be difficult. Implementation can be especially hard if the company that is being dealt with does not see the human element as an important factor within their ships. We can expect regulatory pressure to increase in order to bring about this change.

Each section references further information in the Alert! bulletin. Alert! is a Nautical Institute project, sponsored by the Lloyd's Register Foundation, to improve the awareness of the human element in the maritime industry. All issues of **Alert!** can be found at Alert

3 WHAT IS THE HUMAN ELEMENT?

The human element is defined as a '*complex multi-dimensional issue that affects the maritime safety security and marine environmental protection. It involves the entire spectrum of human activity performed by ship crews, shore based management, regulatory bodies, recognized organizations, shipyards, legislators and other relevant parties, all whom need to co-operate to address human element issues effectively*' (assurance of human factors). For design this means creating a ship that is habitable, has appropriate manoeuvring capabilities, is easy to maintain, easy to work on board, easy to control, adequate safety features, doesn't affect occupational health, and has safety system features to stop people misusing them.

The human element needs to be considered during design. It is often stated that 80% of all accidents at sea are attributable to human error, but it would be more correct to say that 80% of all accidents at sea are attributable to operator error, and 100% of accidents are due to human error; because the root cause can often be traced back to the human influences on the design or operation of a ship, or its system. Part of the human element is looking into human factors and ergonomics. These are defined by the International Ergonomic Association as '*the scientific discipline concerned with the understanding of interaction among human and other elements of a system and the profession that applies theory and principle, data and methods to design in order to optimize human wellbeing and overall system performance*'.

- **Alert!** Issue No.1 centrespread - *Exploring the human element*
- *The Human Element – an introduction* (Lloyd's Register) http://www.he-alert.org/filemanager/root/site_assets/standalone_article_pdfs_0605-/he00740.pdf
- *Best practice for addressing human element issues in the shipping industry* (J. Earthy, B. Sherwood Jones) http://www.he-alert.org/filemanager/root/site_assets/standalone_article_pdfs_0905-/he00940.pdf

4 HUMAN-CENTRED DESIGN

Human-centred design focuses on making a design usable. It is the process of systematically applying human factors, and ergonomic knowledge and techniques to minimize human error, enhance effectiveness and efficiency, improve human working conditions and counteract possible adverse effects of use on health, safety and performance of the mariner. (**Alert**! Issue No. 7, page 1 - *Know thy users- for they are not you!*).

This involves having a clear and explicit understanding of users, tasks, and environment. (**Alert!** Issue No.24 centrespread - *Human element knowledge and skills framework - design, build, maintain*). It also requires the involvement of the user throughout the design and the development and specifically designing for the user experience. (**Alert!** Issue No. 35 page3 - *Taking a human-centred approach*). Before building a new ship conduct an operational review of current vessels to identify the good and to build on them is recommended. The ship designer needs to listen to seafarers and, even better, to have one or more on hand whilst building or direct contact with a human factor engineer during the build. Knowing the crew, organization, and specific strengths and weaknesses will help to build a better ship

(**Alert!** Issue No.1, page 2 - *One Naval Architect's view of the Human Factor*; Issue No. 3, page 3 - *A case for a decent design*; Issue No. 7, page 7 - *Identify the good and build upon it*; Issue No. 24 page 1 - *The Ultimate aim*). To know how the ship is really used there has been a recommendation for the ship designer go to sea before becoming a designer. In reality, this is not easy especially for students. A good commercial to view is http://gcaptain.com/this-might-be-the-best-maritime-commercial-ever/#.VcB5l_lViko. Another good source to read is https://www.chirp.co.uk/newsletters/maritime. CHIRP for Maritime = Confidential Hazardous Incident Reporting Program which gives an insight into accidents at sea. Another good video to watch is https://www.youtube.com/watch?v=85uO5gbi5oU which is an interview with a young seafarer on board his ship. (**Alert!** Issue No. 1 page 2 - *One naval architect's view of human factors*; Issue No. 2 page 2 - *Some thoughts from the sharp end*; Issue No. 3 page 3 - *The case for a Decent design*; Issue No. 25 page 1 - *It's all about team work).*

Alert! Issue No 7 centrespread - *A human-centred approach to ship and system design*

Below is a diagram from IMO NCSR 2/6 showing the generic life cycle of design:

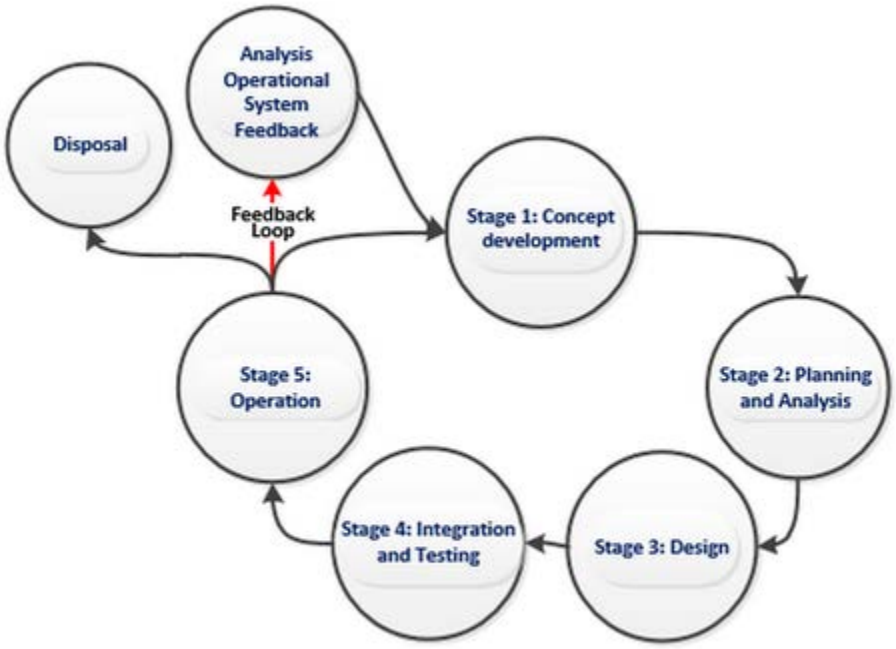


Figure 2: Generic life cycle

For this life cycle to become human centred at each stage activities would be added to each stage with an emphasis as follows:

- Pre-activity: Conduct Early Human Element Analysis
- Activity 1: Understand and specify the context of use. This is the main activity at stage 1
- Activity 2: Specify the user requirements. This is the main activity at stage 2
- Activity 3: Produce design solutions to meet user requirements. This is the main activity at stage 3
- Activity 4: Evaluate the designs against usability criteria. This is the main activity at stage 4

- Activity 5: Maintain operational usability. This is the only activity at stage 5

The documents produced during the life cycle are as follows:

- Stage 1: User and organisational requirements
- Stage 2: System Concept
- Stage 3: Prototype
- Stage 4: System and usability goals
- Stage 5: Usability and operational requirements

During the design process the following should be thought about:

- Consider human-system issues and the relative importance of ergonomics/human factors early in the project and continuously throughout the project
- Identify user needs and specify the user requirements based on an explicit understanding of users, tasks, interactions and environments.
    - *User feedback in ship design* (D A Joiner) http://www.he-alert.org/filemanager/root/site_assets/standalone_article_pdfs_0605-/HE00625.pdf
    - *Interaction design in ship building: An investigation into the integration of the user perspective into ship bridge design* (U. Meck, S. Strohschneider, U. Bruggermann) http://www.he-alert.org/filemanager/root/site_assets/standalone_article_pdfs_1220-/he01260.pdf
- Establish ergonomic criteria for the design. **Alert**! Issue No. 3 centrespread *An A to Z of ergonomics*
- Include ergonomics and user requirements in design solutions.
- Take account of ergonomics criteria in conceptual and detailed design.
    - Anthropology
        i. Design for smallest: force and reach distance
        ii. Design for largest: clearances
        iii. Design for average: work station and adjustable items, e.g. table and chairs
        iv. Design for range: amount of adjustability (**Alert!** Issue No. 3 page 5 *Anthropometry-Designing to fit the user*)
- Prevent negative effects by application of ergonomic principles.
- Identify appropriate methods and resources for human-centred design activities.
- Integrate these activities and their outputs with other system development activities.
- Feedback and communicate on human-centred design activities as they affect other design activities and trade-offs.

Other reference documents:

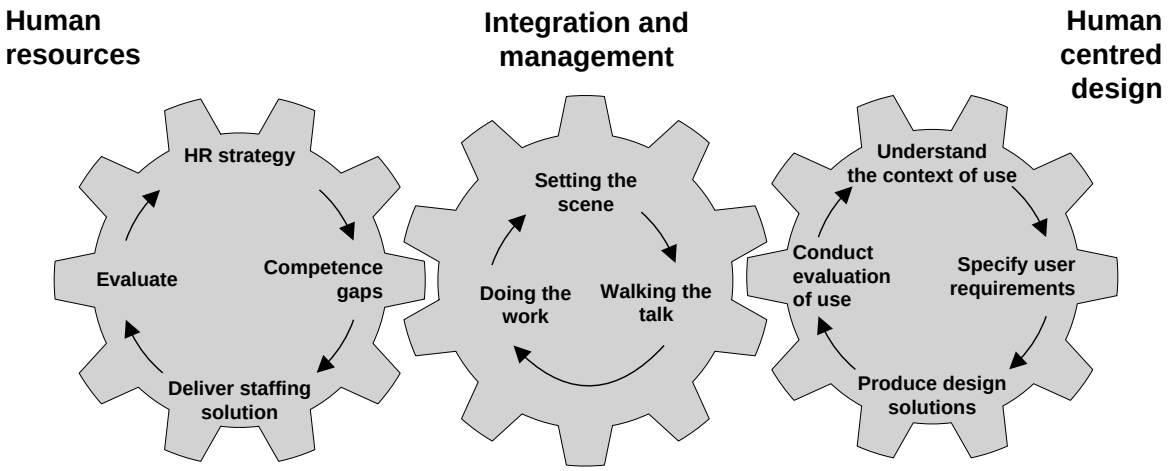
- *The Human-Centred Approach A best practice guide for ship designers* (Lloyd's Register) http://www.webstore.lr.org/products/716-the-human-centred-approach-a-best-practice-guide-for-ship-designers.aspx
- **Alert**! Issue No. 8 centrespread - *Addressing the human element during build*
- **Alert!** Issue No. 26 centrespread - *A human centred approach to HSEQ* (health, safety and wellbeing, environment and quality)

- *ATOMOS II Conceptual Standard for SCC Design (including HMI)* page *19 Human Centred Lifecycle Human centred flow chart* http://www.he-alert.org/filemanager/root/site_assets/standalone_pdfs_0355-/HE00450.pdf
- *Designing usable* ships (J Rasmussen) http://www.he-alert.org/filemanager/root/site_assets/standalone_pdfs_0355-/HE00360.pdf

5 HUMAN FACTORS INTEGRATION

Human factors integration is achieved by processes for human resources and processes for human factors. The human resources process looks into the manning of the ship, the personnel on board, the training of the staff, and the social and organization of management of those on board. The human factors process (called human-centred design) looks at habitability, manoeuvrability, maintainability, workability, controllability, human survivability and occupational health and safety.

The diagram below show how the human resources process integrates with the human-centred design process.



All sub headings can be found in **Alert!** Issue No. 11 centrespread - *Integrating the human element a rough guide*. The points listed below are the main points mentioned in the **Alert**! series.

5.1 HUMAN RESOURCES

This is an overview of the main human element issues with human resources. The main objective for the designer with regards to human resources would be to design an ergonomically liveable environment to tend to the seafarers psychological side. **Alert!** Issue No.4 centrespread - *Mind, Body and Spirit the 7 needs of the mariner.*

5.1.1 Recruitment

Defining the competencies of, and the selection of, suitably competent personnel is necessary to achieve the required performance of a ship and its system. The marine industry is suffering due to not being the industry of choice. This may be due to the long hours, time away from home, lack of shore leave, the environment, lack of job stability, and the living conditions. The designer should take account of the fact that having the best facilities on board a ship would help this issue. These reasons come from a variety of **Alert!** Due to the lack of new seafarers there is now a situation where old seafarers are coming back to the industry at a higher wage. (**Alert!** Issue No. 19)

Beyond core responsibilities competencies can be reallocated. For example a ship owner could employ administrative staff to help with the general running of the ship and relieve the paperwork load upon the master. However, it is largely up to the seafarer to ensure that their company complies with legal obligations when it comes to the employment, training, and certification of seafarers. There is more on recruitment in:

- **Alert!** Issue No. 19 centrespread - *Recruitment and retention - perceptions, experience and expectations*
- **Alert!** Issue No. 31 centrespread – *Personnel: Recruitment and retention, identification of required skills, crewing mixes, maintenance of competencies*.

5.1.2 Manning

Determining the number of people required to operate and maintain a ship and its systems in both normal and emergency situations is important. The number of people manning a ship has decreased because there is currently a shortage of seafarers. This means that underqualified staff are taking up positions. The seafarers on board are having to work longer hours, receive less holiday, and less training time resulting in them becoming more fatigued and stressed. Working longer hours also decreases the amount of social time on board and to get cheaper labour companies are recruiting staff from developing countries, mixed nationalities. This means that it can be hard to for colleagues from a range of countries to communicate. This is can have an effect on seafarer wellbeing mental health. More on manning in:

- **Alert!** Issue No. 32 - *The complete guide to ship manning*.
- *A Rough Guide to interpreting the Principles of Safe Manning* (Captain Michael Lloyd, Commodore David Squire) http://www.he-alert.org/filemanager/root/site_assets/standalone_article_pdfs_0905-/he01125.pdf

5.1.3 Training and competence

Training is required for development of the competencies needed to safely operate and manage a ship and its systems. A motivated, skilled, crew is thought to do a better operating job and if an accident were to occur they would be better prepared for mitigating damages with limiting fixes. With all the new equipment available the all staff need to be highly trained and continuously trained whilst on board. This can done by reading, lectures, and online tests. For the designer to help with the training needs it is best to make usable systems that do not need much training to be used successfully. The training for seafarers is not just about the ship, training also needs to be undertaken on leadership, communication, safety, problem solving, team work, and dealing with such issues as fatigue and stress.

An issue for training and competency is that of different seafarers being taught at different centres. This can means some people will hold the same certificate as others but will be less well trained, so it is important that a company also provides its own training. The standard of training depends on additional experiences and the teacher. Another issue is that the procedural language is English, and some seafarer may be taught to pass exams even though they cannot really follow the language well in practice

More on communication in:

- **Alert!** Issue No 14 centrespread - *The alphabet of effective communication*. This can make the bridge unsafe if the bridge team can't understand each other.
- **Alert!** Issue No. 6 centrespread - *The development and maintenance of the human components of ship systems*.

More on training and skills in:

- **Alert!** Issue No. 20 centrespread - *Education, training and development- a route map*.
- **Alert!** Issue No. 29 centrespread - *Maritime Educators and Trainers: knowledge, skills and attributes*.
- **Alert!** Issue No. 33 centrespread - *An A to Z of maritime education and training*.

5.1.4 Social and organizational

This involves consideration of ways of working, the management structure, and the social environment in the office and on the ships. For the designer they would involve creating a living space with good size rooms, a common spaces, room, a large galley, a gym area, an IT room, and a dining area. This would help the seafarers to enjoy a good social life, with space to relax and to exercise. Bad rest and lack of exercise can cause stress and fatigue which can lead to lack of motivation which can then lead to accidents.

The problem with creating such areas for the crew is the limited financial margins which restrict the ability to invest. Having the crew help design the areas will give a sense of ownership which will help motivate the crew. Psychology plays an important role in human performance and behaviour. Examples of social and organizational issues are:

- rogue behaviour
- the total quality lifecycle
- fatigue (causes, effects and mitigation)
- seafarer health, safety and wellbeing
  the mental health of seafarers
- addressing personal perspectives on leadership in seafaring

More on social and organisational in:

- **Alert!** Issue No. 16 centrespread - *Exploring rogue behaviour*.
- **Alert!** Issue No. 5 centrespread - *A total quality lifecycle*
- **Alert!** Issue No. 13 centrespread - Fatigue Causes, effects and mitigation.
- **Alert!** Issue No.18 centrespread - *The good guide to seafarer health, safety and wellbeing*.
- *The mental health of seafarers* (Robert T.B. Iversen) (http://www.he-alert.org/filemanager/root/site_assets/standalone_article_pdfs_1220-/he01320.pdf

- *A Mariner's guide on Human Element issues* (Captain Shahrokh Khodayari). This is a mariner's personal view. http://www.he-alert.org/filemanager/root/site_assets/standalone_article_pdfs_0605-/he00730.pdf

5.1.5 Alert! articles related to Human Resources and Social and Organisational issues

- Issue No. 1, page 1 - *Improving the awareness of the human element in the Marine Industry*; page2 - *One Naval Architect's view of the Human Factor*; page 3 - *A Marine Engineering perspective*
- Issue No. 2, page1 - *Paperwork…what paperwork*; page.3 - *Cracking the Code*; page.3 - *improving the Application of the Collision Regulations*; page 6 - *Port State Control and the ISM Code*; page 8 - *Reports and Studies*
- Issue No.3, page1 - *An ergonomic nightmare*; page 6 - *The Human Element in Pilotage*; page 6 - *Prevention through people: an overview*
- Issue No. 4, page 1 - *Garbage in, garbage out*; page 3 - *Crew Endurance Management*: *Extending beyond Fatigue*; page 6 - *Joined up maritime health*; page 7 - *Seafarer's wellbeing an holistic approach*
- Issue No. 5, page 1 - *Investing in quality*; page 3 - *Building the company culture*; page 6 - *Corporate social responsibility in shipping*
- Issue No. 6, page 1 - *Competent people make the difference*; page2 - *Invest in yourself*; page 6 - *Training the trainer*; page7 - *Leadership-a training need?*
- Issue No. 9, page 2 - *Forget the image…*; page 3 - *Communication skills are vital to safe ship operations*; page 3 - *Stress at sea*; page.7 - *Good working practices have always given good results*
- Issue No. 10, page 7 - *The effects of Regulation*
- Issue No. 11, page 2 - *Crew continuity and competence, Training Needs Analysis - What, How, Why*; page3 - *Leadership and managerial skills*; page 6 - *Developing a Climate of Trust: the Human Face of Shipping*
- Issue No. 12, page 2 - *Negligent or incompetent? A need for due diligence*; page 3 - *A welfare for seafarers;* page 3 - *Towards safer ship operations and the economic viability of a company*
- Issue No. 13, centrespread - *Fatigue: Causes, effects and mitigation*
- Issue No.14, page 2 - *Culture and communication or the loneliness of modern ship's master*; page 3 - *Whose culture? The impact of language on safety and compliance at sea*
- Issue No. 16, page 1 *Rogue behaviour is not the hallmark of a professional mariner;* page 6 - *Routine should spring from the core;* page7 - *Seafarers as an investment- not a cost*
- Issue No.18, page 3 - *Regional Seafarers' Welfare Development Programmes*
- Issue No. 19, page 1 - *Let's get positive*; page 2 - *Life At Sea surveys;* page 6 - *Attracting Generations Y and M to seafaring*; page 7 - *True North values*
- Issue No. 20, page 6 - *Occupational standards for shore-based ship management*
- Issue No. 22, page 2 - *Essential skills for addressing human element issues in a shipping company;* page 7 - *Looking at the role of the human element in the safety of marine operations*
- Issue No. 23, page 3 - *An understanding of what makes human error less likely lies at the heart of loss prevention*; page 6 - *Managing the impact of the human element on risk*; page 7 *How much seafarer's worth?*
- Issue No. 25, page 2 - *What makes the ultimate Ship Manager?*
- Issue No. 26, page 2 - *Woven into Fabric*; page 2- *The ISM Code: just an overrated tool*; page 6 - *Safety culture and the human element;* page 7 - *Providing human element tools for seafarers and ship managers*

- Issue No. 27, page 2 - *The human elements are what they are, and they are what make us human*
- Issue No. 30, page 1 - *The people managers… looking after the company's most valued assets*
- Issue No. 31, page 6 - *Competence Management...vital in the pursuit to reduce the risk of human error*
- Issue No. 32, page 7 - *Crew endurance Management*
- Issue No. 33, page 8 - *Trainee induction*
- Issue No. 37, page 2 - *Introduction*

5.2 HUMAN FACTORS ENGINEERING

5.2.1 Habitability

- Comfort and habitability are of increasing concern; the quality of life to the seafarer is one of the keys to successful operations (**Alert!** Issue No.7, page2 - *A good design is one that exceeds the owner's expectations*). This is about having comfortable, clean (cleanable) and convivial accommodation, washing and toilet facilities, mess rooms, group meeting and exercise areas. The main goal is to provide a design that will enhance human performance, mental alertness, quality of life and crew recruiting (**Alert!** Issue No. 34, page 3 - *Crew habitability: what you need to know*, **Alert!** Issue No. 35, page 3 - *Taking a human centred approach*); this can be done by minimizing the effects of noise and vibration on the seafarer (**Alert!** Issue No. 18, page 2 – *A momentous milestone for the international shipping* industry). Decent quarters to live and rest in: crew bar, gym, IT equipment and game facilities (**Alert!** Issue No. 18, page 3 - *Regional seafarers' development programme*; Issue No. 19, page 7 - *True North Value*; Issue No.35, page 3 - *Taking a human-centred approach*). Different cultures will need different designs (**Alert!** Issue No. 24, page 1 - *The ultimate aim*; Issue No. 35, page 3 - *Taking a human-centred approach*).

- Decrease noise: insulation, noise absorbent flooring, large diameter propeller, shock absorbers engine and rubber suspension exhaust system (**Alert!** Issue No. 34, page 7 - *Less noise and vibration is good for the working environment*).

Related documents (these are important documents and should be studied carefully):

- *The International Maritime Labour Convention 2006* (MLC 2006). http://www.ilo.org/wcmsp5/groups/public/@ed_norm/@normes/documents/normativeinstrument/wcms_090250.pdf
- *Guidelines for implementing the occupational safety and health provisions of the Maritime Labour Convention, 2006.* http://www.ilo.org/wcmsp5/groups/public/---ed_dialogue/---sector/documents/normativeinstrument/wcms_325319.pdf

5.2.2 Manoeuvrability

The most appropriate manoeuvring capabilities. The ship will need good ship manoeuvrability (**Alert!** Issue No. 7, page 2 - *A 'good design 'is one that exceeds the owner's expectations*) and a good field of view (Issue No. 36, page 7 - *Increasing the safety of offshore operations through usability*).

Related papers:

- *Over the limit? Current issues in ship manoeuvring* (George Lang) http://www.he-alert.org/filemanager/root/site_assets/standalone_articles_not_linked_to_a_bulletin/HE00195.pdf).
- *Critical significance of Human Factors in Ship Design* (Thomas G. Dobie) http://www.he-alert.org/filemanager/root/site_assets/standalone_pdfs_0355-/HE00420.pdf

5.2.3 Maintainability

Operational maintenance task to be rapid, safe and effective to allow equipment and systems to achieve a specified level. Maintenance responsibilities starts from the top managers of the company who should be committed to direct efforts, resources and investment in order to ensure that their ships are properly maintained and operated by qualified competent crew. Poor maintenance increases risk of casualty, pollution and damage to property. (**Alert!** Issue No. 3, page 2 - *Shipboard Maintenance: a top management responsibility*)

The greater control achievable by automation allows engines and systems to remain within close desired operating parameters, thus reducing the need for maintenance. But an important management consideration should be how to manage without automation, so that in an emergency the ship's power can quickly be restored (Alert! Issue No. 15, page 3 - *A chief engineer's perspective*).

More on Ergonomics and maintainability:

- **Alert!** Issue No. 15, page 3 - *A chief engineer's perspective*
- **Alert!** Issue No. 35 centrespread - *Ergonomics and maintainability: a rough guide*
- *Human factors guidance for maintenance* (D. J Pennie, N. Brook-Carter, W.H Gibson) http://www.he-alert.org/filemanager/root/site_assets/standalone_article_pdfs_0605-/HE00630.pdf

5.2.4 Workability

Ensuring ships and systems are appropriate for the proposed work situation (context of use).

- Need a way of fitting in trained staff otherwise automation just for the sake of saving cost is an accident waiting to happen. More on automation in **Alert!** Issue No. 15 centrespread – *Automation: Trust and Dependability*; Issue No. 15, page 1 - *Let's be clear about automation*
- Demonstration of usability requirements for all significant aspects of operations and maintenance (Addressing the Human element – ship and equipment design)
- Stakeholders are not working together to ensure master and crew have right tools in place (**Alert!** Issue No. 2, page 6 - *Port State Control and the ISM Code*).
- Strong focus in design and optimal technical solutions and on ergonomic solutions during building phase is fundamental in prevention of future accidents (**Alert!** Issue No. 3, page 2 - *Human error: a fragile chain of contributing elements*).
- Risk factors: temperature, motion, vibration intensity of lighting (**Alert!** Issue No. 4, page 3 - *Crew Endurance Management: Extending Beyond Fatigue*);
- User requirements are derived from human factors data considered context of a particular ship its manning, outfitting and operation (A**lert!** Issue No. 7, page 5 - *A human-centred approach to ship and system design*).

- Have an operating manual standard easy to understand operating instructions for all micro processes controlled equipment (**Alert!** Issue No. 2, page 3 - C*racking the code*; Issue No. 15, page 1 - *Let's be clear about automation*).
- Simplicity of operation and ease of maintenance (**Alert!** Issue No. 24, page 7 - *Factoring in the human element in the design of ships*).
- From a Human Systems Integration (HIS) perspective major concern is to maximize human performance and minimize human performance risk to established deficiencies in any one or more of the constituents of human performance including: human capability, human proficiency, human availability, human utilization, human accommodation, human health and safety, human survivability (A**lert!** Issue No. 24, page 3 - *Adopting a Human System Integration approach to design*).
- Navigation systems need to be simple to understand (**Alert!** Issue No.24, page 7 - *Factoring in the human element in the design of ships*).

5.2.5 Controllability

Integrating people with equipment, systems and interfaces.

- Requirement of relevant standards for electronic displays of chart, radar, bridge system, displays. Being harmonized: same colour, symbol, terms, abbreviation, unit and controls. Trying to reduce number of screens. (A**lert!** Issue No.1, page 6 - *The International Maritime Organization and the Human element*)
- Integrated bridge/navigation systems (**Alert!** Issue No. 21 page 3 - *Information Management a shipmaster's perspective*)
- Computers are good but a constant stream of alarms can prove a great distraction and have potential to generate extremely hazardous situations (**Alert!** Issue No. 2, page 3 - *Improving the Application of the Collision Regulations*; Issue No. 7, page 3 - *The role of the International Organization for Standardization in relation to Ships and Marine Technology*)

5.2.6 Survivability

Adequate firefighting, damage control, lifesaving and security facilities to ensure the safety and security of crew, visitors and passengers. Also the desired human performance for detection, response, evacuation, survival and rescue in emergencies, and the interface with emergency procedures, systems, facilities and equipment.

- Need to be able to manage without automation, so that in an emergency ship's power can be quickly restored by manua intervention (**Alert!** Issue No. 15, page 2 - *A Chief engineer's perspective*)
- *Survivability – Conventions, Codes and Guides* http://www.he-alert.org/filemanager/root/site_assets/standalone_article_pdfs_1220-/he01300.pdf

5.2.7 Occupational Health and Safety

The effect of work, the working environment and living conditions on the health, safety and wellbeing of the person and considering conditions inherent in the operation, use and maintenance of the ship or its system which can cause death, injury, illness, disability or reduce human performance.

- Close involvement with stakeholders; ship to be 'safe for purpose' (**Alert!** Issue No. 1 page 1 - *Improving the awareness of the Human Element in the Maritime industry*)
- Master and crew to be provided with proper tools (**Alert!** Issue No. 1, page 1 - *Improving the awareness of the Human Element in the Maritime industry*)
- **Alert!** Issue No. 17 centrespread - *Mitigating slip, trip and fall hazards*

More on occupation health and Safety in:

- **Alert!** Issue No. 38 centrespread - *Exploring Occupational Health and Safety*

5.2.8 System Safety

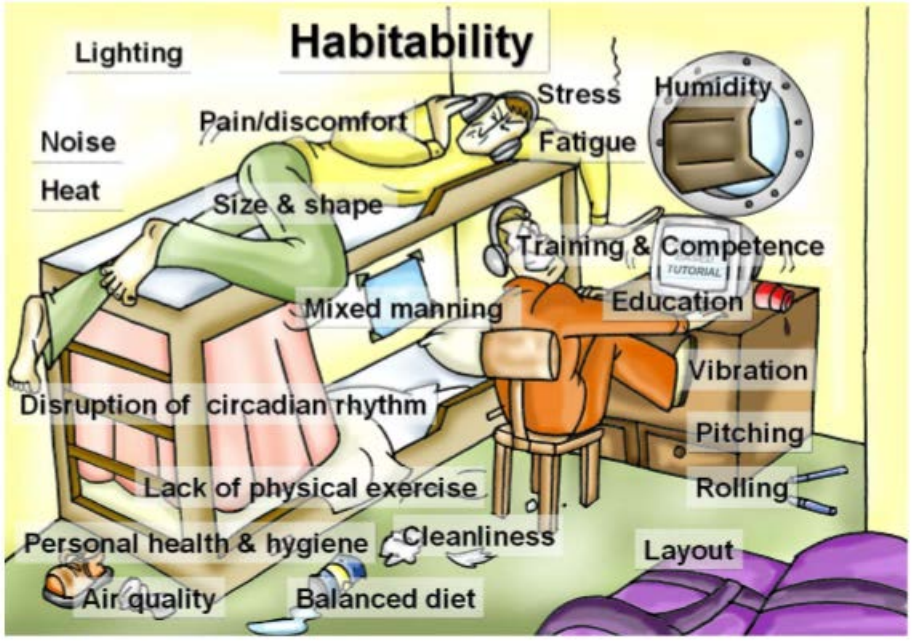
The risks from people using (or misusing) the system

- Off the shelf systems may not fit the purpose (A**lert!** Issue No. 2, page 3 - *Cracking the Code*)
- Need for Automation to be verified by observing what is actually happening against what should be happening. (A**lert!** Issue No. 15, page 3 - *A Chief engineer's perspective*)

More can be found in *ATOMOS II Conceptual Standard for SCC Design (including HM*I), page 27. http://www.he-alert.org/filemanager/root/site_assets/standalone_pdfs_0355-/HE00450.pdf

6 EXAMPLES

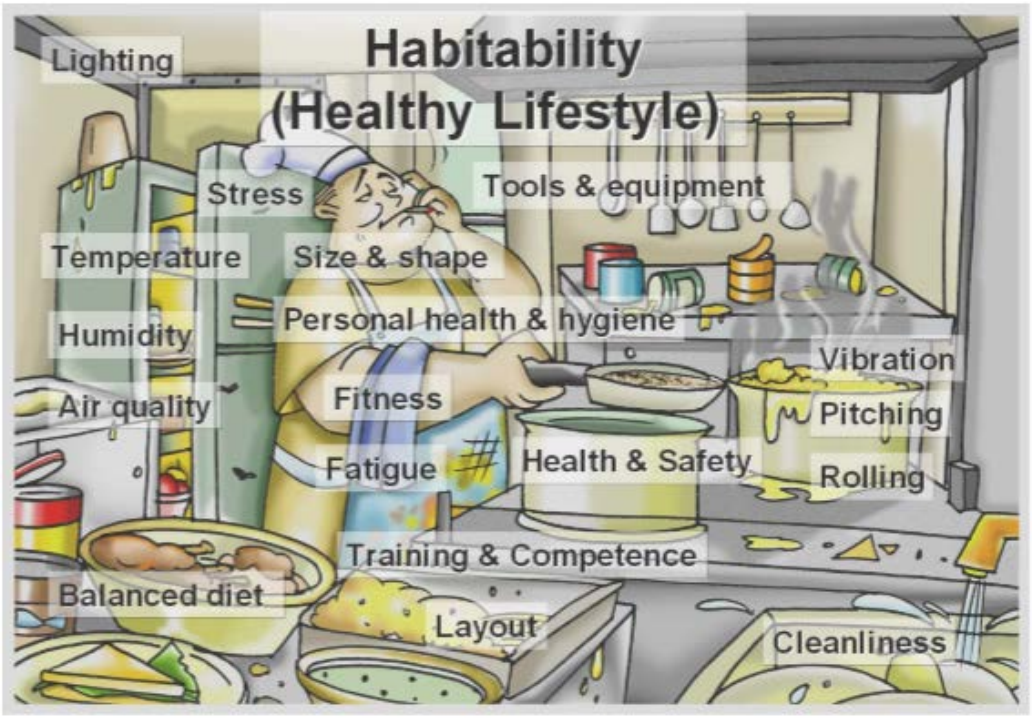
The series of cartoons below show some scenarios from on board a ship.



This cartoon is an example of habitability there is two crew members sharing a cabin the problems with this our:

- a small cabin
- close to the noise and heat of the engine room
- the cabin is susceptible to vibration
- ship is pitching and rolling heavily
- One of them is from northern Europe and the other is Asian. The ship has been designed and built in the Far East. The European is trying to sleep in a bunk that is clearly too short for him and he is being tossed around by the ship movement.
- The other is attempting to study using the computer at the desk, while trying to overcome the vibration and pitching and rolling – he is keen to advance his training, competence and education.
- Both are wearing ear defenders to reduce the noise.
- The cabin is hot and humid and, despite the wind chute, there is little air circulating around the cabin – the air conditioning is not working due to poor maintenance.
- There is no evidence of any proper maintenance routines around the ship, but the Port State Control inspectors haven't yet picked this up.
- The ship managers have not seen fit to provide curtains for the top bunk, nor for the porthole, nor have they provided a carpet.
- The cabin is lit by a single fluorescent tube, with no diffuser – there are no bunk or desk lights.
- The desk is too close to the bunk and the bunk is placed athwart ships rather than fore and aft which suggests that layout has not been properly considered.

- Weekly rounds by the master are not conducted, which is evident by the untidiness and the lack of cleanliness in the cabin, which has an effect on the air quality and on the personal hygiene of the occupants.
- The 'sleeping' man is clearly suffering some pain and discomfort and is stressed.
- Both crew members are watch keepers, which affects their circadian rhythm; they are too tired to bother about physical exercise
- The food onboard is not conducive to a healthy lifestyle.
- In short, their health, safety and overall performance are severely compromised.



This cartoon show a cook – who is overweight, unhealthy, unclean, and unfit. The problems here are:

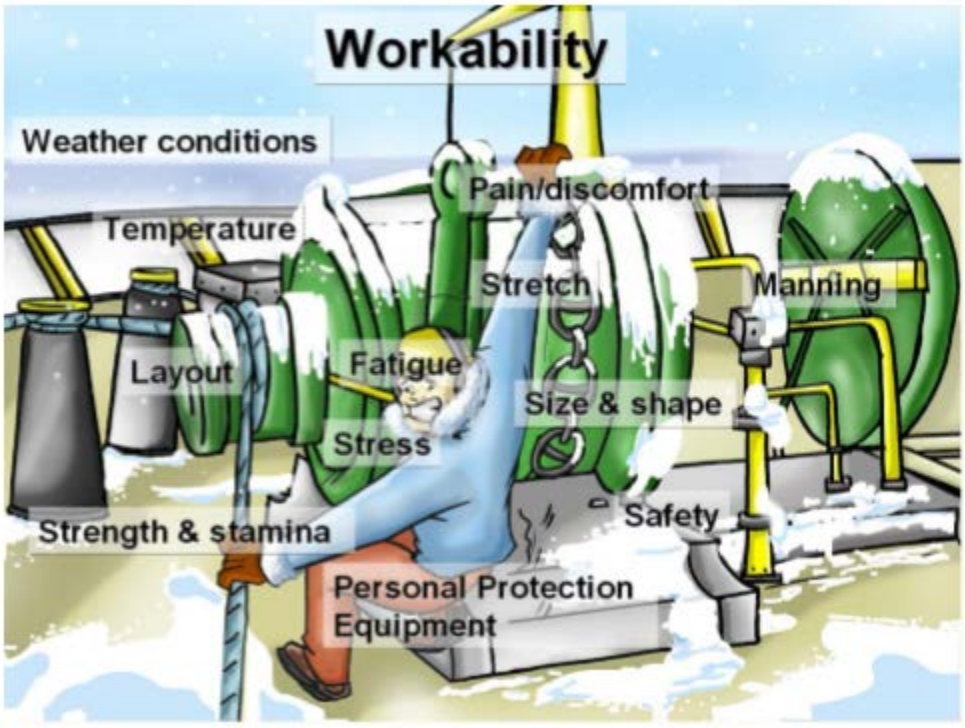
- He is neither complying with health and safety rules nor with the company's policy on smoking.
- The cleanliness of the galley itself is questionable and there is far too much raw food lying around, which creates a health hazard.
- The cook is preparing a 'fry-up' for the evening meal and is not aware of the importance of a balanced diet.
- His budget is barely sufficient to properly feed the crew.
- He has to contend with ship vibration, pitching and rolling,
- There is high temperatures, and poor humidity and air quality, because the air conditioning is not working, but also because the filters on the galley extractor fans are blocked.
- The galley itself is poorly lit and, to say the least, compact and badly laid out, with insufficient and inadequate safety guards.

- The cook is fatigued - because he has been unable to sleep properly, due to the heat and the motion of the ship – and is stressed because of all the complaints about the standard of the food that he prepares for his ungrateful colleagues

This shows an engine room with two engineers of North European descent the problems here are:

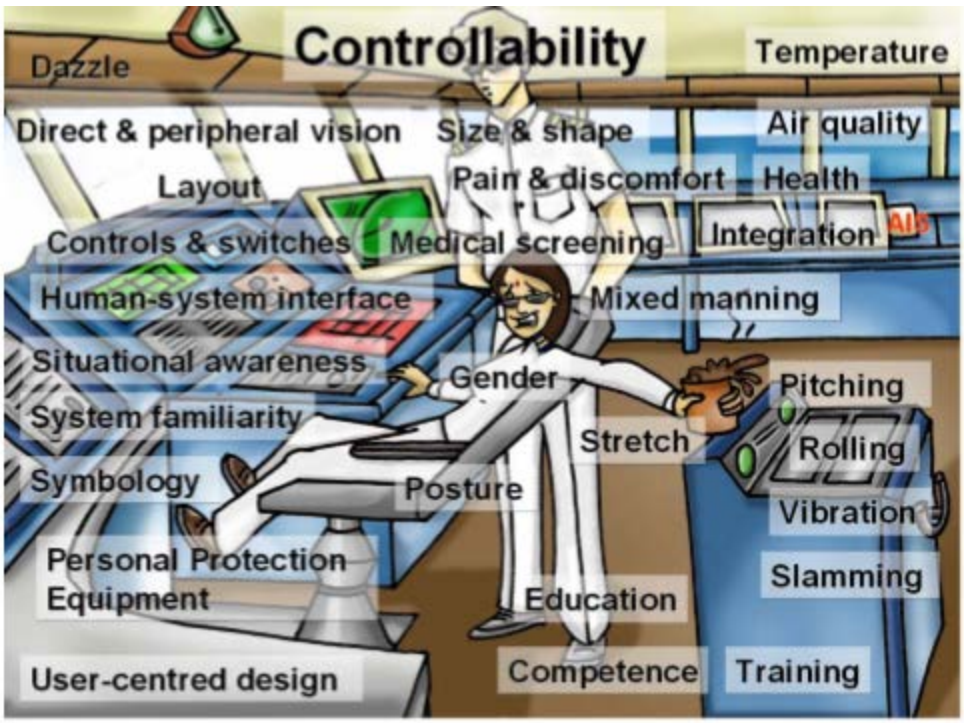
- This is a dark, hot, humid and noisy engine room space.
- Where the smell of heavy fuel oil pervades.
- Installed illumination is dim, and working illumination comes from a single portable light taped to a piece of piping
- One of the workers is working on a pipeline; although he is very tall,
    - The pipe is inaccessible such that he has to stand on an upturned drum
    - He has to stretch to reach it.
    - He is obviously not aware of safe working practices which would require him to use the proper tools and equipment for the job.
    - He has also to counter the effects of ship vibration, rolling and pitching.
    - These conditions have an effect on his posture, which is causing him some pain and discomfort.
- The other is trying to remove a piece of equipment that is too heavy and the task is testing his strength and stamina.
- The machinery space layout is poor, and little consideration has been given to removal routes.
- Oil and trailing wires are creating tripping and cleanliness hazards.
- Both are wearing the correct personal protection equipment.
- One is wearing his safety helmet back to front.
- One ear defender clear of his ear, trying to listen to what the other is saying.
- The noise is making communication very difficult.

- Both are sweating profusely (unsuitable clothing); they are fatigued and stressed.



This cartoon shows a single Asian crew member is on the fo'c's'le tending the windlass at the same time as he is taking in a tug's line. It is very wet and cold with a wind chill factor that makes for freezing conditions. The problems are:

- He needs to be well protected against the weather but while his gloves may protect him from frostbite they are not suitable for tending lines.
- The windlass is bigger than him, and he has to stretch to his limits to carry out the two tasks, which is a test of his strength and stamina.
- It has been a long standby and he is numb with cold, tired and stressed, and in need of a hot drink
- No obvious assistance or means of communcation.



This cartoon shows a state of the art ship control centre comprising of an Integrated Bridge System (IBS). While it seems that some attention has been given to the layout of the IBS (by the equipment manufacturer) there has been no user input to the design of the bridge space itself. The Master is British - at 6'5" (1981 millimetres) he has problems of:

- He is taller than average, and he has a permanent stoop which gives him some pain and discomfort. He has been suffering in silence for many years, but has always managed to get through his medical examination.
- He is one of the 'old school' having served for 40 years at sea, 20 of them as Master. He has spent the last few years in command of the company's older ships and it is only through the long term sickness of the resident Master that has caused him to do a pier-head jump to this state of the art ship.
- Hitherto, he has struggled to keep up with the technology – give him a sextant, a chronometer, the ARPA radar, a gyro compass and paper charts, together with competent officers of the watch, and he will be happy. GPS is alright, as long as he can switch it off occasionally just to test the basic navigational skills of the watch keepers.

The officer of the watch is a young lady from Southern India, who is on her first trip as third mate. She is well qualified with a good degree in nautical science and she holds the appropriate STCW qualification for an officer in charge of a navigational watch. She has been using computers since she was a young child and considers herself to be computer literate and is well up to date with the latest developments in information technology. Her problems are:

- However, she belongs to a generation of mariners that is being brought up to rely on technology to solve problems without having to think for themselves. She has become so

absorbed in technology that her awareness of the situation around her is nearly always confined to the display rather than looking out of the window.

- She has not previously sailed in a ship with an Integrated Bridge System, but has worked with one in the college simulator, as part of her Bridge Resource Management Training. However, she is not familiar with this particular system and notes that the various switches and controls are different from those found on the IBS in the college simulator.
- She has no experience of the new Automatic Identification System which has recently been fitted as an 'add-on', using something called the 'MKD', and she notes that the symbology on this small box of tricks is different from that on the ARPA.
- She hasn't had time to read the various manufacturers' handbooks but her predecessor, who had been with the ship since build, spent a couple of hours explaining it all to her.
- She is sat in her chair which is clearly too big for her; it is tilted back too far and her legs are dangling because someone has removed the footrest.
- While she can see all the displays and just reach the various controls, by leaning forward and stretching her arms, she can only see out of the window by standing up.
- She is holding a mug of tea in one hand, with her arm outstretched trying to find a place to put it down safely, and can only find the top of the steering console. The contents of the mug are splashing onto the console, because the sea conditions are causing the ship to pitch, roll, vibrate and slam.

Both the Master and the watch keeper are wearing sunglasses to protect them from the dazzle of the sun the problem of this is:

- Which makes it difficult for them to see the various displays clearly.
- The Master's view ahead is good but the beam of the ship is such that his peripheral vision is poor.

The working environment, however, is good – the temperature is well controlled by the air conditioning and the air quality is satisfactory, not least because of the company policy which bans smoking on the night, the array of lights, the glare from the screens and their various reflections are affecting their bridge.

At night it has been a busy four hours for the Officer of the Watch; she has only recently returned to sea after her time at college her problems are:

- She has not yet fully settled into the routine of watch keeping
- She didn't sleep well before she came on watch because of the ship motion and the disruption to her normal pattern of sleeping.
- She is tired and stressed having just completed a transit of the Malacca Strait, in poor visibility.

The Master is totally bemused by all this new technology. The problem with this is:

- His attention is diverted from one system to another and he wishes that he could have all the displays consolidated into one;
- He is frustrated at the number of alarms that keep going off. He is tired and stressed, having just spent the night on the bridge.

- He is relieved that he has completed a transit of the Malacca Strait without being attacked by pirates and is thankful for the International Chamber of Shipping's Guidance on the Protection of Ships from Terrorism and Sabotage.

7 IMPLEMENTATION

The implementation of human centred design can prove more difficult than first thought; this is due to a number of reasons. Many accidents in the marine industry are blamed on the personnel whose actions ultimately triggered the incident or accident. The root cause, such as a hard operating system or an unrested crew due to inadequate living conditions, will not necessarily be investigated. Human capabilities and limitations cannot be directly altered. However, the environment and living conditions can be. The human error is part of a system; not just the end user. Everyone involved in implementation and design of the system could be involved in causing the error. The mind set of those working in the marine industry needs to be changed to believe the error isn't caused by the end user alone. However, as this remains an ambiguous concept, it can be very difficult to change the mind-set of those whom are influential in the industry. (Alert 26 pg.3 *Changing mind set*)

Another reason that implementing human-centred design is hard is because of lack of regulations and underinvestment. Trying to get regulations passed on human-centred design is difficult due to many people not wanting it and, furthermore, failing in understanding the importance of this issue. One of the reasons ship owners do not want to implement human-centred design is due to financial implications that the implementation comes with: increased up front cost and some benefits of the investment (e.g. safety, morale, retention) will not be shown in the profit and loss account. Ship owners, understandably, will seek to optimise both finances and timescale when constructing their product – 'investing' in the human element will likely cost the owner more and will be more time consuming, neither will be seen as a benefit. Naval architects already have a large work load when it comes to design, they will not want to increase this. This may mean that the ship yard will have to employ more staff (probably consultants) to deal with the extra work.

However, there will be some ship owners who will see the benefit in funding human-centred design, and will invest to provide a better environment for their crew in order to reduce the amount of accidents occurring at sea which, essentially, could save firms money from cost of repairing and days unable to trade, as well as through-life cost from increased efficiency.

A good document from Lloyd's Register on implementing the human element is: http://www.webstore.lr.org/products/716-the-human-centred-approach-a-best-practice-guide-for-ship-designers.aspx

8 REGULATIONS

Alert! Issue No.10 centrespread - *The human face of regulation: Good intentions and human nature*

Alert! Issue No. 22 centrespread - Human element knowledge & skills framework: Regulation, Administration & Management

The ISM Code versus the STCW Convention (Jan Horck) http://www.he-alert.org/filemanager/root/site_assets/standalone_article_pdfs_0605-/he00720.pdf

The Human-Centred Design Forum - Regulation 15 on bridge design http://www.he-alert.org/filemanager/root/site_assets/standalone_pdfs_0355-/HE00390.pdf

Best practice for addressing human element issues in the shipping industry (J. Earthy, B. Sherwood Jones), Section 3 - *Standards for ergonomic and human centred design* http://www.he-alert.org/filemanager/root/site_assets/standalone_article_pdfs_0905-/he00940.pdf

Human Element Recommendations for structural design of lighting, ventilation, vibration, noise, access and egress arrangements.
http://www.iacs.org.uk/vdguidelinesandrecommendations/Rec._No._132_pdf2241.pdf

This link shows the Maritime Labour code of practise this has regulations on seafarers rights: min working age, max working hours, food, size of room, heating, noise and vibration, sanitary facilities, lighting and hospital.

http://www.ilo.org/wcmsp5/groups/public/@ed_norm/@normes/documents/normativeinstrument/wcms_090250.pdf

In the appendix there is a list of the human element-related IMO circulars, resolutions and voluntary codes which we believe are most useful to the industry. Statutory regulations are excluded, but many of the publications are related to understanding or implementing particular regulations. Others are more widely applicable.

The ABS suite of human element guides and guidance notes. All documents can be downloaded from www.eagle.org.

- Guidance Notes for the Application of Ergonomics to Marine Systems (2013). Updated during 2012, to be republished in the first quarter of 2013. Publication # 86
- Guidance Notes on Ergonomic Design of Navigation Bridges (2003.) Publication # 119
- Guidance Notes on Safety Culture and Leading Indicators of Safety (2012.) Publication # 188
- Guidance Notes on the Investigation of Marine Incidents (2005). Publication # 142
- Guide for Compliance with the ILO Maritime Labour Convention, (2006). Title 3 Requirements. Offers one notation. Publication # 166
- Guide for Crew Habitability on Mobile Offshore Drilling Units (MODUs) (2012). Offers three notations. Publication # 190
- Guide for Crew Habitability on Offshore Installations (2012). Offers three notations. Publication # 105
- Guide for Crew Habitability on Ships (2012). Offers three notations. Publication # 102
- Guide for Crew Habitability on Workboats (2012). Offers three notations. Publication # 163
- Guide for Ergonomic Notations (2013). Offers four notations. Publication # 201
- Guide for Means of Access to Tanks and Holds for Inspection (2007). Offers two notations. Publication # 154
- Guide for Passenger Comfort on Ships (2001). Offers two notations. Publication # 103

- Guide for the Class Notation Comfort – YACHT (COMF(Y)) AND COMFORT PLUS – YACHT (COMF+(Y)) (2008). Offers two notations. Publication # 162
- Guidance Notes on Vibration and Noise Control (in preparation)
- Guidance Notes on the Application of Ergonomics to Marine Engineering Spaces (in preparation)
- Guidance Notes for the Development of Procedures and Technical Manuals. (in preparation)
- Guidance Notes on the Implementation of Human factors engineering into the Design of Offshore Installations. (in preparation)

9 TOOLS

Alert! Issue No. 36 centrespread - *Ergonomic criteria for control room equipment and layout: A checklist*

Checklist for considering human element issues by IMO bodies http://www.imo.org/en/OurWork/HumanElement/TrainingCertification/Documents/MSC-MEPC7%20Circulars/1.pdf

The need for Human Factors Engineering skills (Gerry Miller) http://www.he-alert.org/filemanager/root/site_assets/standalone_article_pdfs_0905-/he01010.pdf

High speed craft human factors engineering design guide http://www.he-alert.org/filemanager/root/site_assets/standalone_article_pdfs_0605-/he00750.pdf

Nautical institute has written a book that has been prepared to assist with the feedback from the user and is based upon a survey of the institutes membership and solutions advocated by experienced practitioners. The boos is called Improving Ship Operation Design and is available from online book store,

9.1 DESIGNING AREAS

- Ship Control Centre - *ATOMOS II Conceptual Standard for SCC Design (including HMI)* page 31 http://www.he-alert.org/filemanager/root/site_assets/standalone_pdfs_0355-/HE00450.pdf
- Work station design – *ATOMOS II Conceptual Standard for SCC Design (including HMI)* page 34
- http://www.he-alert.org/filemanager/root/site_assets/standalone_pdfs_0355-/HE00450.pdf
- Human machine interface - *ATOMOS II Conceptual Standard for SCC Design (including HMI)* page 35 http://www.he-alert.org/filemanager/root/site_assets/standalone_pdfs_0355-/HE00450.pdf
- Machinery spaces for merchant ships - *Designing efficient and safe machinery spaces for Merchant ships: a human factors approach* (Nicolas. J. Méry & Jonathan McGregor) http://www.he-alert.org/filemanager/root/site_assets/standalone_article_pdfs_1220-/he01245.pdf
- Alarm systems – *Improving the design and management of alarm systems* (B. Sherwood Jones, J.V. Earthy, Ed Fort, Duncan Gould) http://www.he-alert.org/filemanager/root/site_assets/standalone_pdfs_0355-/HE00550.pdf
- Maintenance manuals - *Marine operating & maintenance manuals: are they good enough?* (CHIRP) http://www.he-alert.org/filemanager/root/site_assets/standalone_pdfs_0355-/HE00600.pdf
- Engine room guidance http://www.imo.org/blast/blastDataHelper.asp?data_id=8819

9.2 RESOURCE BASE CYCLADES

The CyClaDes project is designed to promote the increased impact of the human element in shipping across the design and operational lifecycle. The project brings together a multi-disciplinary team to focus on all the key steps in the lifecycle; the stakeholders; where the barriers to human element integration occur; and how to best locate, produce, disseminate, and apply human element knowledge within the overall context of shipping. The advantage is realized by supporting the integration of the human element in the design and operational life-cycle from appreciation, to concept, to design, to application, to evaluation and approval, to maintenance. The outcome will directly address pressing needs identified in the shipping industry and specifically by this call.

The background is at http://www.cyclades-project.eu/CyClaDes/background

Further documents can be found at http://www.cyclades-project.eu/CyClaDes/documents

10 REFERENCES

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11 APPENDIX

11.1 TABLE OF LINKS

Alert issues	http://www.he-alert.org/en/all-issues.cfm
Human element	
Lloyds introduction	http://www.he-alert.org/filemanager/root/site_assets/standalone_article_pdfs_0605-/he00740.pdf
Paper best practice addressing Human element	http://www.he-alert.org/filemanager/root/site_assets/standalone_article_pdfs_0905-/he00940.pdf
Human centred Design	
User feedback in ship design	http://www.he-alert.org/filemanager/root/site_assets/standalone_article_pdfs_0605-/HE00625.pdf
Video commercial of life at sea	http://gcaptain.com/this-might-be-the-best-maritime-commercial-ever/#.VcB5l_lViko.
Interview of a seafarer	https://www.youtube.com/watch?v=85uO5gbi5oU
Chirp	https://www.chirp.co.uk/newsletters/maritime
Integration of the user perspective into bridge design	http://www.he-alert.org/filemanager/root/site_assets/standalone_article_pdfs_1220-/he01260.pdf
Lloyds register human-centred approach	http://www.webstore.lr.org/products/716-the-human-centred-approach-a-best-practice-guide-for-ship-designers.aspx
Human centred flow chart pg.19	http://www.he-alert.org/filemanager/root/site_assets/standalone_pdfs_0355-/HE00450.pdf
A guide to designing usable ships	http://www.he-alert.org/filemanager/root/site_assets/standalone_pdfs_0355-/HE00360.pdf
Human factor integration	
A rough guide to	http://www.he-

interpretation of safe manning	alert.org/filemanager/root/site_assets/standalone_article_pdfs_0905-/he01125.pdf
Mental health of seafarers	http://www.he-alert.org/filemanager/root/site_assets/standalone_article_pdfs_1220-/he01320.pdf http://faros-project.eu/pub_docs_1.html
A mariners guide on human element	http://www.he-alert.org/filemanager/root/site_assets/standalone_article_pdfs_0605-/he00730.pdf
Current issue on ship manoeuvring	http://www.he-alert.org/filemanager/root/site_assets/standalone_articles_not_linked_to_a_bulletin/HE00195.pdf
Critical significance of human factors	http://www.he-alert.org/filemanager/root/site_assets/standalone_pdfs_0355-/HE00420.pdf
Human factors guidance for maintenance	http://www.he-alert.org/filemanager/root/site_assets/standalone_article_pdfs_0605-/HE00630.pdf
Survivability-convention, codes and guides	http://www.he-alert.org/filemanager/root/site_assets/standalone_article_pdfs_1220-/he01300.pdf
System safety pg.27	http://www.he-alert.org/filemanager/root/site_assets/standalone_pdfs_0355-/HE00450.pdf
Regulations	
ISM vs STCW Convention	http://www.he-alert.org/filemanager/root/site_assets/standalone_article_pdfs_0605-/he00720.pdf
Regulation 15 on bridge design pg.72	http://www.he-alert.org/filemanager/root/site_assets/standalone_pdfs_0355-/HE00390.pdf
Standards for ergonomic and human centred design	http://www.he-alert.org/filemanager/root/site_assets/standalone_article_pdfs_0905-/he00940.pdf
ABS suite of human element	www.eagle.org.

guides	
Iacs rec 132	http://www.iacs.org.uk/vdguidelinesandrecommendations/Rec._No._132_pdf2241.pdf
Maritime labor code of practice	http://www.ilo.org/wcmsp5/groups/public/@ed_norm/@normes/documents/normativeinstrument/wcms_090250.pdf
Tools	
Check list for considering human element issues IMO body	http://www.imo.org/en/OurWork/HumanElement/TrainingCertification/Documents/MSC-MEPC7%20Circulars/1.pdf
Checklist for how human element should be used	http://www.he-alert.org/filemanager/root/site_assets/standalone_article_pdfs_0905-/he01010.pdf
High speed crafts human factors engineering design guide	http://www.he-alert.org/filemanager/root/site_assets/standalone_article_pdfs_0605-/he00750.pdf
System control centre pg.31	http://www.he-alert.org/filemanager/root/site_assets/standalone_pdfs_0355-/HE00450.pdf
Work station pg.34	http://www.he-alert.org/filemanager/root/site_assets/standalone_pdfs_0355-/HE00450.pdf
Human machine interface pg.35	http://www.he-alert.org/filemanager/root/site_assets/standalone_pdfs_0355-/HE00450.pdf
Machinery spaces for merchant ship	http://www.he-alert.org/filemanager/root/site_assets/standalone_article_pdfs_1220-/he01245.pdf
Alarm systems	http://www.he-alert.org/filemanager/root/site_assets/standalone_pdfs_0355-/HE00550.pdf
Maintenance manuals	http://www.he-alert.org/filemanager/root/site_assets/standalone_pdfs_0355-/HE00600.pdf
Navigation symbols	http://www.he-alert.org/filemanager/root/site_assets/standalone_pdfs_0355-/HE00435.pdf
Engine room guidance	http://www.imo.org/blast/blastDataHelper.asp?data_id=8819
Cyclades	http://www.cyclades-project.eu/CyClaDes/documents http://www.cyclades-project.eu/CyClaDes/background

11.2 HUMAN ELEMENT CIRCULAR

Human element publications from the IMO

Circulars, resolutions and voluntary codes of relevance to the marine industry

Successful management of human element risks requires action at all stages in the lifecycle of a vessel and its systems.

There is a lot of human element guidance available to the industry, much of which is published by the IMO. However, many of the people or organisations that could put this to use and receive the most benefit may not be aware of the variety of publications which exists.

This list the human element-related IMO circulars, resolutions and voluntary codes which we believe are most useful to the industry. Statutory regulations are excluded, but many of the publications are related to understanding or implementing particular regulations. Others are more widely applicable.

MSC-MEPC.3/ Circ 1	Casualty-related matters: Reports on marine casualties and incidents	2005	Annexes suggest some human element considerations which can help to guide investigations
STCW.7/Circ 14	Guidance for masters on keeping a safe anchor watch	2004	Brief suggestion of considerations to support decisions
Res A.960(23)	Recommendations on training and certification and on operational procedures for maritime pilots other than deep-sea pilots	2004	Includes information for masters and bridge teams on working and communicating with pilots
MSC/Circ 1061	Guidance for the operational use of integrated bridge systems (IBS)	2003	Guidance on system functions to support competence development
Res A.954(23)	Proper use of VHF channels at sea	2003	Guidelines on communication technique and procedures
Res A.918(22)	IMO standard marine communication phrases	2002	Covers a comprehensive range of topics
MSC/Circ 1014	Guidance on fatigue mitigation and management	2001	Guidelines with 'modules' for different stakeholders

STCW.7/Circ 10	Interim guidance on training and assessment in the operational use of the Electronic Chart Display and Information System (ECDIS) simulators	2001	"Interim" but still latest.
Res A.917(22)	Guidelines for the onboard operational use of shipborne Automatic Identification Systems (AIS)	2001	Guidelines "to inform the mariner" about operational use and limits of AIS
Res A.890(21)	Principles of safe manning	2000	Principles for determining the minimum safe manning level. As amended by A.955(23), 2004
Res A.891(21)	Recommendations on training of personnel on mobile offshore units (MOUs)	2000	Recommended training standards and information on emergency drills
Res A.893(21)	Guidelines for voyage planning	2000	Guidance for appraisal, planning, execution and monitoring
MSC/Circ 853	Guidance on shipboard assessments of proficiency	1998	Guidance for formal assessment of competence based on in-service experience on board ship
Res A.852(20)	Guidelines for a structure of an integrated system of contingency planning for shipboard emergencies	1997	Produced to support introduction of ISM, but still useful for new SMS development or review of existing SMS
Res A.865(20)	Minimum training requirements for personnel nominated to assist passengers in emergency situations on passenger ships	1997	Replaces A.770(18) from 1993. See also MSC/Circ 735
Res A.864(20)	Recommendations for entering enclosed spaces aboard ships	1997	Recommended safety procedures. Includes example of entry permit
MSC/Circ 621	Guidelines for the investigation of accidents where fatigue may have been a contributing factor	1993	Factors affecting fatigue and questions for investigating accidents
Res A.771(18)	Training requirements for crews of fast rescue boats	1993	Brief overview of theoretical and practical considerations

Design and build			
SN Circ 288	Guidelines for bridge equipment and systems, their arrangement and integration (BES)	2010	Updated guidelines, superseding Res MSC 64(67)
Res A.1021(26)	Code on alerts and indicators, 2009	2010	Replaces Res A.830(19) Code on alarms and indicators [note name change]
MSC.1/Circ 1263	Revised recommendation on safety of personnel during container securing operations	2008	Outline of the risks and brief suggestions for design solutions. Supersedes MSC/Circ 886
Res MSC 252(83)	Adoption of the revised performance standards for integrated navigation systems (INS)	2007	See also Res MSC 86(70) for different installation dates
SN.1/Circ 265	Guidelines on the application of SOLAS Regulation V/15 to INS, IBS and bridge design	2007	Guidelines for the system and its component equipment to meet user needs
MSC-MEPC.7/ Circ 3	Framework for consideration of ergonomics and work environment	2006	Shows IMO's priority areas for action which reflect identified high risks
SN Circ 243	Guidelines for the presentation of navigation-related symbols, terms and abbreviations	2005	Guidance to support harmonised and consistent presentation of information to users
Res MSC 191(79)	Performance standards for the presentation of navigation-related information on shipborne navigational displays	2004	Standards for consistent presentation and human-machine interface philosophy
Res A.952(23)	Graphical symbols for shipboard fire control plans	2003	Symbols for structural fire protection, fire-protection appliances and means of escape and escape-related devices
MSC/Circ 1091	Issues to be considered when introducing new technology on board ship	2003	Description of considerations for seafarers interacting with technology and associated training needs
Res MSC 128(75)	Performance standards for a Bridge Navigational Watch Alarm System (BNWAS)	2002	Includes operational requirements, ergonomic criteria, design and installation, and interfacing

MSC/Circ 982	Guidelines on ergonomic criteria for bridge equipment and layout	2000	Guidelines for user-centred design of the bridge and its equipment
MSC/Circ 888	Preventing falls at corrugated bulkheads in general cargo ships	1999	Short list at annex of suggested methods to protect people working near corrugated bulkheads
Res A.889(21)	Pilot transfer arrangements	1999	Guidelines for pilot ladders, accommodation ladders used with pilot ladders, and mechanical pilot hoists
MSC/Circ 834	Guidelines for engine room layout, design and arrangement	1998	Guidelines to reduce risks to users and support performance including coordinated emergency response
Res MSC 86(70)	Adoption of new and amended performance standards for navigational equipment	1998	Integrated navigation system (INS) performance standard at Annex 3. See also Res MSC 252(83) for different installation dates
MSC/Circ 734	Interpretations of phrases on human performance criteria in SOLAS Chapter II-1	1996	Usable definitions of phrases such as "readily accessible" and "clearly audible"
MSC/Circ 686	Guidelines on the means of access to structures for inspection and maintenance of oil tankers and bulk carriers	1995	Guidance on access to allow safe and practical examinations of tanks, cargo holds and double hull spaces
Res A.760(18)	Symbols related to life-saving appliances and arrangements	1993	Illustrations of standard symbols for emergency equipment, escape routes and muster and embarkation stations
Res A.757(18)	Standards for the calculation of the width of stairways forming means of escape on passenger ships	1993	Standards to enable the timely flow of passengers and crewmembers to muster stations
Res A.694(17)	General requirements for shipborne radio equipment forming part of the Global Maritime Distress and Safety System (GMDSS) and for electronic navigational aids	1991	Design considerations taking account of the needs of operators and maintainers
Operations and design and build			

Res A.1024(26)	Guidelines for ships operating in polar waters	2010	Detailed guidance for operational and design considerations. See also MSC/Circ 1056-MEPC/Circ 399 for Arctic ice-covered waters
MSC.1/Circ 1253	Shipboard technical operating and maintenance manuals	2007	Brief description of considerations for language and diagrams, and reference to IACS Recommendation No.71 as a useful model
MSC-MEPC.7/ Circ 1	Checklist for considering human element issues by IMO bodies	2006	Produced for IMO's use but the checklist at annex can be more widely applied for evaluating changes or solutions.
MSC-MEPC.7/ Circ 4	The Organization's strategy to address the human element	2006	Produced for IMO's use but the appendix illustrates priority areas for action and therefore suggests likely future output of IMO
MSC 79/23 Annex 39	Voluntary guidelines for the design, construction and equipment of small fishing vessels, 2005	2005	Produced for small fishing vessels but some principles can be applied to larger vessels. See especially chapters 6 and 11.
Res A.947(23)	Human element vision, principles and goals for the Organization	2004	Produced for IMO's use but contains valuable guiding statements for the industry and a wide-ranging definition in Principles section
MSC/Circ 1056 / MEPC/Circ 399	Guidelines for ships operating in Arctic ice-covered waters	2002	Detailed guidance for operational and design considerations. See also Res A.1024(26) for polar waters
STCW.7/Circ 13	Issues to be considered when integrating computer-based technologies into the training and assessment of seafarers	2002	Report of Nautical Institute research. Includes advantages and disadvantages comparison table
MSC/Circ 846	Guidelines on human element considerations for the design and management of emergency escape arrangements on passenger ships	1998	Design and operational guidelines
MSC/Circ 813 / MEPC/Circ 330	List of human element common terms	1997	Terms and definitions provided to support common understanding
MSC/Circ 735	Recommendation on the design and operation of passenger ships to respond to elderly and disabled persons' needs	1996	Recommendations considering the needs of people with restricted mobility. See also Res A.865(20)

Res A.796(19)	Recommendations on a decision support system for masters on passenger ships	1995	Recommendations to support rapid decision-making in emergencies given the complexity and diversity of information sources
Res A.772(18)	Fatigue factors in manning and safety	1993	Mostly operational guidance but some design and build
Res A.468(XII)	Code on noise levels on board ships	1981	Limits on levels and exposures to support health, safety and communication