The Human Element in shipping

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Editor
Alert! – The International Maritime Human Element Bulletin

Introduction

In the maritime context, the term human element embraces anything that influences the interaction between a human and any other human or system or machine aboard ship. The human element has been with us since time immemorial, but it is the humans, systems and machines that have changed, not only through the increase in technology, but also because of the need for operators to maintain the competitive edge by reducing running costs, which has resulted in a reduction in manning scales and the employment of multi-national, multi-cultural and multi-lingual crews.

There is no such thing as ‘the perfect ship’, because the end product is inevitably a compromise between what is needed to satisfy the regulations, what is absolutely necessary to fulfil the operational role, and what is affordable. But, it must be ‘fit for purpose’.

However, the global nature of our business is such that not only is the maritime workforce multinational and multicultural, but also there can be differing interpretations of international guidelines and inconsistent standards in lifestyle, training and education.

The importance of people

People are important and ships need good, qualified, and motivated seafarers to operate well. They need to be provided with the proper tools and be adequately trained to be able to conduct their business in a safe and efficient manner. Hitherto, little emphasis has been placed on honing the personal attributes of the seafarer, yet the quality of the end product depends not only on the standard of education and training provided, but also on the basic human needs of the Mind, the Body and the Spirit. The term ‘Garbage In, Garbage Out’ (GIGO) is one of the great proverbs of the computer age, which says that if invalid, inaccurate or inappropriate data is entered into a system, the resulting output will be invalid, inaccurate or inappropriate. In other words, the quality of the output is directly dependent on the quality of the input. In terms of the Mind, the Body and the Spirit, therefore, the personal output of the mariner is dependent on 7 needs (Figure 1):

**Competence.** The seafarer’s level of competence will depend not only on good and effective education and training and realistic competencies, but also on aptitude – the ability to absorb knowledge and to understand the subject – and on his own skill and proficiency.

**Attitude.** The seafarer’s attitude towards education and training will be driven by his mental ability, intelligence, personality, character and sensitivity. Self-awareness and self-evaluation are the key drivers.

**Motivation.** Motivation is driven by good communication, direction, teamwork, empowerment and character building in order to provide the seafarer with a sense of leadership, interoperability and adaptability.
• **Happy & healthy lifestyle.** A happy and healthy lifestyle through the encouragement of a balanced diet, good hygiene, exercise, rest and recreation, together with acceptable standards of habitability and regular medical screening, including drug and alcohol testing, will ensure that the seafarer has the energy, physical fitness, physical strength, stamina and a sense of wellbeing to enable him to do the job.

• **Safe & secure working environment.** Good ergonomics, safe working practices, the provision of protective equipment, together with proper physical security will lead to an improved safety culture and greater security awareness.

• **Self-actualisation.** Personal ethics, conscience, cultural integration and leadership, together with proper supervision and adequate remuneration can generate a sense of pride and purpose, identity, conviction, trust, expectation, realisation, belonging, loyalty, esteem, fellowship and personal security.

• **Moral values.** Moral values are equally important; an awareness of the various religious beliefs, together with one’s personal faith and self-discipline are drivers towards cultural awareness.

Some of these attributes can be taught, and some are developed through self-education, while others fall to the shipowner or shipmanager who has a duty to provide a safe and secure working environment, decent working and living conditions and fair terms of employment.

Some employers, however, show little interest in the health, safety, wellbeing, training and motivation of their people such that they are prepared to employ poor quality and under-qualified seafarers. Sadly, there are some administrations, owners, shipmanagers and crewing agencies whose compliance with such conventions as STCW, and the ISM Code, aspires only to the acceptable, particularly in respect of crew working and living conditions, safety of life at sea and accident prevention. But, in fairness there are many owners, shipmanagers and crewing agencies that do invest in training beyond minimum mandatory international standards.

**The human influence**

It is often stated that around 80% of all accidents at sea are attributable to *human error* (or more correctly *operator error*) while the remaining 20% may result from hull or equipment failure due to unrecognised faults or lack of expert maintenance. The causes of maritime incidents can be linked to a number of contributory factors:

• Poor ship or system design;

• Equipment failure through poor maintenance;
- Fatigue;
- Ineffective communication;
- Lack of attention to rules, regulations and procedures;
- Inadequate training in the operation of equipments;
- Unawareness of the vulnerabilities of electronic systems;
- Complacency.

Crew competence does not feature in this list; indeed, rarely does an accident investigation report cite crew incompetence as a cause. More to the point, every one of these causes can be linked to inadequacies or failings in the education and/or training not only of the seafarer, but also on the part of the various stakeholders involved in the maritime sector.

Figure 2 tells the story of the life of a modern ship in terms of the human element; it identifies the various responsible stakeholders and their linkage, at each stage of the lifecycle from conception to disposal.

While every one of these stakeholders has an influence on the human-system integration on the ship, the degree of influence can be more, or less, direct. For example, someone on a ship

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2 Downloadable from: http://www.he-alert.org/documents/newsletter/centrespreads/centrespread_1.pdf
who does not take account of health and safety issues will have a very direct influence on the operation of that particular ship, whereas a Government, which takes an interest in the health and safety of seafarers generally, could have a small but significant effect on all seafarers sailing under that country’s flag.

**Human Factors**

*Human Factors, or The Human Factor,* are terms that are often misinterpreted and are used as covers for the human element or even human error. Human Factors are defined as the body of scientific knowledge relating about people and how they interact with their environment, especially when working.

Applying human factors to the design and operation of a ship or its systems means taking account of human capabilities, skills, limitations and needs. Human Factors should not be confused with the term Human Resources, which is a closely related activity that addresses the supply of suitably qualified and experienced staff. But, when considering the operation or design of any ship and its systems both of these domains should be considered – Human Resources for the selection and preparation of staff able to do the required work and Human Factors to account for the use of people as a component of the system.

Both domains contain a number of sub-domains:

- **Human Factors** (Fitting the job to the person):
  - Human Factors Engineering – The comprehensive integration of human characteristics into the definition, design development, and evaluation of a system to optimise Human-Machine performance under specified conditions.
  - Health Hazards - The identification, assessment and the removal or reduction of short or long-term hazards to health occurring as a result of normal operation of a system.
  - System Safety - The human contribution to risk when the system is functioning in a normal or abnormal manner.

- **Human Resources** (Fitting the person to the job):
  - Manpower - the number of personnel required, and potentially available, to operate, maintain, sustain and provide training for a system.
  - Personnel - The cognitive (trainability and mental aptitude) and physical (fitness levels, physical size, gender) capabilities required of a person to train for, operate,
maintain and sustain a system, and to provide optimum quality and quantity of the crews to man the ship.

- Training - The instruction or the education, and on-the-job or part-task or full-mission training required to provide personnel with their essential job skills, knowledge, values and attitudes.

A simple way to view Human Factors is to consider three main aspects: the Person (Figure 3), the Job (Figure 4), and Organisation and Management (Figure 5) and how they - together with the environment in which the organisation and person are operating - impact on the behaviour of people.

![Figure 3](http://www.he-alert.org/documents/newsletter/centrespreads/centrespread_2.pdf)
<table>
<thead>
<tr>
<th>SKILL</th>
<th>PHYSICAL STATE</th>
<th>PHYSICAL CAPABILITY</th>
<th>PSYCHOLOGICAL STATE</th>
<th>PSYCHOLOGICAL CAPABILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competence</td>
<td>Personal health &amp; hygiene, fitness, balanced diet</td>
<td>Strength, stamina, stress, fatigue, pain/discomfort, hunger, thirst, temperature extremes, vibration, movement constraint, lack of physical exercise, aberration of circadian rhythm</td>
<td>Task speed, task load, threat of future roles of job, monotonous, degrading or meaningless work, long/monotonous vigilance periods, conflicts of motives about job performance, reinforcement absent or negative, sensory deprivation, distractions (noise, glare, movement, flicker, colour), inconsistent cues</td>
<td>Perception, motor requirements (speed, strength precision), control display relationships, anticipatory requirements, interpretation, decision-making, information lost, unawareness of task, frequency &amp; repetitiveness, task criticality, long/short-term memory, calculation requirements, feedback, (knowledge of results), dynamic vs step-by-step results, team structure &amp; communication, man-machine interface</td>
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<td>Previous training</td>
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<td>Experience</td>
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<td>Currency</td>
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<td>Leadership</td>
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**CULTURAL DIFFERENCES**  
Religion, national tradition, custom, language

**MOTIVATION**  
Work environment  
Temperature, humidity, air quality, lighting, noise, vibration, cleanliness  
Working hours  
Continuous operations, watchkeeping, locality

**ADAPTIVE TOOLS & EQUIPMENT**

**MEANING LEVELS**

**ORGANIZATION STRUCTURE**

**AUTHORITY, RESPONSIBILITY, COMMUNICATION**

**ACTIONS BY OTHERS**

**REWARD**

**RECOGNITION**

**BENEFITS**

**JOB DESCRIPTION**

**INSTRUCTIONS**

**PROCEDURES**

**CONTINUATION TRAINING**

**KNOWLEDGE**

**EDUCATION & TRAINING**

**EQUIPMENT & WORKSPACE DESIGN**

**SYSTEM DESIGN**

**USABILITY**

**HUMAN-HUMAN, HUMAN-MACHINE, HUMAN-MACHINE INTERFACE**

**ANTHROPOMETRY**

**BODY SIZE**

**BODY STRENGTH & STAMINA**

**LIMITS OF STRENGTH AND ENDURANCE**

**WORKSPACE DESIGN**

**USER CAPABILITIES AND LIMITATIONS**

**STRESSORS AND HAZARDS**

**WIND, WHOLE BODY MOTION, MOVEMENT INDUCED FATIGUE, VIBRATION, NOISE, DARKNESS/DAZZLE, TEMPERATURE, SLEEP LOSS**

**VISION AND LIGHTING**

**HUMAN VISION, VISUAL DISPLAYS AND LIGHTING DESIGN**

**AUDITORY INFORMATION**

**TRANSMISSION OF INFORMATION TO HUMAN OPERATORS USING THEIR HUMAN OR MEDICAL RESPONSE**

**VOICE COMMUNICATION**

**CHARACTERISTICS OF SPEECH AND HEARING**

**FACE-TO-FACE AND ELECTRONICALLY ASSISTED SPEECH COMMUNICATION**

**CONTROLS**

**OPTIMUM SIZE, SHAPE, OPERATING DYNAMICS AND SAFETY**

**MAINTAINABILITY**

**ACCESSIBILITY**

**TOOLS & EQUIPMENT**

**HANDBOOKS, PROCEDURES**

**Figure 4**
Ergonomics

Ergonomics is essentially the science of fitting the workplace to the worker, that is, *the study and design of working environments - such as ship bridges, machinery control rooms, galleys and their components, work practices, and work procedures - for the benefit of the worker’s efficiency, effectiveness, health, comfort, and safety.*

Ergonomic considerations do not just start at the design stage of a ship and finish at build - they must be applied throughout its lifecycle, especially when updating its role or its manning philosophies or when retro-fitting new systems or equipment. *Figure 6*\(^4\) offers some user-friendly ergonomic definitions that are relevant to the design and operation of a ship and its systems.

A ship is unique in that it is not only a place of work, within which there are a number of workspaces - the bridge, the machinery control room, the engine room, the cargo control room, cargo holds, galley etc - each of which may have different operational criteria, but also it is a ‘home’ to those who work onboard. Furthermore, it is a floating platform which can be affected by external and internal environmental conditions such as weather, temperature, humidity, noise, vibration and ship motion (pitching, rolling and slamming), any of which can also be detrimental to the safety and performance of those who work and live onboard.

The mariner is generally a trusting sort of person, who has implicit faith in those who have conceived, designed and built his ship. His expectations are of a ship that is fit for purpose in every respect, but he may not always find that this is the case, because neither he nor any of his predecessors was involved in the design process. The end product is inevitably a compromise between what is needed to satisfy the regulations, what is absolutely necessary
to fulfil the operational role, what is affordable and what the design team perceive to be acceptable to the ‘generic’ seafarer.

For any ship to operate safely and effectively, therefore, it must be designed to support the people who work it, without detriment to their health, safety and overall performance particularly in respect of:

- **Habitability.** The provision of adequate and comfortable accommodation - including furnishings and washing facilities - galleys, messrooms and recreational spaces, having due regard for the variations in the size, shape and gender of the seafarer, and for the various environmental stressors such as noise, heat and vibration.

- **Maintainability.** Designing operational maintenance tasks to be rapid, safe and effective to allow equipment and systems to achieve a specified level of performance. This includes consideration of access, removal routes, tools, expertise, disposal and through-life support.

- **Workability.** Due consideration must be given to the context of use - the users, tasks, equipment (hardware, software and materials) and the physical and social environments in which a ‘system’ is used. The level and amount of information provided in handbooks must be appropriate to the required technical skills of the user and be written in his/her native language.

- **Controllability.** Designing the layout of ship control centres, machinery control rooms, cargo control rooms etc, bearing in mind the integration of people with equipment, systems and interfaces, such as communication, controls, displays, alarms, video-display units and computer workstations.

- **Manoeuvrability.** Having the most appropriate manoeuvring capabilities consistent with the intended role, manning and operating pattern of the ship. These should include type, number and power of propulsion systems, steering systems and thrusters, all having due regard for the environment and fuel economy.

- **Survivability.** The provision of adequate firefighting, damage control and lifesaving facilities (including manpower) and security arrangements to ensure the safety and security of the crew, visitors and passengers.

The human element, therefore, is a critical feature of all aspects of ship or system design and operation. User-input is essential to ensure that the operational parameters and the layout and procedures for the operation of shipboard systems are being optimised for the specific role or trade of the ship.
Those who are involved in the design, build and updating of ships and their systems and in their operation need to be aware of the problems associated with onboard operations not only in terms of workplace design but also in respect to crew habitability and the education and training needs of the seafarer. There is now a worrying trend towards recruiting non-seafarers into the industry in operational posts, such as the employment of naval architects etc as ship surveyors and superintendents, which has been brought about by the decline in the number of former seafarers available to fill these positions. In principle, this should not present a problem, provided that they are sufficiently educated in ‘the ways of the sea’. Naval architects and designers, for example would benefit from periods at sea, in a variety of ship types, both early in, and on occasions throughout their careers in order to understand the various design and operational problems that the seafarer is faced with.
Maintenance

According to the International Association of Classification Societies, shipboard maintenance is the least-developed and weakest element in many of even the most well intentioned companies. One of the prime responsibilities of a shipowner and ship management company is that the ship's hull structure, machinery and equipment are maintained and operated in accordance with applicable rules and regulations and any relevant additional requirements, procedures and standards established by the company. That responsibility starts from the top managers of the company, who should be committed to direct efforts, resources and investments to ensure that their ships are properly maintained and operated by qualified and competent crew.

Fatigue

The issue of fatigue features in many accident reports, albeit mainly relating to minimum manned short sea shipping. According to the IMO, fatigue is an important issue that has hitherto been discounted as a potential cause of or contributor to human error. It had been suggested that fatigue could be prevented through some of the characteristics described in the context of personal attributes articulated above. But, if the seafarer is unable to identify the causes of fatigue, he will be unable to take measures to prevent it.

The IMO Guidelines on Fatigue are comprehensive and provide advice to all the various stakeholders - including training institutions and management personnel in charge of training - on how to combat fatigue. However, it is important to recognise that fatigue is not just about working hours and minimum manning levels. The US Coastguard’s Crew Endurance Management Program (CEM) takes the IMO Guidelines one step further in identifying the various environmental, operational, physiological, and psychological factors that can affect crew endurance, and addresses the specific endurance risks pertinent to ship operations. It looks at the science behind, and effects of, fifteen interrelated risk factors, which include those of temperature, motion, vibrations, intensity of lighting, and other physical considerations aboard a ship.

Although current IMO thinking is that training in fatigue management should be addressed through voluntary guidance rather than mandatory requirements, fatigue now poses a major problem in terms of safety of life at sea.

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5 Shipboard Maintenance – a top management responsibility, Alert! Issue No 3, April 2004
6 IMO, MSC/Circ.1014, 12 June 2001 - Guidance on Fatigue Mitigation and Management, Annex, Page 4
7 MSC/Circ.1014 dated 12 June 2001 - Guidance on Fatigue Mitigation and Management (International Maritime Organisation)
9 STW 34/14, 14 March 2003
**Communication**

In the maritime world, the ability to *communicate* at all levels by a variety of means is essential. *Communication* is about the transmission of information through a common system of symbols, signs, behaviour, speech, writing, or signals – in its various forms it can be described as:

- The activity of conveying information;
- An exchange of information between parties;
- An act of sharing, and coming together.

**Conveying information**

The ability to properly convey information by word of mouth, whether directly or indirectly (by the use of technology) is important to the safety of ships’ crews, visitors and passengers. Multi-national crews are a common feature aboard more than 65% of the ships of the world’s merchant fleet, of which some 10% of crews are made up of five or more nationalities.\(^{10}\) The commonly used language onboard may not be the native language of the majority of the crew. This can lead to communication problems, which may be exacerbated by the unwillingness of individuals to admit their difficulty in understanding and communicating. Furthermore, misunderstandings can occur when communicating externally by use of the VHF radio, or internally through the ship’s public address system, if the native language of the intended recipients is not the same as that of the person who is delivering the message.

The ergonomics of communication systems need also to be carefully considered, not least:

- The siting of VHF units on the bridge, so that they are easily accessible to the bridge team - including the pilot - without detriment to the safe navigation of the ship;
- The provision and positioning of ‘talk-back’ units to permit the relay of information between such stations as the bridge wings and the central control position, machinery control room/bridge, fore/aft mooring stations/bridge and cargo control room/machinery control room/bridge;
- Siting of sufficient public address loudspeakers to permit full and clear coverage throughout the ship.

\(^{10}\) *Transnational Seafarer Communities*, Seafarers’ International Research Centre, 2001
• Adequate signage, in a language appropriate to the native languages of all onboard.

**Information Exchange**

Increasing paperwork can sidetrack the mariner (especially the master and the chief engineer) from his primary purpose of working the ship. ‘*Routine clerical or administrative work*’ is one dictionary’s definition, but it would seem that in the maritime world it is becoming far more than simply *routine*.

Electronic paperwork (especially e-mail correspondence) seems to have increased the burden on the ship’s master. For example, the master of a 15000gt LPG tanker\(^{11}\) (managed by a very reputable company) reports that he spends on average 3 to 4 hours a day on sending and receiving information by e-mail. He adds that on the tankers there are plenty of inspections, where the inspectors are looking for checklists. On his ship there are some 22 checklists for assorted bridge, deck and cargo operations, which begs the question whether there is now a need for a checklist to check the checklists.

On a more positive note, he suggests that the use of software programs for activities such as routine administration, recording ISM non-conformances, the management of spare parts and routine planned maintenance, can cut down the amount of paperwork, but only if it is used wisely and if proper IT training is provided.

Some manufacturers’ handbooks and operating procedures can be technically complicated and difficult to understand, even if they are written in the native language of the reader. It is therefore incumbent upon the various manufacturers to ensure that the level and amount of information provided in their handbooks is appropriate to the required technical skills of the user; and the shipowner or shipmanager to ensure that such handbooks are written in the native language of the user.

**Sharing and coming together**

Breakdowns in communication and teamwork are common factors in many major P&I claims.\(^{12}\) There is no place today for the ‘autocratic shipmaster’ – he needs the support both of management and of his crew to ensure the safe conduct of his ship and the safe and timely arrival of its cargo. Good communication is the key to the successful operation of any ship; in this context, communication is about empowerment, inclusion, leadership and teamwork.

**Attention to rules, regulations & procedures**

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\(^{11}\) *Alert!* Issue No. 2 January 2004

\(^{12}\) *Alert!* Issue No.4, July 2004
The purpose of regulation and enforcement of the regulations is to guard against human failing and complacency on the part of the master, owners, managers and operators.13

There is increasing evidence of a lack of attention to rules, regulations and procedures. The 2003 Port State Control report of the Tokyo MOU14, for example, notes that 34% of the total number of deficiencies related to life-saving appliances and fire safety measures. The report also notes an upward trend in the number of deficiencies under the categories of stability, structure and related equipment, safety of navigation, radiocommunications, ISM and MARPOL - all of which indicate a lack of attention to the application of international rules and regulations.

The Paris MOU,15 meanwhile, reports a 186% increase in the number of ISM major non-conformities when compared with the 2001 results – an increase which, the report adds, demonstrates that management systems are not working for certain ships.

There is a blunt message from the Paris MOU:

_If all parties are quality minded there is a strong bond and the involvement of port State control should be minimal. On the other hand the objectives may be focussed only on profits, at the expense of a safety culture. For these entrepreneurs there is no room for complacency._

In the main, these relate to ‘material’ rather than ‘operational’ deficiencies. However, there is a worrying trend of reports of collisions and groundings resulting from the inappropriate or incorrect application of the International Regulations for Preventing Collisions at Sea (Colregs). In an article16 about his preliminary report on a survey into the application of the Colregs, for The Nautical Institute17, Captain Roger Syms, the project leader, comments:

_Ignorance of the current Colregs is widespread and is not in any way confined by nationality or experience. The overall picture tends to be one of a game with no referee, played by contestants with different rulebooks, each perfectly convinced they have the right answer._

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16 Seaways, August 2003
This raises questions as to the commonality in standards of training and examination in the application of the Colregs.

Human nature is such that we all, at times ‘break the rules’ – each time we do we take a risk, and occasionally we may take one risk too many which results in an accident. It is not possible to create a completely risk free working environment and no matter how well trained and equipped the seafarer may be, accidents may still occur. But, it is the responsibility of the shipowners and shipowners to educate and motivate their seafarers towards a culture of compliance, not just through the ISM Code, but also through the development of a ‘company culture’, which encourages communication and empowerment.

**Education and Training**

Education is the gradual process of acquiring knowledge through learning and instruction. It is as much about the development of personal attributes through upbringing and observation as it is about gaining knowledge through textbooks. It is a lifelong process; we never stop learning, whether through formal education (degree courses, Continuous Professional Development, etc) or through the ‘University of Life’ (observation and experience). Training is the development of skills or knowledge through instruction or practice. If correctly applied, it is a planned systematic development of the aptitude, knowledge, understanding, skill, attitude and behaviour pattern required by an individual so that he/she can adequately carry out a given task or perform in a particular job. Together, education and training are about the development and maintenance of the human component of ship systems: the mariner. However, the education and training of designers, surveyors, trainers etc is equally important, not least knowing how to specify and deliver the human component of ship systems, and having an up to date knowledge of ‘the ways of the sea’. The competence of a mariner will depend not only on good and effective education and training, but also on his aptitude, knowledge and understanding of the subject, on the availability of opportunities to develop his skills and, ultimately, his experience.

The International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW) recognises the importance of establishing detailed mandatory standards of competence necessary to ensure that all mariners are properly educated and trained, adequately experienced, skilled and competent to perform their duties. However, in the way of all international Codes, the standards of competency set out in STCW are a minimum set. Furthermore, the maritime workforce is now multinational and multicultural. This may allow differing interpretations of international guidelines and inconsistent standards in training and education. Indeed, there are still numerous reports, mainly anecdotal, of poor standards of education and training in the maritime sector. In fairness, there are owners, managers and manning agents who invest in the education and training of their mariners to beyond the minimum criteria set out within the STCW Code - but they are in the minority.

Learning is important, particularly in this global maritime industry in which standards of education and training vary and where technology is revolutionising the way in which we do
our business. It would appear that awareness, effective communication, common sense and basic seamanship and engineering skills are taking a back seat to increased automation and electronic decision support systems etc.

Figure 7\(^{18}\) shows the personal characteristics and other factors, together with the training needs required for the development and maintenance of the human component of ship systems.

It is important, therefore, for all stakeholders to be aware of the human element issues associated with the human machine interface, and to encourage and promote the highest standards of education and training, and a common spirit of professionalism in the industry.

**The effects of modern technology**

Modern technology has revolutionised the way in which the seafarer can conduct his business. He can now be presented with a plethora of information, from a variety of stand-alone systems having differing user interfaces, with the potential for confusion and information overload, particularly if he is not properly acquainted with the operational parameters of any one of those systems.

Although in principle the more information that can be made available to the seafarer the better should be his understanding of the situation and the better informed his decision-making, this is not entirely the case in practice. It is probable that technology is having an adverse effect on the way in which some seafarers conduct their business. There are various reasons for this, not least the universal problem of a generation that is being brought up to rely on technology to solve problems without having to process information for themselves.

Decisions are made using knowledge rather than information alone, and it is the management and processing of data and information, which needs to be designed and trained for. Accident investigation reports suggest that some junior bridge watchkeepers are so absorbed in technology that their awareness of the situation around them is confined to the display rather than looking out of the window. Furthermore, there is an increasing tendency for some seafarers to become over reliant on electronic systems with scant regard for the vulnerability of those systems in terms of their accuracy, reliability, availability, and integrity.

Although most equipment is required to be type approved to an IMO specification, there is a natural tendency for manufacturers to add their own features, in an attempt to make their equipment ‘user-friendly’ or made distinct within the market. For example, the seafarer can be faced with either joystick, trackball or menu-driven controls, depending on the equipment fit in the vessel in which he is serving. Very advanced technology and integrated systems are being put onto a ship with the risk of over-saturating the untrained mariner with information that may be replicated through different means. The different nationalities and cultures of today’s mariners (and of those of the future) dictate a need for commonality of symbols, switches and control keys, together with appropriate education in the basic principles of new technology.

Today’s seafarers need to be trained on new technology and equipment; they should not be expected to pick it up after they have joined the vessel, or to undergo familiarisation by other staff onboard, who themselves have no formal training or qualifications in the use of such equipment. In fairness, the more responsible companies do invest in the training of their key staff in the use of integrated systems, before they join a vessel that is so fitted, and then allow them some time for familiarisation onboard before they are permitted to work with those systems. But this may be the exception rather than the rule, and the tendency for seafarers to move from one ship type to another, where each has different equipment fits, makes it impractical for them to be properly trained in the use of a variety of different manufacturers’ equipments. This makes it all the more important for manufacturers to strive towards a basic and common standard so as to allow for a generic training programme for all the different systems. This is particularly the case with Pilots, who may need to rely on these systems for
critical information and who may only have minutes to familiarise themselves with the equipment.

Two years ago, The Nautical Institute held an international conference on Integrated Bridge Systems and the Human Element. The aim of this conference was to examine how mariners use integrated bridge and navigation systems to support their tasks, and to determine best practice and learn how to improve the effectiveness of these and other systems through the processes of design, procedures for their use and training.

The conference focused on the human element and looked at how mariners and pilots interact as part of the total system to achieve the safe navigation and operation of ships. It was concluded that there is a need to raise awareness across the industry – designers, engineers, owners/managers, trainers/educators, insurers, regulators etc - of human element issues related to the use of technology and automation, particularly in regard to training.

Further to the conference, a paper was submitted to the IMO’s Maritime Safety Committee (MSC) articulating the training issues for seafarers resulting from the implementation of onboard technology. The paper has subsequently been adopted and issued as MSC Circular 1091 entitled Issues To Be Considered When Introducing New Technology On Board Ship\textsuperscript{19}, and is currently being used by such bodies as the IMO Human Element Working Group. However, it should also be essential reading for all of those who are involved in the design and operation of ships and of their systems.

Training must be an integral part of the introduction of new technology and equipment and it must be defined in advance and by statute.

Conclusion

For any ship or system to operate safely and effectively, not only must it be designed to support the people who work it, without detriment to their health, safety and overall performance, but also those people must be sufficiently educated and trained to be able to operate it.

A ship is unique in that it is not only a place of work, within which there are a number of workstations, each of which may have different operational criteria, but also it is a ‘home’ to those who work onboard. It is also a floating platform which can be affected by external and internal environmental conditions such as weather, temperature, humidity, noise, vibration and ship motion (pitching, rolling and slamming), any of which can also be detrimental to the safety and performance of those who work and live onboard.

\textsuperscript{19}Issues To Be Considered When Introducing New Technology On Board Ship - IMO MSC/Circ.1091, dated 6 June 2003 (http://www.imo.org/includes/blastDataOnly.asp/data_id%3D7578/1091.pdf)
All responsible stakeholders need to work together to ensure that ultimately the master and his crew have the right tools in place, and are properly trained, to ensure the safe conduct of the ship, and the safe and timely delivery of its cargo. Ergonomic and human factors considerations do not just start at the design stage of a ship and finish at build – they must be applied throughout its lifecycle, especially when updating its role or its manning philosophies or when retro-fitting new systems or equipment.

If the seafarer is not competent, healthy, happy, well trained and motivated then the commercial efficiency of the ship will be compromised.