Deliverable D8

FINAL REPORT

Status : P

THALASSES
WA-97-SC-2108

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Partners:

- ARISTOTLE UNIVERSITY OF THESSALONIKI (AUTh)
- TRANSEUROPEAN CONSULTING UNIT OF THESSALONIKI (TRUTh)
- COOPERATION AGENCY FOR EUROPE OF THE SEA (ACEM)
- NETHERLANDS ECONOMIC INSTITUTE (NEI)
- FACHHOCHSCHULE HAMBURG (ISSUS)
- BOMEL LTD

Date: JUNE 2000

PROJECT FUNDED BY THE EUROPEAN COMMISSION UNDER THE TRANSPORT RTD PROGRAMME OF THE 4th FRAMEWORK PROGRAMME

ABSTRACT

The project's main objective was stated as : *The assessment of the socio – economic impacts of new technological concepts in maritime transport, on the human element*
Main partial objectives contributing to the achievement of the previous one were: to identify trends in the development of new technologies in maritime transport focusing on their impacts on the human element, also changes in maritime working cultures, develop and apply appropriate tools for the assessment of human factors impact from the implementation of new technologies, consider how new technologies can be utilised by European registers via the development of a new tool making them more efficient and having in parallel positive impacts on the human element.

A new technology in the context of the THALASSES research is defined as *"a technology that has already been implemented on board ships/harbour and/or is expected to be implemented to a large extent in the near future".* Five main categories related to new technology have been defined : Ship Design, Cargo, Navigation support, Communication and management support, Machinery.
For each category the main related new technologies have been identified and their impact on the human element was discussed.

Concerning the definition of the working cultures in maritime transport, THALASSES, for the purposes of its research, adopted a selection of human factor elements that are most important for the job satisfaction of the seafarer and the specific characteristics of the seafaring job. The ten elements selected are : *Organisational structure onboard the ship, mental work demand, physical conditions, working time, payment levels, need for training and education, career development, social contacts, integration of tasks, multi-skilling, working procedures.* Based on the literature review performed, it can be concluded that the main effect of the introduction of key technologies on the working culture is caused by the introduction of navigation, communication and management support technologies.

A framework assessment tool has been developed aimed to expand the knowledge basis in the field of measurement of new technology impacts in the maritime sector. A combination of three (of which two already existing) tools have been selected to meet the objectives of the framework assessment. These tools are: *the stated Preference Analysis (SPA), the Multi Criteria Analysis (MCA) and the Social Impact Table (SIT).* Elements that have a big influence on the observed relationships between new technologies and working culture include the following: *ship Register, ship type, function on board, ship management.* The purpose of the framework tool application was principally to validate the methodology proposed for the assessment of impacts. The safety element in the assessment framework was selected as a special focus because of its important relationship both with new technologies and with human factor elements. The research on the relationship between safety and human factor costs was based on recent historical accident data collected over a period of 9 years.

The state of the art of the implemented integrated ship operation concepts was examined, aiming in the analysis of the impacts on crew members, on MET, based on the example of the ECDIS implementation and also the new systems on the integrated bridges.

The possibilities and to a certain extent, the demonstration of how new Information and communication technologies (ICT) can be utilized by European Registers were examined and also considered how this utilisation may influence positively the human element, mainly seafarers and shipowners. The requirements of various actors involved in relation to a new proposed tool named Vessel Register Communication Manager (VRCM) have been identified and also a prototype of the VRCM tool has been developed with limited functionalities and only for demonstration purposes.

A task model of work organisation onboard ship was adopted by the THALASSES Consortium to identify in each task the involved new technologies, the relevant human needs and the MET technological means/methods. Simulator based training should aim at the maximally effective controllable parts of human error: not at the work environment but at the individual level. A problem must adequately be diagnosed and appropriate action must be taken. The applicability of human factors analysis and design tools (SHIP- MATE tools) that results in ship crew workload and manpower reductions and which support the achievement of safe and effective human factors designs has been also examined in THALASSES.

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Main partners

1. Aristotle University of Thessaloniki (AUTh)

2. Cooperation Agency For Europe of The Sea (ACEM)

3. Netherlands Economic Institute (NEI)

4. Institute of Ship Operation, Sea Transport and Operation, Fachhochschule Hamburg (ISSUS)

5. TransEuropean Consulting Unit of Thessaloniki (TRUTh)

6. BOMEL Limited (BOMEL)

2. Executive summary

The project's main objective was stated as :

The assessment of the socio – economic impacts of new technological concepts in maritime transport, on the human element

Main partial objectives contributing to the achievement of the previous one were:

- The identification of trends in the development of new technologies in maritime transport with a focus on their impact on the human element.
- The identification of technology driven pressures for changes of working cultures in maritime transport.
- The analysis of the changes of the crew's role as a result of the introduction of new technologies.
- The investigation of the role of human factors in the development and implementation of technology in order to reduce workload in ships.
- The application of appropriate assessment methods of the improvement of ship operation by the introduction of improved Human – Machine Interfaces (HMI).
- The development of tools to allow for a cost – benefit analysis on the role of human factors on safety standards on a ship's life cycle.
- The consideration and demonstration of how new technologies can be utilised by European registers providing to them a management advantage with parallel positive impacts on the human element.

The THALASSES project had a duration from January 1998 to November 1999 and produced in total seven deliverables including this one. Six main contractors and one subcontractor participated, of which, one University, one University Research Institute, four Consultancy Companies and one Cooperation Agency from 6 E.U. countries.

The project has followed, in principle, the workprogramme described in its Technical Annex, including 8 main workpackages split in 18 activities.

Impacts of the human factor in shipping due to the Introduction of new Technologies.

A new technology in the context of the THALASSES research is defined as *"a technology that has already been implemented on board ships/harbour and/or is expected to be implemented to a large extent in the near future"*.

Five main categories of new technology have been defined :

a. Ship Design related new technologies
b. Cargo related new technologies
c. Navigation support related technologies
d. Communication and management support related new technologies
e. Machinery related new technologies

For each category the main new technologies have been identified and their impact on the human element was discussed.

Concerning the definition of the working cultures in maritime transport, THALASSES, for the purposes of its research, adopted a selection of human factor elements that are most important for the job satisfaction of the seafarer and the specific characteristics of the seafaring job. The ten elements selected are : *Organisational structure onboard the ship, mental work demand, physical conditions, working time, payment levels, need for training and education, career development, social contacts, integration of tasks, multi-skilling, working procedures.*

Based on the literature review, it can be concluded that the main effect of the introduction of key technologies on the working culture is caused by the introduction of navigation, communication and management support technologies.

The shipping industry can learn from other industries with respect to the impact of new technologies on the human factor and thus THALASSES has paid specific attention to this issue. One of the main things that have become clear from the experience in other industries is, that human centered system design can have a positive impact on the job satisfaction of the seafarer, when a new technology is being implemented.

In the field of the assessment of socio-economic impacts in maritime transport, little structured information is available up to now. Thus a framework assessment tool has been developed aimed to expand the knowledge basis in the field of measurement of new technology impacts in the maritime sector. Elements that have a big influence on the observed relationships between new technologies and working culture include the following: *ship Register, ship type, function on board, ship management.*

After careful consideration, a combination of three (of which two already existing) tools have been selected to meet the objectives of the framework assessment. These tools are: *the stated Preference Analysis (SPA), the Multi Criteria Analysis (MCA) and the Social Impact Table (SIT).*

The purpose of the framework tool application was principally to validate the methodology proposed for assessment of impacts. The results of the framework tool application show that the selected tools are appropriate for assessing the relationship between new technologies and the human factor. This goal of validation has therefore been achieved.

It is also possible to draw some general conclusions with respect to the identified relationships between human factor elements and new technologies, with respect to different results between officers and students. Though the number of interviews in which the assessment tool was applied was adequate (for the intended purpose of validating the framework methodology (50)), the results were not yet fully stable. It is therefore recommended for future research to perform additional interviews to fine-tune conclusions on the actual preference of human factor elements and of the importance of the different items of new technologies.

The safety element in the assessment framework was selected as a special focus because of its important relationship both with new technologies and with human factor elements. The methodology used in identifying and modelling human factor cost for the THALASSES project was based on the Formal Safety Assessment (FSA) methodology.

Also the issue of cost associated elements in the relationship between new technologies and the human factor was thought to be of special research interest. In order to fit cost estimations into the framework model, a selection has been made of a shipping cost model, allowing for segmentation between different cost elements. There are direct relationships between new technologies and ship costs, such as the capital cost of investment in new technologies in a ship. From the viewpoint of the human factor, there are also indirect relationships between new technologies and costs via the human factor element.

The research on the relationship between safety and human factor costs was based on recent historical accident data collected over a period of 9 years. The review of the assessment of the safety impact of new technology was thorough, involving experts in risk assessment and mariners with some 200 man-years of shipping experience. Reliable and comprehensive data from Lloyds Casualty Archives were used as a basis for assessing the baseline of risk. This contained accident information on as much as some 143,830 vessel years of operations.

Main impacts identified and their consequences.

The risk of loss of life has increased because of the implementation of new technologies in the context of a changing international maritime industry. Accordingly the human costs associated with generic cargo shipping operations are likely to be experienced in terms of increasing fatalities in a given time period.

Technology innovations have significant impacts on different elements of the cost structure of ships. Based on the results of THALASSES it is not possible to make an analysis of the costs and benefits of the implementation of a specific investment in new technology, this should be done on a case – by – case basis. An insight though has been provided into the various cost elements that can be affected by new technologies and into the relative average importance of the various elements.

Concerning the results of the Stated Preferences Analysis and the weights attached to the elements of working culture, in general there is little distance between the elements. More specifically, “working procedures” (the organisation of work) has been selected as the most important element, followed by social contacts. The least important elements to the respondents are the integration of tasks and mental workload.
The results from the Multi Criteria Analysis integrated with the results of the Social Impact Tables show a marked difference between the opinion of current officers and the interviewed maritime students on the importance of the selected (groups of) new technologies on the maritime working culture. This may either indicate that actual

job experience, or that future commanding officers will have a different opinion on the importance of the different technologies.

The results also show that students think that computer communications innovations have the highest impact on the maritime working culture, whereas officers and captains think the (un) loading technologies show the highest impact. Students may be more aware of new computer-to-computer communications such as EDI as a result of the training that they currently receive at their schools. Captains and officers might be inclined to think of (un) loading technologies as having the main impact because they have seen the rapid evolution of container technology in the last decades and the results this has had on ship turn-around time and sailing patterns. Both groups clearly agree in assuming that increased ship size has had the smallest impact on the maritime working culture. This might be explained by the fact that the biggest reduction in crew numbers is already some years in the past.

The level of user acceptance is very much dependent on the reasons why the new technology will be implemented. The following motivations can be found for implementation of new technologies in the maritime industry:

1. *Safety considerations*: contributing to disaster prevention and pollution;
2. *Regulatory requirements*: a minimum level of technological equipment is required by regulatory institutions;
3. *Cost-effectiveness* (cost-push): the intense global competition stimulates the use of new technology as a contribution to the reduction of operational costs
4. *Customer demands*: some technological concepts are developed to (better) fulfil customer needs such as faster or more environmentally friendly transport;
5. *Technological innovation* (technology-pull): new designs fresh from the drawing table may create their own demand;
6. *Improvement of working conditions and quality of life* on board ships: in order to attract appropriate personnel, ship owners may want to invest in technology applications which provide for instance better ergonomics or workload reductions.

New technologies that have been implemented for reasons of safety and improvement of working conditions have a much bigger chance of immediate user (crew) acceptance than for instance new technologies based on customer demands or cost effectiveness because the relationship with the crew's interest is more direct.

Human element in the application of Integrated Ship Operation concept.

This part of the work of the THALASSES project focused to present the state of the art of the implemented integrated ship operation concepts aiming in the analysis of the impacts on crew members, on MET, based on the example of the ECDIS implementation and also the new systems on the integrated bridges.

A top down approach has been used. Following the IMO Generic ship function description, the several levels of "internal on board functions" and the "external function" ashore have been analysed.

The development of technology and the increasing costs of personnel have led the 1980's to a revolution in the ship operation. New ergonomical, technical and operational concepts had been developed towards the integrated ship operation. Rather than distinct functions being manually controlled by several persons the trend was towards a single person supervising all main functions / tasks. One important role in the integrated decision support systems is the transfer of the holistic view to the operators watch officer.

The IMO defines the integrated bridge system as:

> *"a combination of* [technical] *systems which are interconnected in order to allow centralised access to sensor information or command/control from workstations, with the aim of increasing safe and efficient ship's management by suitably qualified personnel".*

More generally spoken, any combination of systems, which are interconnected to allow centralised access to data and/or command/control to fulfil a particular task or purpose, can be called an *integrated system*.
However, these definitions are still quite global. A better understanding of what is behind all that, can be given by distinguishing the following three aspects of (technical) integration. *Physical /spatial Integration, Functional integration, operational integration.*

Workload are outside demands of a task resulting form the way in which the work is done and the work environment. Demand describes the specific reaction of the individual to a given workload. Thus, the work demand can be expressed as a function of workload independent from person and individual capacity and ability of the operator. Human workload and demand are valued in four hierarchical levels: 1) workability 2) tolerability 3) expectancy 4) satisfaction. All four tasks, each of which is part of the mechanism of human information processing in different combinations, can be integrated in the complex working task of bridge command.

Concerning the conception of a technical system which has to be controlled or monitored by man e.g. the integrated bridge system as a bridge control center, it is necessary to find a fine balance between technical design characteristics – which can be influenced by ergonomical factors – and demand characteristics – the requirements of human performance.

The ship handling and the ship operation are two, most important task areas, on board of a vessel. Traditionally, both areas use technically and physically separated systems. The bridge is the centre for all ship operation tasks while the machinery control room is the place where most of the ship operation takes place. Due to the spatial distance between bridge and machinery, but also due to the very different tasks and required skills, both areas cannot easily be integrated into one system.

During the last ten years, several approaches have been made to merge these two into one control centre on the bridge. Actually, a mariner (if trained) is able to control the entire ship handling and ship operation process from the bridge today. Special education programs were set up to train officers for such an integrated working environment. Latest tendencies look like that both areas will (at least technically) be integrated further into the integrated bridge system. Most of the machinery systems do already have their place on today's bridges. Nevertheless the respective MET systems – bridge/engine still have a separated structure, some efforts to harmonise the two educational structures have failed.

The *Integrated Bridge System* and the *Integrated Machinery Control* are related to the *Sensor* area. Again, there are strong differences in type and number of sensors for both parts. Conventionally, the ship handling requires some few parameters, which are provided by a handful of navigational sensors (e.g. positioning sensors, gyros). The ship operation (and thus the machinery) requires a significant amount of sensors and actuators controlling values like cooling water temperatures, air pressures, fuel consumption, etc.

The *Communication* is going to become the most innovative part for future system integration due to the enormously development speed in communication technology. Most of the data is exchanged by radio or fax via satellite today. However, new means like GSM or low orbit satellites in combination with the growing Internet techniques (email, World Wide Web) and an increasing bandwidth, force the conversion of the former "isolated" vessel to a single communication node in a world-wide control network.

In the “STCW78 as amended”-code the term “Integrated Navigation Systems” (INS) was never used, but terms which may be a link to the INS are mentioned. The use of integrated navigation systems requires a good knowledge and understanding of the systems, the subsystems and their limitation, the influence of the different parameters used, the flow of information, the dynamic and time factor.
Following general training objectives can be seen up to now that the trainee has to be able to :

- demonstrate knowledge and understanding of the basic system,
- operate the basic system,
- demonstrate the knowledge and understanding of the basic functions of the system,
- operate the basic functions,
- demonstrate the knowledge and understanding of the sensor fundamentals of the system,
- demonstrate the knowledge and understanding of the sensor limitations,
- demonstrate the knowledge and understanding of the warnings issued by the system,
- demonstrate the way to handle failure coming up within the system,
- demonstrate the way the plausibility check of the information issued may be carried out,
- demonstrate how to react when system break down occurs.

This list is not complete and requires further replenishment when standards are developed. Since the systems will be different, the training should be done in three steps:

Step 1: Theoretical knowledge about the system / classroom training

Step 2: Operation of the system in a part-task simulation training

Step 3: Training in the complexity of a full mission simulator using the INS in situations close to the real life.

For an on board training a computer based training (CBT) tool, as part task simulation is recommendable.

ECDIS systems offer numerous benefits compared to conventional navigation (automatic display of own ship's position, automatic updating, potential radar overlay etc.) and are considered a significant step towards safer navigation. They will eventually replace paper charts on board many ships. In the "STCW78 as amended". Convention, no particular formal emphasis is placed on ECDIS systems. Instead they are considered to be included under the term "charts" (Table A-II/1). Thus in the framework of THALASSES, ISSUS produced a model course of ECDIS following the guidelines of IMO model courses indicating its general aims and potential problems. This model was proposed to IMO and has now been accepted.

On standard vessels (conventional ships), when the integrated concept/technology has been installed it is necessary to be careful with the reduction of crew numbers in order to maintain ship/crew members integrity and safety.

Operative systems on board ships with Integrated Ship Control Centres are so different that operators have to do specific courses for each ship. This implies the need to standardise these operative systems on integrated bridges by means of a standard computers programme / interface, adaptable to the different applications and systems installed on board.

The different manufactures should come to an agreement designing and developing standardised systems. Continuous investigation into how to improve the seafarers' social level and standard of living and working on board should be carried out.

Integrated ship operators increasingly understand their role not restricted to waterborne transport but considering this mode just as one important link of the whole transport chain composed by intermodal transport services. This requires a wider service understanding of seafarers and maritime transport operators, which needs to be supported by improved knowledge and skills. The dramatically increased role of telematics in transport services and their realisation will need special emphasis in the conception of new MET modules.

Utilisation of new technology in ship registration

The ship's management depends on the legal, safety, technological, taxation and social provisions of the Register in which it is registered. This part of the THALASSES work aimed to explore the possibilities and to a certain extent, to demonstrate how new Information and Communication Technologies (ICT) can be utilized by European Registers and also how this utilisation may influence positively the human element, mainly seafarers and shipowners.

Initially a review of international competition with regard to Registers was performed using also a series of SWOT analyses aiming to define how a register can utilize new technologies for enhancing the registered ships' competitiveness in regard to safety, cost effectiveness and seafarers welfare and satisfaction. The national, international, second national registers have been examined and also their strengths weaknesses, opportunities and treats in relation to the application of new technologies have been analysed.

Until the present time the open registers remain attractive for European shipowners with no or low taxation, with a quite a freedom in manning, and also with weak constraints in safety provisions.

Such advantages have a cost: repairs, bad image, lack of confidence from customers and authorities, controls, etc., at the owner's expense. Above all the open Register's laxity, even the second national flexibility, induce the loss of maritime skill on board ships as ashore. If the maritime industry and especially the European one, wish to keep the maritime competency, which is essential for the industry's effectiveness, for the whole world trade and for the marine environment, it is most important to protect and to promote the seamen's skill.

Next the possibilities and opportunities offered by ICT systems for the registers were examined. Such systems considered were the following: *E-mail, File Transfer Protocol, Internet Web site, Satellite communications system, GPS, GMDSS, Video Conference facilities, mobile digital storage means, voice phone, EDI.*

Special emphasis was paid to identify the user requirements concerning the information exchange among registers and various actors. The various actors' involvement in the shipping business requires the exchange of a great amount of information among them something which justifies the use of new ICT technology. Registers can greatly facilitate the exchange of this information utilising new technologies. These user requirements have been captured using a series of interviews.

The types of information to be exchanged via the Register include:
Register information, Vessel's ownership, company's ability, vessel's character, seafarers affairs, ship crew, Navigation, Legal information, Financial information, Training Technical information, ship handling, Health, social information.

The actors for which information requirements have been defined include:
S*hipowners, Representatives of national authorities, other Registers, Bankers, classification societies, coastal Guards, ship crew, Seafarers, Everybody.*

The opportunities offered by new I.C.T to enhance ship's Registers condition and services can be utilised if the different I.C.T systems are integrated. Their integration can be facilitated by the creation of a sophisticated WWW site.

Such a WWW site should be able to integrate many ICT technologies via specific user-friendly interfaces. The basic principle to be applied in the proposed WWW site by THALASSES is its capability to manage various channels and communication means via dedicated communication interfaces. Such a WWW site allows vessel Registers to promote new services and increase their efficiency and transparency. Such a tool is named here web site "Vessel Register Communication Manager" (VRCM).

The web site "Vessel Register Communication Manager" is not simply a series of HTML pages but the core of the new type of Register system, having the responsibility to manage the communications that it will facilitate or generate for the benefit of the various users.

A prototype of the proposed VRCM with limited functionalities has been created for demonstration only purposes. This prototype is accessible at the AUTh WWW-site. As the system Architecture is open, new functionalities can be blugged into it, as soon as they emerge as "mature" technical solutions (e.g. videophones) or as soon their market acceptability is verified (positioning data).

The development of a Web application, incorporating new information and communication technologies is feasible and can provide the competitive edge on European Registers, but requires a lot of resources to be allocated to it, especially with regard to the testing and deployment phase. It is also necessary to take into serious consideration the security concerns, as they were expressed by the potential users in order to create a tool that will be easy to use and above all, dependable.

While the European Union has a worldwide lead in shipping, it lags behind on Internet related ICT applications. The proposed VRCM tool is such an innovative application opportunity in the maritime sector with promising potential.

New technologies and MET

Present Maritime Industry faces the problem of shortage of skilled seafarers but also the requirement to readjust Maritime Education and Training (MET) due to the introduction of new technologies.

As human performance is the key to the general performance of the industry, one has to consider how the reorganisation of MET and the supply of qualified labour is linked with the reorganisation of the maritime transport industry.

As M. Mazzarino and E. Maggi concluded in the METHAR/I.S.T.E.E. report(87), the main technological developments onboard can not imply a sort of "self sufficient" Education and Training (E&T) for the maritime personnel. On the contrary a suitable general framework of E & T must be developed and it must be implemented through MET institutions.

A task model of work organisation onboard ship was adopted by the THALASSES Consortium to identify in each task the involved new technologies, the relevant human needs and the MET technological means/methods.

The main ship tasks considered are: *Navigation, Ship handling/ship berthing, communication/management support, ship safety, maintenance and repairs, energy, administration, catering-cooking, cargo care, health & care/welfare, attendance.*

Various new technologies have been introduced or are under introduction having a lesser or greater impact on MET. Some main conclusions resulted from this exercise are :

- Automation and computerisation on the ship's functions have arguably reduced the seafarer's work to repetitive and tedious duties. On the other hand evolutions in telecommunications and information create new opportunities for reducing the isolation and also spend the free time in a more creative, useful and interesting way.

- Innovations that are not yet widely used should not concern MET in its general context. Depending on particular countries/areas MET adjustments concerning the use of new introduced technologies can be made by local MET institutions.

- The navigation of the newly introduced fast ships should concern MET. Fast ships require special training, due to the decrease in the reaction time, which is inhibited from the substantial increase in the speed under which they travel.

- The modern ship machinery reaches a high level of down scaling, power increase, reliability and monitoring. The operation of engines is controlled by the integrated bridge system; the engineers' part is limited to watch and maintenance. In spite the higher level of machinery automation and air conditioning, the subordinate technical mates' work is still essential due to possible break-down of the electronic systems.

- The introduction of "New technologies" have also their impact and effect on MET. The degree of emphasis between fundamental knowledge and operator skills has changed and STCW 78 as amended, has placed further emphasis on the acquisition and demonstration of skills. New technologies like advanced radar and ARPA collision avoidance systems, ECDIS, AIS (Automatic Identification Systems) have changed tasks like :

    - Voyage planning, monitoring and control (Officer and Engineer)
    - Special navigation techniques for high speed crafts

  New holistic MET models are required in order to educate, train and familiarise seafarer (officers and engineers) with new technologies.

- MET should continuously observe evolutions and be readjusted according to the demands. The establishment of a strategy in order for MET institutions keep track of changes and upgrade their organisational structures in order to cope with new training needs, is of primary importance.

Simulator based training should aim at the maximally effective controllable parts of human error: not at the work environment but at the individual level. A problem must adequately be diagnosed and appropriate action must be taken. The aim of training using simulators is therefore threefold:

1. Adequately diagnosing the situation, detection of a possible deviation;

2. Reduction of the occasions where knowledge-based decision reasoning is required;

3. Improvement of the knowledge-based reasoning process to allow for a more effective action execution.

Education refers to the creation of an appropriate knowledge-base and it is a long term process whereas training refers to practical application of knowledge in order to acquire and exercise skills.
The simulator training must clearly identify the education and training objectives, the standards of competence and the levels of knowledge, understanding and skill. This means that simulator training should comprise the following:

- one or more scenarios and
- an assessment standard, stating the assessment criteria by which the performance of the trainee can be appraised.

Both the scenarios and the assessment standards have to be developed, prior to the training.

Human factors are defined here as :
"The study of how humans accomplish work-related tasks in the context of human-machine system operation, and how behavioural and non- behavioural variables affect the accomplishment".

The applicability of human factors analysis and design tools (SHIP- MATE tools) that results in ship crew workload and manpower reductions and which support the achievement of safe and effective human factors designs has been also considered in THALASSES. The impact of human factors on the affordability and competitiveness of European shipping is evident in three major areas: (a) human factors directly address the fact of manning reductions, the cost of which comprises one of the most important elements of a ship's life cycle cost; (b) human factors directly reduced the incidence and impact of human error, the cause of 80% of ship accidents; and (c) human factors directly address the impacts of advanced automated technology by improving shipboard human cognitive performance through improved training and decision support.

Tools available to address human factors issues and activities are the SHIP-MATE (Ship Manning, Affordability, Training, and performance Effectiveness) tools, including specific tools for defining the human factors process, function analysis and allocation, comparability analysis, task analysis, workload assessment simulation, and human factors assessment.

The SHIP-MATE process identifies how job-tasks and how job skills and knowledge will change with the introduction of automated technology in a reduced ship manning configuration.
The SHIP-MATE process will also define requirements for evaluating existing training media, curricula, and systems, as well as changes required to support the reduced manning ship.

Main conclusions and suggestions

- The impact of new technologies on the human element seems to be more context specific than one would think.
- The risk to life arising from shipping accidents is predicted to increase due to changes in maritime operations that have the potential to erode the safety benefits of new technology.
- Analysing the effects of new technologies on the human element the main ones seem to be caused by navigation and communication related technologies.
- There is a trade-off between costs of safety measures and levels of risk avoidance.
- It seems that new Information and Communication Technologies offer a great potential to strengthen the efficiency and above all transparency of vessel register.
- Integrated concepts and their application have impact on M.E.T
- Simulators are used today mainly for MET, though could be used also in other areas
- New technologies need to be evaluated by specific instrument during their implementation in the overall maritime sector. THALASSES has developed specific tools for assessing human factors' impacts from the implementation of new technologies.
- Maritime students and officers have different opinions on the socio-economic impacts of specific types of new technology.
- One of the main things that have become clear from the experience in other industries is that human-centred system design can have a positive impact on the job satisfaction of the seafarer, when a new technology is being implemented.
- The impact of new technologies on safety standards was modelled using the influence diagram approach. This approach developed as part of the FSA methodology, enables assessment of all the factors that influence the likelihood of accidents occurring.
- The level of user acceptance is very much dependent on the reasons why the new technology will be implemented.
- Technology innovations have significant impacts on different elements of the cost structure of ships.
- Technology innovations related with MET should be seen within the STCW framework.
- New ICT may offer significant potential to strengthen the efficiency and above all transparency of vessel Registers.

3. Objectives of the project

The project's main objective was:

The assessment of the socio – economic impacts of new technological concepts in maritime transport, on the human element

Main partial objectives contributing to the achievement of the previous one were:

- The identification of trends in the development of new technologies in maritime transport with a focus on their impact on the human element.
- The identification of technology driven pressures for changes of working cultures in maritime transport.
- The analysis of the changes of the crew's role as a result of the introduction of new technologies.
- The investigation of the role of human factors in the development and implementation of technology in order to reduce workload in ships.
- The application of appropriate assessment methods of the improvement of ship operation by the introduction of improved Human – Machine Interfaces (HMI).
- The development of tools to allow for a cost – benefit analysis on the role of human factors on safety standards on a ship's life cycle.
- The provision of an overview of requirements for MET, based on the new technologies under implementation and the investigation of the application of new methods of training.
- The consideration and demonstration of how new technologies can be utilised by European Registers providing to them a management advantage with parallel positive impacts on the human element.

4. Means used to achieve the objectives

The methodology followed in the THALASSES project was the so-called "productive method" initially introduced by Aristotle (4th Century B.C.) where from the general issues, one moves to the specific ones, similar to what is known in modern times as the "top down" approach.
Diagram 1 presents an outline of the approach followed and the relationships among the 8 distinct workpackages.

In WP 1 (New Technology and the human element in maritime transport) an overview of working cultures and new technologies in maritime transport has been produced together with a first stage assessment (based on expert judgment) of their impacts on the human element and a review of relevant research results.
The basic aim of the work carried out was to produce a holistic state of the art view, which was used to identify areas of importance and be used also as a solid reference basis for subsequent stages of the THALASSES research.

In WP 2 (New Technologies and their impact on Maritime Education and Training (MET)) a framework is developed where main ship tasks are defined and new technologies applied to serve them are identified. Next MET requirements were identified on a macro scale following a systematic consideration of various components i.e. ship tasks, involved new technologies, human need MET technological needs/ methods. Two issues considered next are:

- The applicability of SHIP– MATE process and Tool Set for European Marine systems.
- The utilisation of new technologies (Simulators) in MET.

The SHIP – MATE is a set of integrated, automated tools designed to facilitate the application of human factors principles, methods, and data to ship system design and development. Here the applicability of this tool has been considered for European marine systems aiming to the improvement of mariner education and training, human error avoidance and shipboard manpower reduction.
The issue of utilisation of new technologies in MET is also considered here. A review of impacts and use of simulators on MET is made, especially in relation to STCW 78 as amended.

In WP 3 the application of the integrated ship operation concept and its impacts on the human element is examined. New trends in innovative integrated navigation support systems are also considered together with their impacts on human information and processing decision making behaviour and MET.

In WP 4 the utilisation of new technology in ship registration is examined, aiming to demonstrate the potential provided to European Registers by new technologies in order to improve their management, but also resulting in positive impacts to the human element.

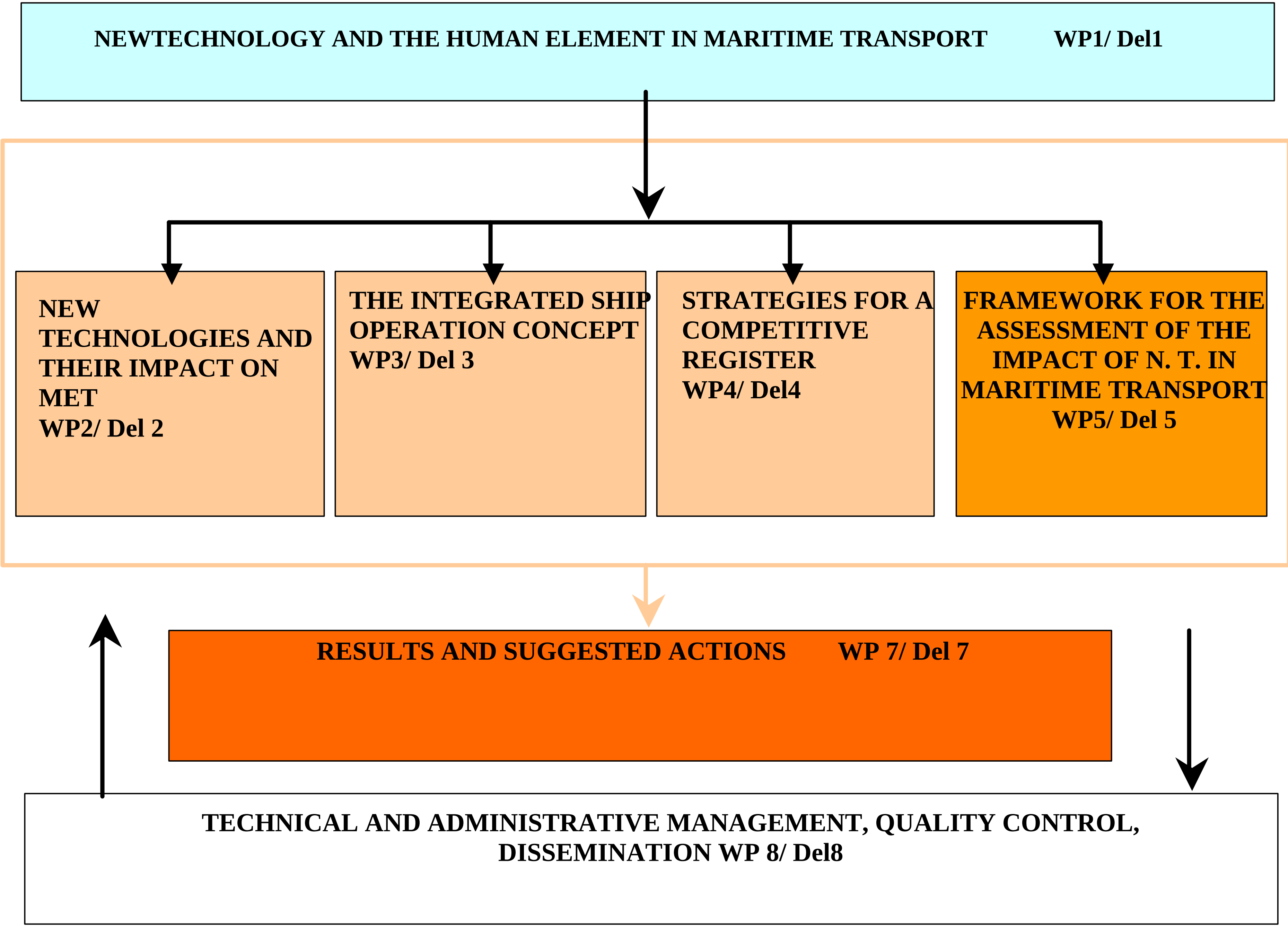
In WP 5 a framework for the assessment of the impacts of new technologies in maritime transport is defined and next applied using a sample of maritime students and officers.

Finally in WP 6 the project's results are presented in the form of:

- main conclusions and suggestions
- main innovative aspects

suggestions for follow up work.

Diagram 4.1 The Approach followed in the THALASSES project



5. Glossary of terms used

AMVER	Automated Mutual-assistance VEssel Rescue
A.R.P.A.	Automatic Radar Plotting Aids
B.R.M.	Bridge Resource Management
C.R.M.	Crew Resource Management
D.G.P.S.	Differential Global Positioning System
D.N.V.	De Norske Veritas
E.C.D.I.S.	Electronic Chart Display and Information System
E.D.I.	Electronic Data Interchange
E&T	Education and Training
F.O.C.	Flags Of Convenience
F.S.A.	Formal Safety Assessment methodology
F.T.P.	File Transfer Protocol
F.U.D.T.	Further and Updated Training
G.M.D.S.S.	Global Marine Distress and Safety System
G.P.S.	Geographical Positioning System
G.U.I.	Graphical User Interface
HCI	Human Computer Interaction
I.A.C.S.	International Association of Classification Societies
I.B.S.	Integrated Bridge System
I.C.T.	Information and Communication Technologies
IEC	International Electrotechnical Commission
IMO	International Maritime Organization
INMARSAT	International Maritime Satellite System.
I.N.S.	Integrated Navigation System
I.S.O. concept	Integrated Ship Operation concept
I.S.M.	International Safety Management code
I.T.F.	International Transport Federation
MARPOL 73/78-	The International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978.
M.C.A.	Multi Criteria Analysis
M.E.T.	Maritime Education and Training
P.L.C.	Port Local Control
R&D	Research and Development
R.I.NA	Registro Italiano Navale
R.T.C.	Rescue Coordination Centre
RAM	Random Access Memory
SHIP-MATE	Ship Manning, Affordability, Training and Performance Effectiveness
S.I.T.	Social Impact Table
S.M.D	Safe Manning Document
S.M.T.P.	Simple Mail Transfer Protocol
S.P.A.	Stated Preference Analysis
S.P.O.S.	Ship Performance Optimisation System
S.Q.L.	Server Query Language
S.S.L.	Secure Server Lines
S.T.C.W.	Standards of Training, Certification and Watchkeeping for Seafarers
S.W.O.T.	Strengths Weaknesses Opportunities Threats
U.S.C.G.	U.S. Coast Guard

V.I.P.	Vessel Identification Package
VRCM	Vessel Register Communication Manager
V.T.M.I.S.	Vessel Traffic Management Information System
V.T.M. S.	Vessel Traffic Management Systems
V.T.S.	Vessel Traffic Services
W.A.P.	Wireless Application Protocol
WWW	World Wide Web

6. Scientific and technical description of the project

1. Introduction – why THALASSES

Although technology issues in the maritime sector have been extensively explored, the evaluation of the impacts on the human factor from the introduction of new technology is an area where consistent efforts have not been made at a sufficient degree neither at European nor at international level. Moreover, as new technologies, operation concepts are continuously developed, it seems that there is a need for a continuous monitoring of their impacts on the human factor.
Human factors is an accepted discipline in many areas, such as aviation, space flight, military systems, nuclear power control systems, process control systems, and manufacturing systems, and is only recently applied to ships and maritime systems.

A definition of human factors is: "the system engineering discipline directed at integrating humans into complex systems". It includes the sub areas of

(1) human factors engineering, concerned with <u>design</u> of human-machine interfaces;
(2) education and training (MET for maritime systems), concerned with education and training to provide the human with the required knowledge, skills and abilities;
(3) system manning, quantity and quality;
(4) safety and health.

A major contributor to the overall safety and effectiveness of marine systems is the performance and readiness of the crew. Human factors initiatives are directed toward personnel requirements in marine systems design. The objective of human factors is to *influence design* with personnel considerations, achieved by addressing personnel requirements early in system development, by emphasizing the role of the human vs. automation in system operation and maintenance, and using simulation to model human performance and workload.

Ancillary objectives of human factors as applied to maritime systems are:

a) Reduced workload and manning;
b) Improved readiness of control systems due to reduced skills, reduced workloads, and task simplification;
c) Improved reliability of ships and ship systems due to reduction of human error rates;
d) Improved personnel availability and survivability due to reduced hazards and accidents;
e) Enhanced system and equipment availability through reductions in time to repair; and
f) Enhanced system affordability, resulting from the reductions in manpower support cost, training cost, cost of systems unavailability, cost of human errors, and cost of accidents.

The European Maritime Industry is experiencing the introduction of new technologies that have significantly changed the way the involved "actors" think and work (operate). It should be pointed out though that the application of innovative technological concepts, is considered necessary in order for Europe to maintain a comparative advantage and safeguard the existence of its strategically important fleet and shipping – related manpower.

THALASSES[1] (New Technologies in maritime transport Interacting with the human element assessment of impacts) is a project funded by E.U/DG VII in the Transport sector of the 4th framework Programme. It is a shared cost project with a total cost of 462,4 KECU's of which 300 are E.U. contribution and its scheduled duration was 18 months starting from January 1998 main aim was to contribute to the assessment of the socio – economic impacts of new technological concepts in maritime transport on the human element by both identifying such impacts and proposing mechanisms for its continuous monitoring and assessment.

The following can be stated as the main contribution of THALASSES.

- Provision of a summary structure of new technology examples where new technologies not yet covered can easily be added. This structure, based on extensive literature review, and expert interviews is a first stepping-stone needed to socio – economic impact assessment of new technologies and was not readily available when THALASSES initiated.
- Provision of a summary structure of human factor examples classified into coherent groups where human factor elements not yet covered in summary structure can easily be added. It is based on extensive literature review, expert interviews and elaboration of WORKFRET results and provides further insight in human factor components on board ship on general level.
- Creation of a structured impact assessment framework, which can be used as a tool for the assessment of the socio-economic impacts of new technologies. This tool has been validated using over 50 interviews with a predominantly enthusiastic reaction concerning tools practicality for non- trained users.
- Development and application of a two-way socio-economic approach to new technology from different angles (looking to human factors from technology perspective versus looking to technology from human factor perspective).
- Application of an integrated ship's life cycle cost approach to integrate ship's life cycle cost in impact assessment of new technology resulting in a further insight in relationship human factor – new technologies via cost elements. This approach provides also the opportunity to take impact of new technologies on ship's life cycle cost more explicitly into account.
- Provision of a thorough analysis of new technology on the human element: social, economic and safety, involving experts in risk assessment and mariners with some 200 man-years of shipping experience. In addition, reliable and comprehensive data from Lloyds Casualty Archives were used containing accident information on some 143,830 vessel years of operation.
- A triangular validation of the results of the impact of new technology on the human element: social, economic and safety has been performed allowing to identify key areas of maritime operations as particularly sensitive to environmental, social and policy changes.

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[1] The Greek work for "seas".

- Contribution in gaining a holistic view of the system human factor-environment and new technologies
- Consideration of the applicability of the Integrated Bridge Operation Concept in relation to the human element issues and to the STCW requirements.
- Production of a review of the Registers world competition, aiming to propose improvements in the working of European registers, utilising new technologies.
- Proposal of a new tool for European Registers, ships the Web site vessel Register Communication Manager that can be utilised to allow profiting of all maritime actors involved.
- Performing a modelling of risk changes, using the Influence Diagram approach, enabling the modelling of human, hardware and external events in risk assessment. Among others, a technique that allows policy makers to predict the outcome of policy decisions on activities remote in time and place has been further refined.

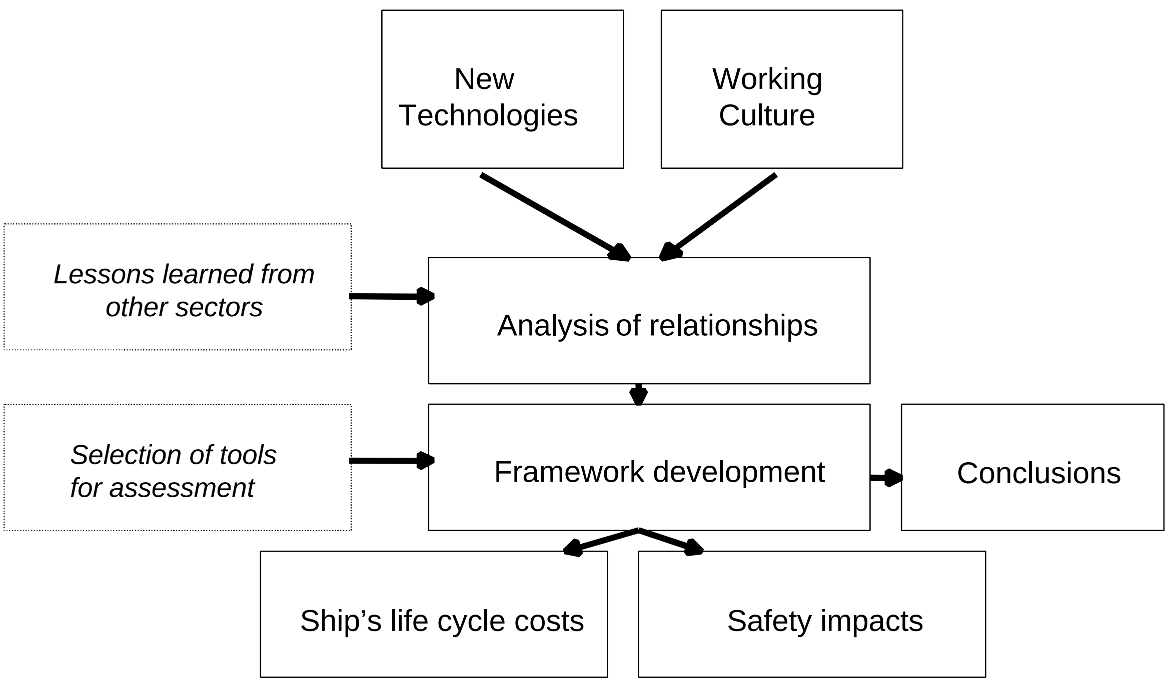
2. Impacts On The Human Factor In Shipping Due To The Introduction Of New Technologies

2.1 Introduction

2.1.1 Methodological approach

This chapter involves research results covering a main objective of THALASSES: the assessment of socio-economic impacts of new technologies on the human factor elements. The methodological approach, which was applied for the structured assessment of the relationship between new technologies and human factor elements, is depicted in Figure 2-1 and will be used as guidance through the main steps of this chapter.

Figure 2-1 Methodology for socio-economic impact assessment of new technologies on the maritime working culture



2.1.2 Structure of this chapter

The first step in describing the THALASSES research results is to clarify the viewpoint of THALASSES on what new technologies are. With respect to the definition of working culture, the THALASSES research refers to the classification of working culture elements of WORKFRET project research. Paragraph 2.2 further includes an overview of new technologies and human factor elements, which was made to come to the selection of the most important elements of (groups of) new technologies and the maritime working culture for further analysis. Also a look is taken at lessons on the implementation of new technologies, which can be learned from other industries.

Paragraph 2.3 then focuses on the assessment framework developed, including the selection of assessment tools for a structured description of the socio-economic impacts. Special focus in the framework assessment is put on cost indications of the relationship between new technologies and the human factor (section 2.3.4) and on safety aspects (section 2.3.3). Finally, the results and main conclusions of the framework tool application are described in paragraph 2.4.

2.2 Overview of new technologies and the human factor

2.2.1 Viewpoint of the THALASSES project on new technologies

What is considered as a new technology by a seafarer may not be considered as such, by for instance, the shipbuilder[2]. It is therefore important to know what is to be considered as a new technology from the perspective of the THALASSES objectives. As the focus of the THALASSES research is on measuring the actual impacts of new technologies in a shipboard environment, it was decided to emphasise on technologies which have already been implemented on board (some) ships or are implemented in a limited number of cases but of which it is expected that implementation will become more widespread. A new technology in the context of the THALASSES research is therefore defined as:

"A technology that has already been implemented on board ships and/or is expected to be implemented to a larger extent in the near future".

The development of new technologies in maritime transport can be explained in different ways according to the perspective with which is looked at those technologies. Given the large amount of either small or big new technology implementations in maritime transport, it turned out to be not feasible to include all new technologies in the research on an individual basis. The new technologies have therefore been looked at from different viewpoints and were then structured along the most appropriate philosophy.

The segments-succession model (Van Eyck, 1977) argues that new technologies are first implemented in one sector and after a while are also applied in another sector, for instance the introduction in the shipping sector of aerospace technology of infrared sensors for improved night-time and adverse visibility conditions. This shows that lessons can be learned from earlier application of specific technology in other industries. This point will be addressed in section 2.2.5.

The Product Life-Cycle theory of the new technologies indicates that new technologies are likely to be implemented to a small extent in the first years after the introduction. After a while, when the technology has become standardised, the new technology is

[2] In the survey of new technology acceptance by Williams &Mills (Public acceptance of new technologies) it is stated that "in new technologies, newness like beauty is essentially being regarded as lying in the eye of the beholder".

expected to be implemented by a much larger number of (shipping) companies. The 'magnitude' of socio-economic impacts of a new technology is expected to be larger when the maturity stage has been reached. However, the 'type' of socio-economic impacts in the different stages is likely to be the same. In the THALASSES research, we have therefore analysed technologies in different stages of the Product Life-Cycle in order to develop the assessment framework.

One of the results of describing the socio-economic impacts of new technologies was that within a certain category of the functional categorisation, the impacts are comparable. Therefore the categorisation based on function of the technology was further used for the development of the assessment framework in the THALASSES project. Five main categories of new technology have been defined, based on categorisation of new technologies that has been used earlier by other researchers. Looking at the categorisation of Donn (1988) and Frankel (1983), three categories of new technology can be distinguished:

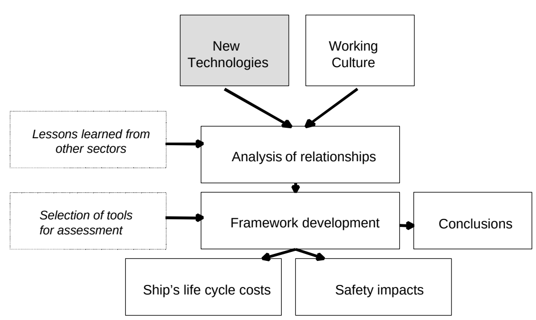
a) New technologies that are related to the design of the vessel;
b) New technologies that are related to the handling and stowage of the cargo;
c) New technologies that are related to the machinery of the vessel.

Not all of the new technologies identified in an early stage of the THALASSES research fitted these three categories. For a safe transport, new technologies are used for navigation, including the communication on board the vessel. Also for the communication between the ship and the outside world, new technologies are implemented. Based on this argumentation two more categories of new technology have been added:

d) Navigation support related new technologies;
e) Communication and management support related new technologies.

2.2.2 Overview and structure of new technologies in maritime transport

New technologies have an impact on the design and machinery of the vessels, the handling and monitoring of the cargo, the navigation of the ship including communication on the ship, and the communication with the outside world. All those categories of technologies that are changing the way the tasks on board the ships are performed are described in this paragraph.



Ship Design related new technologies

The design related new technologies are defined as the development of new vessel types and the design of the interior of the ship. Based on the literature review, three main sub-categories of design related new technologies can be distinguished that each have their own impact on the maritime working culture. The three main sub-categories are Ship size, Ship speed and Ergonomic design of the interior of the ship.

The increase in ship size is still going on. The main socio-economic impacts are the reduction in the number of seafarers that are needed per shipped tonne of cargo, and a decrease in the time that the seafarer can spend in the port while the ship is (un) loaded. An important factor that will influence the ability of the liner operator to work with small crews on large ships is the flag under which the ship is registered. Every register has its own specific demands with respect to the number of people on board.

The main conclusions of the impact of design related new technologies on the human factor, via vessel speed, are illustrated by the fast ship concept. The socio-economic impacts of the fast ship are: the extra workload for seafarers of working in an environment where there is less room for mistakes, the need for extra training to work in a new type of vessel, to work with modern navigation support technologies, and to work to airline style schedules. Much of the impact of the fast ship is related to the use of new navigation support technologies, which are needed to operate the ship.

Ergonomic ship designs aim to adjust the systems on board the ship to the physical and mental capacity of the seafarer. This has a positive effect on the mental workload and the occupational health of the operators and maintenance people on board the ships.

Cargo related new technologies

New technologies related to cargo are defined as innovations in cargo storage on board the ship and cargo handling as far as the handling is taking place on board the ship (and not by shore based equipment in the port). Containerisation has led to more shore-based handling of the cargo and to a rapid turnaround of vessels. This reduces the time that the seafarer spends ashore. The improvement in cargo handling and planning on board ships is further improved by the use of computers. This leads to a reduction in operational tasks for the people on board and an increase in passive monitoring, and also it requires knowledge from the people who have to work with these new systems. The use of completely different designs of vessels to improve the unloading process is still not widespread. Impacts hereof on the human factor are hard to define.

Navigation support related technologies

The navigation support related technologies are the technologies that are used for the communication between the functions and systems on board a ship for data exchange and the common use of sensors and facilities, that support the navigational officer in defining his route, manoeuvring and collision avoidance. This group of technologies refers to technologies such as automated pilots, GPS, ECDIS, SPOS and ARPA. Most of the navigation support related new technologies such as ECDIS and SPOS are increasingly used on board ships. The autopilot and ARPA are already used on almost every ship, and no new additional socio-economic impacts are expected of this technology. Based on

earlier research, it can be concluded that the implementation of navigation support technologies can reduce the repetitive tasks and the workload for the seafarers, if the number of crewmembers remains unchanged.
The navigation support related technologies might also lead to a reduction of the number of ship accidents. More time can be spent on decision making, instead of collecting and processing data. The implementation of navigation support systems makes it possible to integrate functions and can lead to a reduction in the number of crewmembers that are needed to operate the ship, which is likely to lead to an increase in mental workload. On the other hand, automation also leads to passive monitoring that can create boredom for the officer. There is also a risk for too much reliance on automation instead of traditional navigational skills, so that seafarers forget how to handle dangerous situations when the navigation support systems fail to do their work. This aspect is addressed in the paragraph relating to safety issues.

Communication and management support related new technologies

Communication and management support related new technologies are defined as the technologies that are used for the communication with the outside world, that supports traffic management systems and shore based management of the ship. Communication with the outside world includes the exchange of information concerning the ship and its cargo to other ships and shore based parties such as the ports, the shipping company and the customers. This category of new technologies contains technologies such as GMDSS, EDI and Internet. Based on the impacts that these technologies have on the maritime working culture, a distinction can be made in three categories of communication & management support technologies:

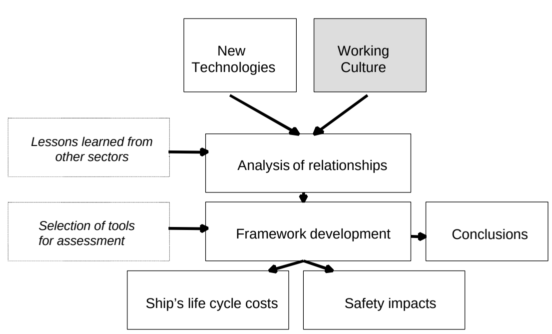
- Distress communication technologies;
- Technologies used for people-to-people communication;
- Technologies used for computer-to-computer communication.

Machinery related new technologies

The machinery related new technologies are defined as all the machines and technological appliances that are needed for the operation of the ship, which are not information or cargo related. Literature review has shown no direct significant socio-economic impact, it has therefore been decided not to include this category in further framework development.

2.2.3 Human factor elements in maritime transport

Working on board a ship has very specific characteristics. Unlike the emergence of technologies, there is no literature containing a structured explanation on what a working culture exactly includes. Stepping stone for the THALASSES research was the



WORKFRET project segmentation of the working culture into five main elements. For the purpose of the THALASSES project a first overview of the maritime working culture with the WORKFRET segmentation was made based on the literature information that was assembled. The approach then adopted was to make a selection of the human factor elements that are most important for the job satisfaction of the seafarer and the specific characteristics of the seafaring job for the purpose of tool application. The criterion of job satisfaction of the seafarer and specific characteristics of the seafaring job has been selected because of the importance to seafarer and the explanatory level of the seafaring culture. The next step, in order to assure that a proper selection of elements was indeed made, was a validation of the selection with the assessment tool application.

The ten selected working culture elements are of course very much interrelated. For instance the payment level is compensation for being away from home and the integration of tasks very much calls for additional training and education. Together, the ten selected elements constitute the main ingredients of working culture on board ships.

1. Organisational structure on board the ship

One of the main features of work organisation on board ships is the segmentation in functions. A rigid segmentation may result in little co-operation between persons, isolation and a high autonomy level for crewmembers. High autonomy means a high independence for the seafarer in making choices. As the deck services, machinery services and civil services become increasingly integrated, hierarchy is less strict and communication lines shorter.

2. Mental work demand

The health of the seafarer is subject to psychosocial burdens. Increased automation on board the ship has resulted in a shift from physical work demand towards mental work demand. Mental work demand is related to the perceptual-cognitive demands of monitoring the technical systems. Too much mental work demand may result in fatigue and stress for the seafarer.

3. Physical conditions

The life of the seafarer is also subject to physical burdens. The conditions on board ship result in a specific physical workload. Ships' decks are unstable because of constant motions, resulting in the need for the seafarer to correct his motions. Specific physical conditions for maritime transport are heat in engine rooms and on deck, vibrations of the engine room, noise from engines and other machinery and radiation by sunlight.

4. Working time

As the crew is always in close proximity of their work, it is rather usual to see long working periods on board, up to some 15 or 20 hours. The longest hours are worked in the highest ranks and watchkeepers. There are of course regulations on working hours (the working hours onboard vessels are foreseen within Directive 98/35/EC and closely controlled by P5C-Officercs), but compliance with at least the minimum rest requirement is difficult to monitor.

5. Payment levels
Seafarers have a relatively high income in comparison with similar functions on shore. This high payment level is a compensation for the long months away from home and a high level of overtime, in short for the less attractive elements of the seafaring job.

6. Need for training and education
The use of new technologies on board ships results in extra training needs for the crewmembers that have to work with these new systems. This means that with regular intervals the seafarer will be asked to take a course/ training in working with new technological systems. However, not all seafarers prefer a function for which a high level of (continuous) training and education is needed.

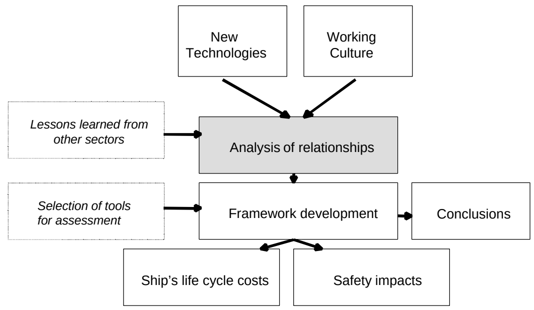
7. Career development
When the seafarer selects his job, one of the aspects he takes into account is the possibility for career development within the company. Included in the career development of the seafarer are the training possibilities that are offered by the shipping company.

8. Social contacts
The fact that working and living conditions are difficult to separate on board ships and the long time away from home puts a lot of pressure on social contacts. New communication technologies such as e-mail, fax and mobile communication have improved the possibility for the seafarer to stay in contact with his family and friends onshore.

9. Integration of tasks, multi-skilling
Automation reduces the number of repetitive tasks in a job, and makes it possible to perform the same tasks with fewer people. Because of the implementation of new technologies on board the ship, different functions are increasingly being integrated. This means that crewmembers must be able to perform different jobs on board the ship. To be able to perform different tasks, the crewmember has to be multi-skilled.

10. Working procedures
One of the main causes for accidents at sea is the lack of adherence to (safety) working procedures. Over the last years, the importance of the human factor in preventing accidents on board and lessening the risk of pollution has been recognised by governments and international organisations (IMO).

1.2.4 Relationships between new technologies and human factor



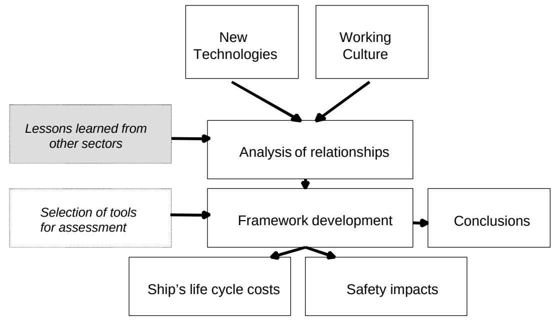
Based on the literature review, it can be concluded that the main effect of the introduction of key technologies on the human factor is caused by the introduction of navigation, communication and management support technologies. The effects of technologies related to navigation support and communication & management support are very similar. The main difference is that the development in information systems on board a ship for navigation support may lead to more decision-making on board, while the development of external information systems may lead to less individual decision-making per ship. This shows an opposite effect in dependence on shore organisation. On the one hand, new technologies facilitate control from shore. On the other hand, it also makes the ship more autonomous. Job tediousness would also be counteracted if certain shore functions would be shifted to the ship.

New technologies in general show the most effect on the number of crewmembers, the job profiles, the workload, the work organisation on board a ship, the safety on board the ship and the necessity of training. New technologies related to navigation, communication and management support are increasingly being implemented, largely in integrated bridge systems, and the effects these technologies have on the human working culture are already partly visible. The expected impact of the support-related technologies is to a large extent based on experience with these technologies on ships where they have already been implemented.

The effects on the maritime working culture caused by the implementation of new designs and new technologies related to cargo are less clear. Most of these new technologies have not yet been implemented. Based on the literature survey it can be concluded that the effects these technologies may have in the near future on the maritime working culture are smaller than the effects of the communication and information related technologies.

Safety aspects of new technologies appear to have counter effects, as can be concluded from the literature review. At first, new technologies improve the shipping safety. On the other hand, the different job functions require more technical people with less operational shipping knowledge, they might not respond adequately in times of calamity. Furthermore, ships also navigate on closer distances between them and other ships, which increases safety risks. This important issue of safety will be addressed in separate sections.

2.2.5 Parallels with the implementation of new technologies in other industries



After recognising the reality that the shipping industry can learn from other industries with respect to the impact of new technologies on the human factor, specific attention was devoted in the THALASSES project to this issue.

The impacts of new technologies in other sectors are summarised below:

- A more indirect relationship between workers (operators) and machines;
- A reduction in the number of complex multitasks which require manual skills and abilities (de-skill);
- A generation of new complex tasks which require mental cognitive problem-solving and interpretative skills and abilities, and an understanding of system interdependencies (up-skill);
- In order to deal with operating contingencies which are not anticipated by the programs controlling the machine, experience associated with the performance of work with the old technology are still required.

Furthermore, managerial decisions and the negotiations of the labour union are likely to influence the impacts of new technologies on the human factor on board vessels. The de-skill effects of the implementation of new technologies can be mitigated, when the management decides to implement job enlargement, job rotation and a flexible workforce. The labour unions can negotiate about the minimum number of crewmembers on board the vessel and the conditions of employment.

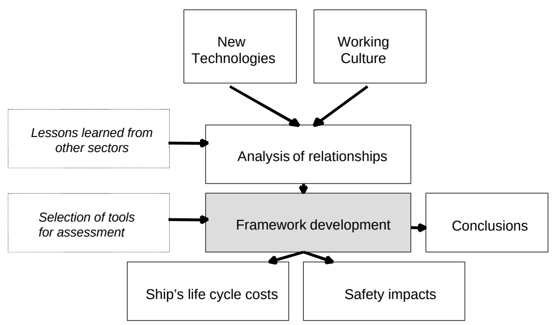
One of the main things that have become clear from the experience in other industries is that human-centred system design can have a positive impact on the job satisfaction of the seafarer, when a new technology is being implemented. Human-centred system design explicitly promotes 'the development and introduction of more skill-based, humanised, or anthropocentric systems' (Badham, 1990), where consideration is given to the implications of technological characteristics and capabilities for organisational outcomes extending well beyond the traditional 'human factor elements' concern with the physiology of individual employees. For example, ergonomic design principles are advocated which involve:

- The design and use of technology in a way which complements rather than replaces human skills;
- Provision of a work environment that maximises social communication and promotes healthy, safe and efficient working.

2.3 Application of assessment framework for measuring new technology impact on the human factor in shipping

This paragraph shows the characteristics of the framework that was developed to provide a structure for the measurement of new technology impacts. The framework assessment tool thus developed aims to provide a contribution in the expansion of the knowledge basis in the field of the assessment of socio-economic impacts in maritime transport, where little structured information is available up to now. First, the objectives and the approach to the development of the assessment framework are described. In addition, the main features of the framework are discussed. Then the various assessment framework tools are described. After this the two special focuses (safety and costs) for which the framework has made special allowances, are described. Finally, the issue of validation of the developed framework assessment tool is discussed.

2.3.1 Assessment framework development



In paragraph 2.2, the ten human factor elements that are expected to be of the most importance to the seafarer, and four main groups of new technologies have been presented. A literature overview has described the most important relationships between new technologies and the human factor elements in sea shipping. The next step is now to develop a structured though flexible framework which will allow for measurement of those expected relationships and which will also allow for an integrative approach to more in-depth research on items which are thought of as especially important.

Apart from the ability of measuring expected relationships and providing the possibility of enlarging upon specific elements of the relationship, the framework should also allow for a segmentation in properties which are 'external' to the relationship between new technologies and human factor elements, but which may have a high explanatory value for the identified relationships, possibly resulting in different relationships. Elements that have a big influence on the observed relationships between new technologies and working culture include the following:

Ship register
Every register has its specific demands on the number and qualification of crew on board of the vessel, its specific regulation with respect to safety issues and specific investment characteristics.

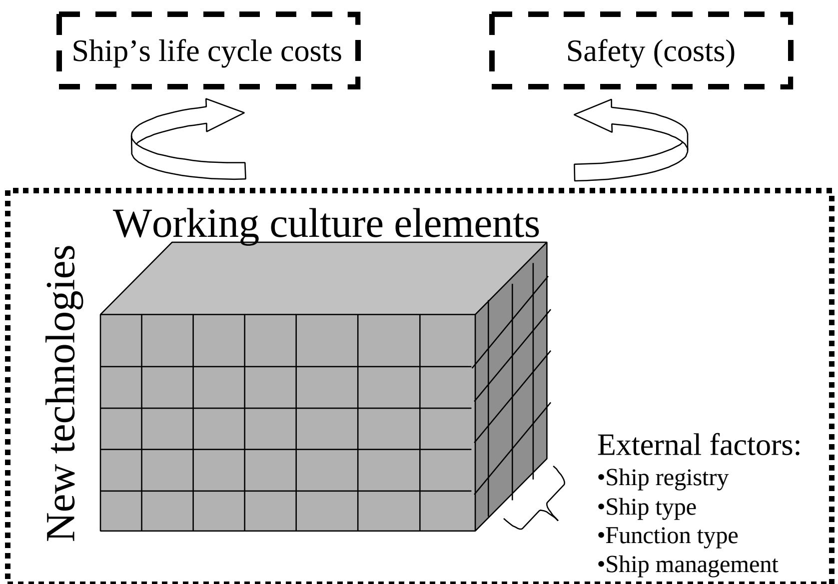
Ship type
Human conditions and the application of new technologies vary between different ship types (e.g. fast ships compared with traditional general cargo ships).

Function on board
The appreciation of working conditions is different depending upon the position in the crew: the captain may have a different opinion from the mates.

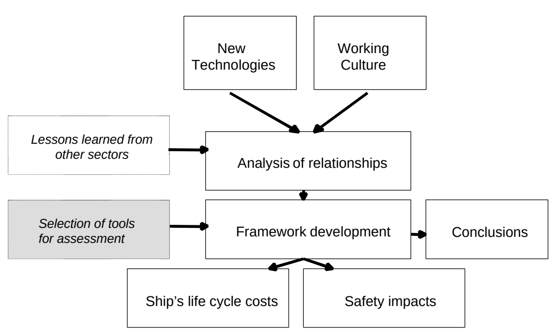
Ship management
The way in which a ship is managed, e.g. the levels of hierarchy and the relationship with the shore management, has influence (on the opinion) of the impact of new technologies on the human factor.

Summarising, the attributes of the assessment framework are shown in Figure 2-2. The figure shows that the relationships between working culture elements and new technologies can be identified categorically in a 3-dimensional cube, with a segmentation according to 'external' characteristics (z-axis), and with special focus on ship's life cycle costs and safety.

Figure 2-2 Assessment framework overview



2.3.2 Assessment framework tools



The assessment framework development actually provides the background for core of the THALASSES research on assessment of impacts: the tool for assessing the socio-economic impacts of new technological concepts in maritime transport on the human factor elements. For this purpose, all main

THALASSES partners made a selection of tools, which were then operationalised and tested in a trial application.

After careful consideration, a combination of three (of which two already existing) tools have been selected to meet the objective of the framework assessment. These tools are the Stated Preference Analysis, the Multi Criteria Analysis and the Social Impact Table:

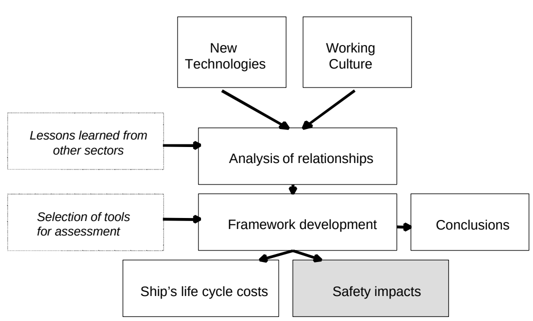
- With the help of the Stated Preference Analysis (SPA) the elements of the human working culture have been ranked according to their importance for the job satisfaction of the seafarer. This way, quantitative insight could be given into the value of non-quantitative elements.
- The Multi Criteria Analysis (MCA) was selected to contribute to the tool because of its ability to take inputs on a micro (respondent) level and translate these to a macro level.
- Finally, the development of the Social Impact Table (SIT) was necessary to link the preferences in human factors to the selected new technologies and thus show the importance of specific new technology categories to the human factor.

As said, the third dimension axis of Figure 2- shows that the impacts of new technologies on the human factor may be different for each so-called ‘external factor’. For example: Each type of crewmember (e.g. bridge officers, mates, machinery crew) varies by country or age. The tool developed allows for such segmentation. For instance, in the trial application with over 50 interviewees a distinction has been made between students and officers.

The assessment tool elements, and thus the assessment framework, are very flexible in the sense that they can be extended to include other new (groups of) technology. This facilitates potential further application as the focus in the research has been on the development of a tool for socio-economic impact assessment of categories of new technology and not so much on providing an extensive overview of all emerging new technologies which are still in a conceptual state.

2.3.3 The safety element in the assessment framework

The safety element was selected as a special focus because of its important relationship both with new technologies and with human factor elements. The methodology used in identifying and modelling human factor costs for the THALASSES Project is based on the Formal Safety Assessment (FSA) methodology. FSA is a new approach to the regulation of shipping safety and is based on the principles of identifying hazards and evaluating risks, and has as its objective the development of a framework of safety requirements for shipping in which risks are addressed in a comprehensive and cost effective manner.



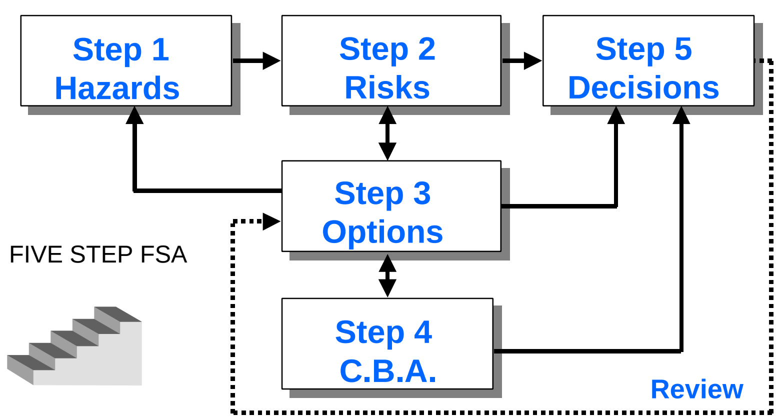
FSA was created to assist regulators to move from a largely prescriptive regulatory approach to one that is proactive. Since its creation, BOMEL has developed the FSA methodology to extend its application beyond the direct interests of international regulators such as IMO. FSA can be, and has been, applied for the following reasons:

- ? To prioritise areas where regulation should be developed;
- ? To consider a particular ship type;
- ? To consider a particular failure mode (e.g. grounding or fire);
- ? To consider a particular failure cause (e.g. engine failure or navigational error);
- ? To consider a geographic area or region (e.g. straits or ports).

Essentially FSA can now be applied to any operation where changes in circumstances create changes in risk levels. In the context of the THALASSES Project, the changes in circumstances are those associated with the implementation of new technology. It was therefore considered appropriate to apply the FSA methodology to assess the extent of the change in risk following from the implementation of these new technologies. In this instance it is to be applied to assess the impact of changing navigational and communication technologies on human factor elements risk and safety standards.
The FSA Methodology is a five-step process as follows (see Figure 2-3):

Identification of hazards;
Assessment of risks (frequency and consequence) associated with these hazards;
Consideration of alternative ways of managing these risks;
Cost benefit assessment of alternative risk management options;
Decision on which option to select.

Figure 2-3 Formal Safety Assessment methodology



Step 1 of the FSA process involves defining the problem area and the identifying and screening of hazards. Deliverable 1 of the THALASSES project provided a definition of the problem area. Historic data from the Lloyd's Register Casualty Database enabled the principal hazards to human life and the level of risk associated with generic shipping to be deduced.

Step 2 of the FSA process involves quantifying the risk associated with the principal hazards identified in Step 1. It also involves the development and quantification of an influence diagram to describe the causal influences involved in generic shipping accidents. Again, historic data were used to establish the base line of risk for generic shipping accidents. Subject matter experts were then used to provide a post hoc review of the influences implicated in the accidents.

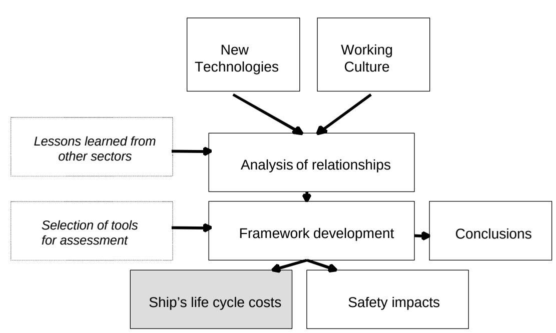
Step 3 of the FSA process involves a reassessment of the risk of accidents following an intervention to improve the status of the causal influences. Ordinarily, the interventions modelled for their impact on causal influences are regulatory in nature. The innovative aspect of the THALASSES Project was to model the intervention of new technology for its impact on the causal influences and thereby to model the impact of new technology on safety levels.

For completion, Steps 4 and 5 of the FSA process are described. However, a full FSA study was outside the scope of the THALASSES Project. Step 4 and Step 5 involve assessing the costs and benefits of the intervention designed to bring about a reduction in risk levels. The Cost Benefit Assessment (CBA) then informs the decision-making process. Where the intervention is a new piece of legislation, then the CBA will inform the rule-making process. Essentially this is a check to ensure that the impact of the intervention provides a net benefit over the cost of its implementation.

In summary, the maritime industry has many facets that are changing. An analysis of the impact of new technology is far from complete, if it concentrates on the technology in isolation of all the other facets that it is influenced by. Accordingly, a complete and thorough analysis has been provided that looks at ALL the interrelationships of technology in a maritime context. The techniques currently used by the risk assessor do not enable all the interrelationships of human, hardware and external events to be modelled simultaneously; e.g. fault trees and event trees. BOMEL has developed an innovative technique as an integral part of the FSA methodology to capture the principal elements involved in accident events: the influence diagram approach. This technique enables changes in the quality of elements, such as equipment operability and crew competence, to be modelled for their impact on one another and for their joint impact on safety.

2.3.4 The element of ship's life cycle costs in the assessment framework

Also the issue of cost associated elements in the relationship between new technologies and the human factor was thought to be of special research interest. In order to fit cost estimations into the framework model, a selection has been made of a shipping cost model, allowing for



segmentation between different cost elements. The activities were focused on the selection of an appropriate existing cost model and explanation of the relations between ships life cycle costs, crew, and technology. A review of models showed that many models might have been used for further elaboration for illustrating the relationship between new technologies, human factor elements and cost elements. Comparison of the model elements showed that they all cover more or less the same elements and are all of them appropriate for use in this context. The most important model elements are the following:

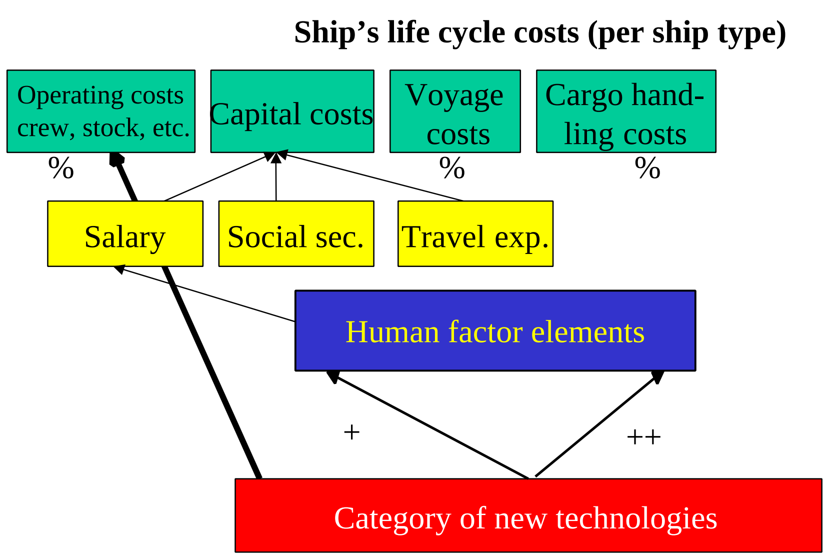
- Ship type;
- Size of the ship;
- Crew composition;
- Fuel;
- Number of operational days.

Four main cost components can be identified:

- Operating costs: comprising the costs that are related to the daily operation of the ship.
- Capital costs: comprising the payback of a loan and the interest cost.
- Voyage costs: comprising the variable costs that are dependent on a specific trip.
- Cargo Handling costs: costs involved with ship loading and unloading.

The total costs of a ship per day can be estimated in a certain year as function of the above-mentioned costs. The relationship between the different ship's life cycle costs and human factor elements is indicated in Figure 2-4.

Figure 2-4 Relationship between ship's life cycle costs, new technology and human factor elements



The figure shows that there are direct relationships between new technologies and ship costs, such as the capital costs of investment in new technologies in a ship. Second, from the viewpoint of the human factor, there are also indirect relationships between new technologies and costs via the human factor element.

Indirect relationships between costs and new technologies via human factor elements can appear in three different ways:

- New technology resulting in lower crew numbers;
- New technology resulting in a different composition of the crew with other wage levels;
- New technology resulting in a change in (overtime) working hours.

2.3.5 Validation aspects

In the assessment framework, relationships are identified between a selection of new technology groups and human factor elements. This selection was based on a literature overview of new technologies and human factors in maritime sectors. The main aim was the development of a framework tool that would allow for a structured assessment of the relationships. The assessment tool now developed is however not only very flexible in allowing for different types of segmentation (function, age, country, etc.) but also in the choice of new technologies and human factor elements to be taken into account.

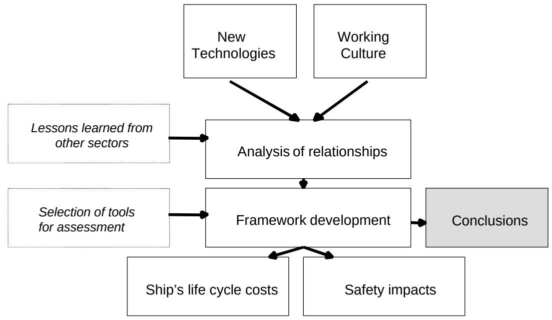
The purpose of the framework tool application was principally to validate the methodology proposed for assessment of impacts. The results of the framework tool application show that the selected tools are appropriate for assessing the relationship between new technologies and the human factor. This goal of validation has therefore been achieved.

It is also possible to draw some general conclusions with respect to the identified relationships between human factor elements and new technologies and with respect to different results between officers and students. Though the number of interviews in which the assessment tool was applied was adequate (50), the results were not yet fully stable. It is therefore recommended to perform additional interviews to fine-tune conclusions on the actual preference of human factor elements and of importance of the different items of new technologies.

The research on the relationship between safety and human factor costs was based on recent historical accident data collected over a period of 9 years. The review of the assessment of the safety impact of new technology was thorough involving experts in risk assessment and mariners with some 200 man-years of shipping experience. Reliable and comprehensive data from Lloyds Casualty Archives were used as a basis for assessing the baseline of risk. This contained accident information on as much as some 143,830 vessel years of operations.

The aspect of ship’s life cycle costs in the framework was based on a selection of ship costs models, which already have proven their value in many applications. No additional validation activities have therefore been undertaken.

2.4 Main impacts identified and their consequences



This paragraph covers the main results of framework assessment tool application with respect to the impacts on the human factor in shipping as a result of the introduction of new technologies. First the main conclusions on the elements on which a special emphasis was put, the safety aspects and ship's life cycle costs, are given. Then the results of Stated Preference Analysis, Multi Criteria Analysis and Social Impact Table on the relationship between new technologies and the human factor are interpreted. Finally, special attention is put to the issue of user acceptance of new technologies.

2.4.1 Focus on safety relation

An important element in the relationship between new technologies and the human factor is the issue of safety. This aspect of the relationship has therefore been given special attention in the THALASSES project. The following overall conclusions concerning the application, the effectiveness and practicability of applying the FSA process to assess the impact of technology on safety standards may be drawn:

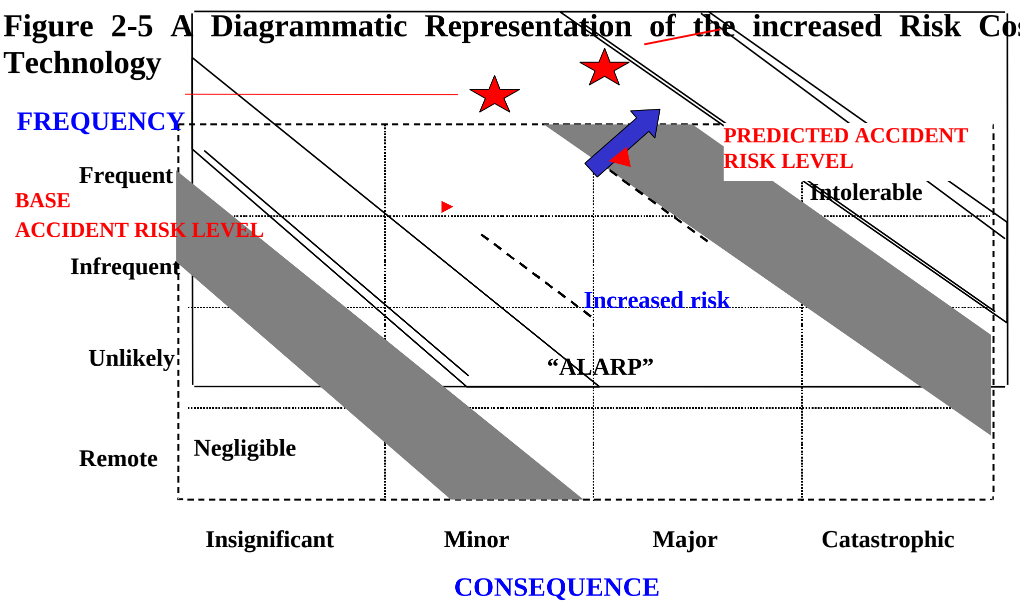
- Human factor costs were assessed using historical accident data collected over a period of 9 years. The review of the assessment of the safety impact of new technology was thorough involving experts in risk assessment and mariners with some 200 man-years of shipping experience. The experiences of the experts indicated that ON BALANCE the risk of accidents has increased by 37 per cent. New technology has the potential to make operations safer. However, factors such as the non-standardisation of design erode this potential safety benefit.
- Given the data were collected in the period 1985 to 1994, the data were also assessed as sufficiently contemporaneous to be of relevance to the assessment of human factor elements costs following the introduction of technology.
- The data enabled the frequency and consequence of accidents to be deduced. With this information, it was possible to estimate a baseline of risk of possible loss of life for all the accident categories. This baseline of risk represented the safety standard of generic shipping for the period prior to the introduction of new technologies.

The impact of new technologies on safety standards was modelled using the Influence Diagram Approach. This approach was developed as part of the FSA methodology for use by the IMO (see reference 51), where such diagrams are referred to as "Regulatory Impact Diagrams" to reflect the regulatory context of IMO decision making. The Influence Diagram approach enables assessment of all the factors that influence the likelihood of accidents occurring, and is described more fully in reference 29, the report of an application of FSA to high speed catamaran ferries.

It is widely accepted in the maritime community that human actions contribute significantly more to a system failure than technical elements, yet there has been an over-reliance on methodologies, which examine solely the technical contribution. The Influence Diagram approach within the FSA methodology enables a systematic review of human and non-human failure mechanisms, as well as their interaction with each other, and their interaction with external elements.

- In order to model the impact of new technology, it was first necessary to determine which factors influence safety standards. A total of 37 influencing factors were defined: four at the societal level, seven at the policy level, ten at the organisational level, and thirteen at the direct level.
- In much the same way as it is necessary to determine the frequency and consequence of accidents to determine risk, it is necessary to define the weight and quality of the influencing factors in order to establish causal chains. Subject matter experts with approximately 200 man-years of shipping operation experience, assessed the weight and quality of the influencing factors for the pre and post implementation of technology. This enabled a model to be drawn of the impact of new technology on safety standards, i.e. the pattern of sway the influencing factors have on accident events.
- Essentially, the pattern of influence on generic shipping operations remains constant, for example, the influence TRAINING will always influence the direct level influence COMPETENCE of employees. The variation occurs in the quality of the influencing factors. The quality of the influencing factors is affected by changes in the generic shipping operation such as the introduction of new technology.
- The influence diagram enables not only the pattern of influence to be modelled, as required for the THALASSES Project, it also allows an assessment of the impact of new technology, by assessing the change in quality of the influencing factors. Thus the cost, in terms of change in risk, is also modelled (see Figure 2-5).

Figure 2-5 A Diagrammatic Representation of the increased Risk Cost of New Technology



The following conclusions may be drawn about the cost of the implementation of new technologies in relation to the safety standards of cargo shipping operating in EU territorial waters:

? For generic cargo shipping, according to historical accident data, the largest risk to human life arises from the collision of vessels. The second and third events with high risk of loss of life are flooding/foundering followed by hull and machinery failure.
? Casual chains indicate that the key initiating events preceding a collision are operational error and system failure leading to the vessel being set on an inappropriate course. For the purposes of the THALASSES project, a causal chain was used whereby all the principal accident events were modelled in one diagram.
? The assessment of risks carried out in Step 3 (Post Implementation Assessment) predicted risk levels in terms of potential loss of life per vessel operating year as shown in Table 2.1.

Table 2.1 Predicted Risk Levels for each Accident Category following the Implementation of Technology.

Accident Category	**Risk Pre Implementation**	**Risk Post Implementation**
Collision	0.0061	0.0084
Foundering / Flooding	0.0041	0.0056
Hull & Machinery	0.0041	0.0056
ALL CATEGORIES	**0.01842**	**0.0253**

The experts indicated that the following deficiencies in generic cargo operations have led to the deterioration in safety standards indicated in Table 2.3 above:

? regulatory confusion as to the mandatory requirements for the type approval of new technologies;
? the inability of the purchaser to influence the specification of the equipment they are purchasing;
? the paucity of standardisation in the design of the equipment;
? the lack of type approval training for operators of the equipment;
? the inadequacy of equipment manuals;
? the over-reliance by officers on the accuracy of systems such as ECDIS
? the inexperience of officers who are being promoted too early;
? and, commercial pressure to put to sea in adverse weather conditions in vessels that are not as robustly constructed.

In summary, the risk of loss of life has increased because of the implementation of new technologies in the context of a changing international maritime industry. Accordingly, the human costs associated with generic cargo shipping operations are likely to be experienced in terms of increasing fatalities in a given time period.

2.4.2 Focus on ship's life cycle costs relation

The human factor has direct relationships with some ship cost departments. The numbers of crew, quality and distribution of skills have probably the highest impact on other cost elements. In the following table the most important ship cost elements are mentioned, with an indication of the importance of the specific element in total ship cost and of the effect of new technology. The indicated distribution of ship's life cycle costs is of a general nature. It might be clear that the actual distribution of costs and the magnitude of the indicated effects depend on ship type, country of registration, etc.

Table 2.2- Cost effects

Cost type	Cost element	Estimated share in total ship costs	Technology impact*
Operating costs	σ Labour costs	20%	+
	σ Stock costs	1%	+
	σ Reparation & maintenance costs	4%	++
	σ Insurance	2%	0
	σ Administration	2%	+
Voyage costs	σ Fuel costs	17%	+/-
	σ Port dues	4%	0
Capital costs	σ Investment costs	46%	--
	σ Financing costs	4%	0
Cargo handling costs	σ (Un)loading costs	Part of operating costs	++

* ++ : there is an important positive relationship between new technologies and the mentioned cost element;
\+ : there is a positive relationship between new technologies and the mentioned cost element;
0 : there is no relationship between new technologies and the mentioned cost element;
\- : there is a negative relationship between new technologies and the mentioned cost element;
-- : there is a large negative relationship between new technologies and the mentioned cost element.

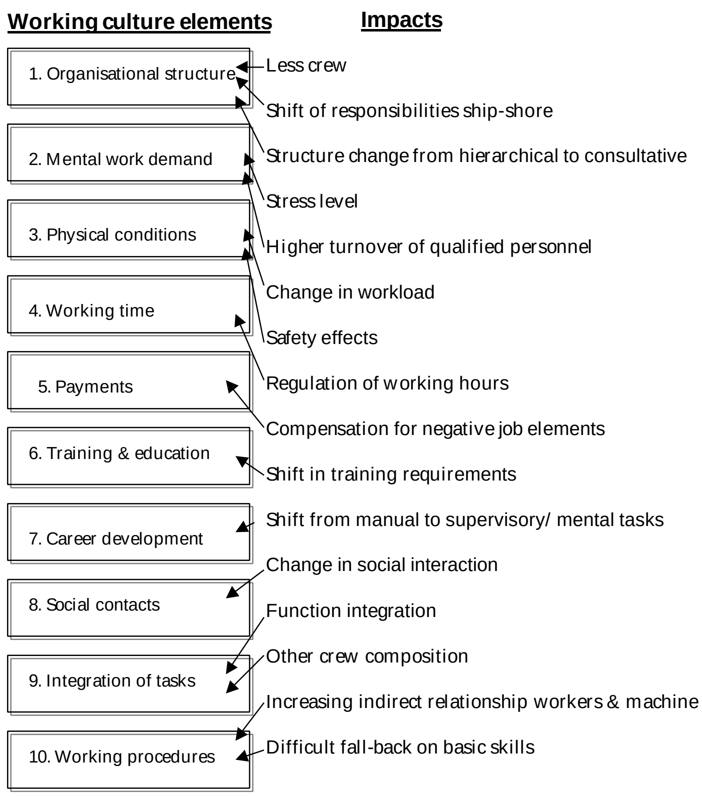
The table shows that technology innovations have significant impacts on different elements of the cost structure of ships. Based on the above table it is not possible to make an analysis of the costs and benefits of the implementation of a specific investment in new technology. This should be done on a case-by-case basis. The merit of the general table above is that it gives insight into the various cost elements that can be affected by new technologies and into the relative average importance of the mentioned elements.

2.4.3 Outcomes of tool application

General

Based on the literature review and tool application a total of 16 main interrelationships between new technologies and human factor elements have been identified, see Figure 2-6.

Figure 2-6 Selection of identified impacts of new technology on the main elements of the maritime working culture



Further to this, next the results of tool application for each of the tool elements (SPA, MCA/SIT) are described and interpreted.

Stated preference analysis

Figure 2-7 shows the results of the Stated Preference Analysis for all respondents, indicating the importance, which is attached to each identified human factor element.

Figure 2-7 Results Stated Preference Analysis: weights attached to the elements of working culture

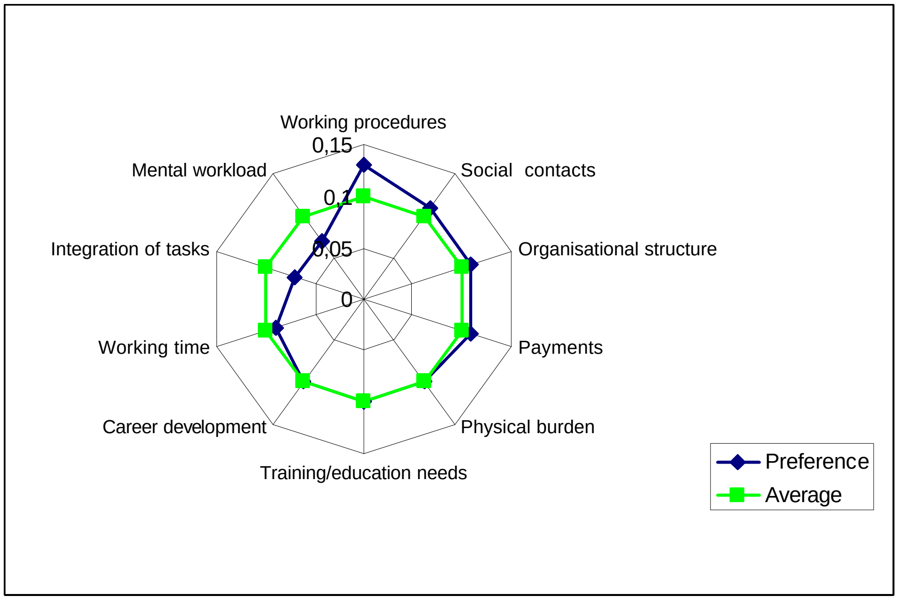
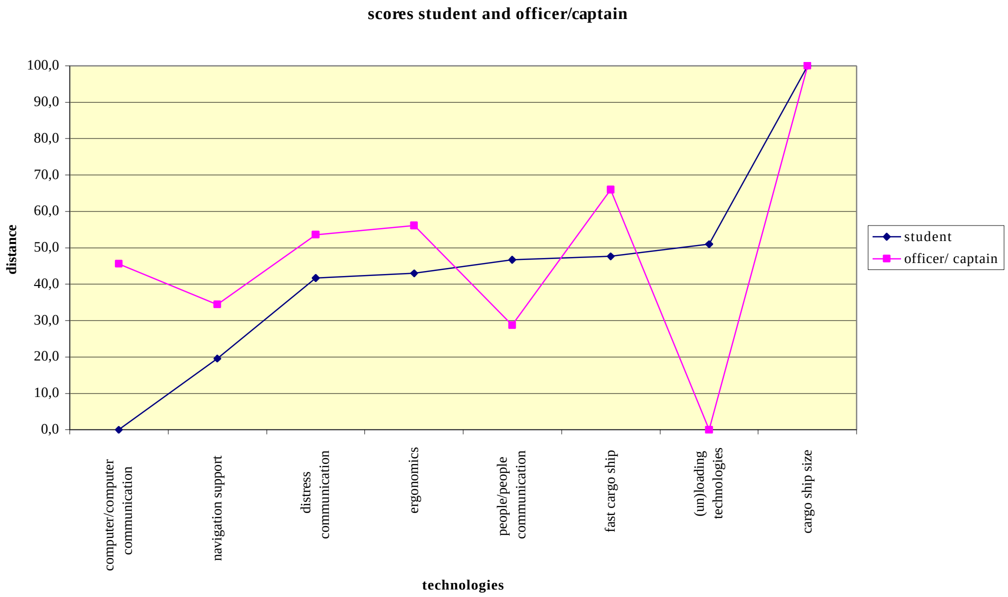


Figure 2-7 shows, in general, that there is little distance between the elements. More specifically, ‘working procedures’ (the organisation of work) has been selected as the most important element, followed by social contacts. The least important elements to the respondents are the integration of tasks and mental workload.

Multi Criteria Analysis/Social Impact Table

The results from the Multi Criteria Analysis integrated with the results of the Social Impact Tables show a marked difference between the opinion of current officers and the interviewed maritime students on the importance of the selected (groups of) new technologies on the maritime working culture. This may either indicate that opinions change once the students have actual job experience or that future commanding officers will have a different opinion on the importance of the different technologies. Figure 2.8 shows for each (group) of new technology the distance to the next alternative, where the most important elements starts from distance zero, and the least important ads up to distance 100.

Figure 2.8 Results of Multi Criteria Analysis: importance of selected new technologies for the total of all working culture elements



The results show that students think that computer communications innovations have the highest impact on the maritime working culture, whereas officers and captains think the (un) loading technologies show the highest impact. Students may be more aware of new computer-to-computer communications such as EDI as a result of the training that they currently receive at their schools. Captains and officers might be inclined to think of (un) loading technologies as having the main impact because they have seen the rapid evolution of container technology in the last decades and the results this has had on ship turn-around time and sailing patterns. Both groups clearly agree in assuming that increased ship size has had the smallest impact on the maritime working culture. This might be explained by the fact that the biggest reduction in crew numbers is already some years in the past.

2.4.4 User acceptance of new technologies

In the THALASSES context, user acceptance is considered as an important issue in the relationship between new technologies and the human factor. The THALASSES research has mainly focused on the appreciation of new technologies that were already implemented, and not at the process of implementation and the role of the human factor in this implementation process. However, some general observations can be made on the subject.

Users of new technology can be defined as those individuals or groups who, during the course of their appointed work, are required to apply this new application. This might refer to both crew on board as to administrative personnel in the shore office. The fact that the group “crew” is not homogeneous in terms of work contents and tasks should be taken into account and for that reason, the impacts from new technologies within the group of individuals are expected to be different, as can be further quantified with the help of the framework tool.

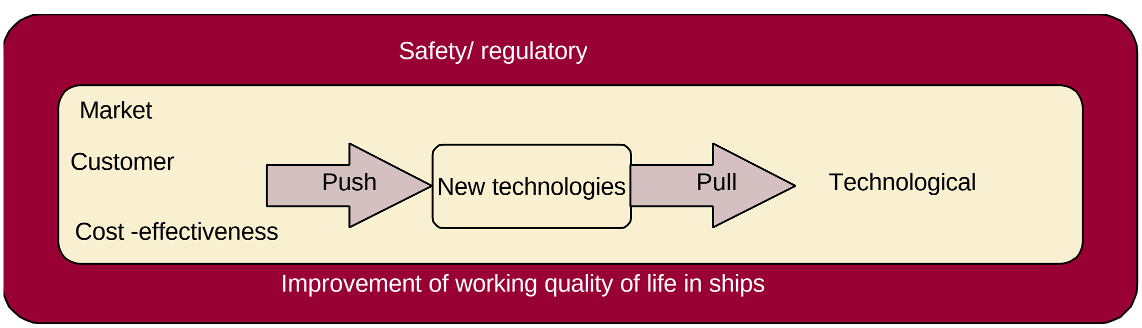
User acceptance is a spectrum of states, ranging from outright opposition by some, via a passive and quite probably grudging condition in which the issue is only just tolerated, to one in which it is positively welcomed. This state is intrinsic to the technology being offered and the individual or group to whom the technology is being offered (Williams & Mills, 1986). Acceptance of new technologies is thought of as having a number of interleaved layers (in order of importance):

1. The health and safety dimension;
2. The loss associated with new technologies, arising from a fall in the value of skills or job-killing consequences some technologies are thought to have;
3. Being deprived of some positional goods: for instance rural remoteness being lost to the advancement of the motor car;
4. The implications for privacy and the fear of an increasingly oppressive state;
5. Criticism on new paths of social behaviour facilitated by the new technologies (TV-watching);
6. Nostalgia for a supposedly simpler life and guilt about comfort;
7. Moral outrage at the interference of man in the natural order;
8. Alteration of the power balance between the interests in a society.

The THALASSES project has been active with the three most important layers of user acceptance: a special focus has been put on the issue of safety, and in describing the relationship between new technologies and the human factor the impacts (both losses and positive effects) have been described. An example of the third layer is the loss of adventurousness of the seafaring job: there is little room in visiting ports as a result of the ever-decreasing ship turn-around times. The layers 4-8 are on broader scale than only the maritime sector and are therefore outside the scope of the THALASSES project.

The level of user acceptance is very much dependent on the reasons why the new technology will be implemented (see Figure 2.9).

Figure 2.9 Reasons for implementation of new technologies



The following motivations can be found for implementation of new technologies in the maritime industry:

Safety considerations: contributing to disaster prevention and pollution;

Regulatory requirements: a minimum level of technological equipment is required by regulatory institutions;

Cost-effectiveness (cost-push): the intense global competition stimulates the use of new technology as a contribution to the reduction of operational costs;

Customer demands: some technological concepts are developed to (better) fulfil customer needs such as faster or more environmentally friendly transport;

Technological innovation (technology-pull): new designs fresh from the drawing table may create their own demand;

Improvement of working conditions and quality of life on board ships: in order to attract appropriate personnel, ship owners may want to invest in technology applications which provide for instance better ergonomics or workload reductions.

New technologies that have been implemented for reasons of safety and improvement of working conditions have a much bigger chance of immediate user acceptance than for instance new technologies based on customer demands or cost effectiveness because the relationship with the crew's interest is more direct.

3. Human Element In The Application Of Integrated Ship Operation Concept

3.1 Methodological approach

This part of the work of the THALASSES project aims to present the state of the art of the implemented integrated ship operation concepts aiming in the analysis of the impacts on crew members and on MET, based on the example of the ECDIS implementation and also the new systems on the integrated bridges.

A top down approach has been used. Following the IMO Generic ship function description, the several levels of “internal on board functions” and the “external functions” ashore have been analysed.

3.2 The social and technical system “ship” in the global transport chain

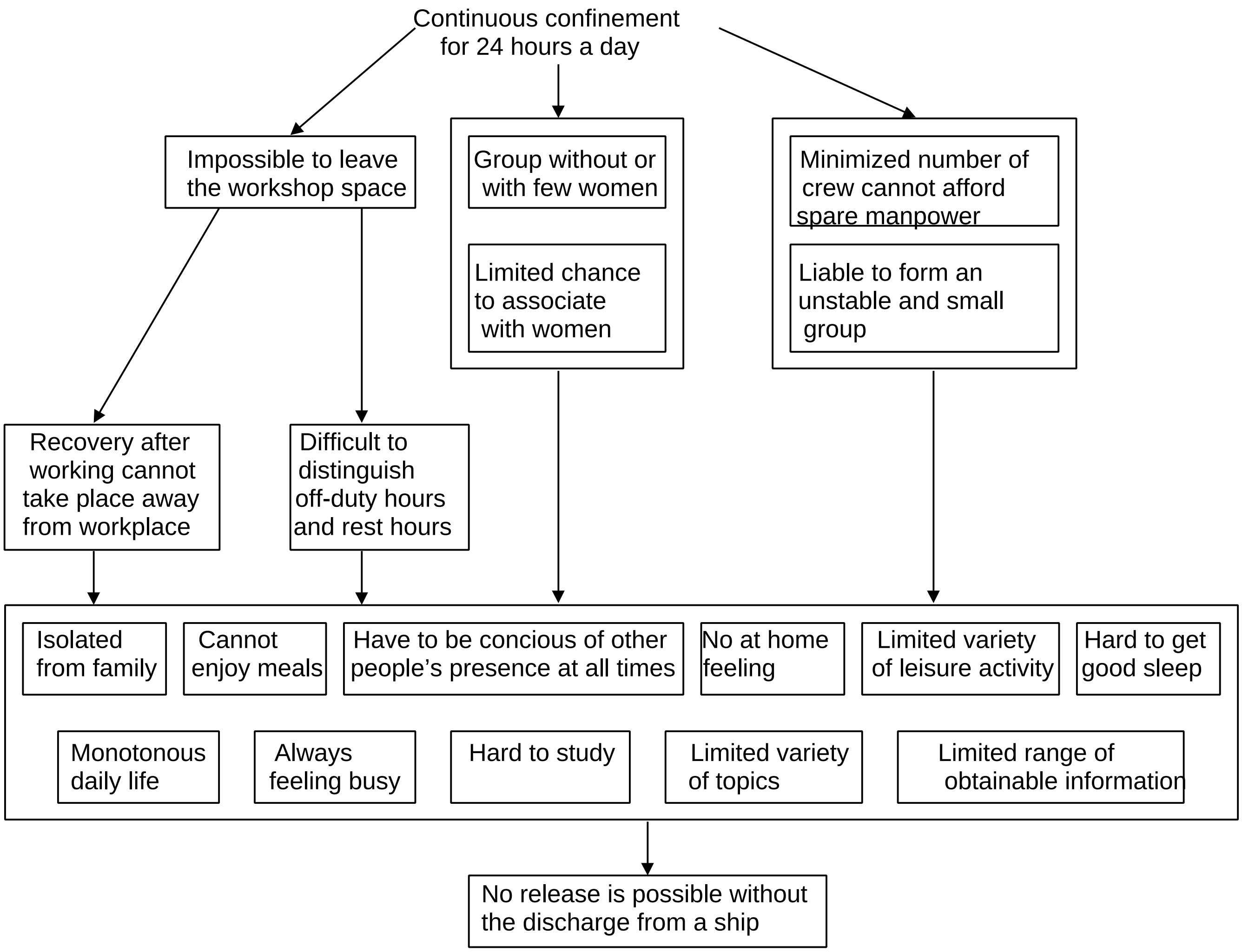
From a sociological and operational point of view a ship can be seen as a “swimming company”, even as a “total Institution“. Goffman (1973) wrote about this concept:

“A total institution is a social system which is geographically distinct, usually isolated by some barrier from the surrounding community and territory. The isolation may be afforded by walls, by rigorous guarding and locking systems, or by great distances from neighbours and population centres. A total institution is an organisation set up with a specific purpose and blueprint; it is not a spontaneously grown social unit.”

Fig. 3.1 shows some relations between work and living conditions on board a ship. Normally, working and living conditions can be separated into a) place of work, b) social field and c) individual sphere. For the ‘total institution’ ship, all three fields are nearly inseparable and unchanging. They form a unit in which each part influences the others constantly, and there is almost no chance for the crew members to forget their function within the working system and play another role during their leisure time. An officer, for example, is an officer in all situations and during his whole presence on-board. Some psychological theories agree on the point that changing roles is important for the mental hygiene of an individual, but the ship is a working place for all its members, so the social structure develops more or less from the working hierarchy.

The management of the working system is incumbent on the master on duty, whose tasks on board can be summed up as follows:

Fig. 3.1 Relations between work and living conditions on board a ship.



Ship Management

Planning, realisation and monitoring of all steps required in the execution of commissions given to the vessel.

Personnel Management

The ship seen as a service enterprise has to be managed according to its constant mobility.

Bridge Command

The task of transportation by ship is to be solved considering all surrounding factors.

Navigation

Track-keeping
Cargo surveillance

Technical Monitoring

Securing the correct function of propulsion and other technical systems.

3.3 Generic Ship approach

The requirement for a generic model[3] is a result of the need to describe operational (integrated) concepts on board. Whereas a technical description of a particular vessel and its operation would be required for describing the approaching integrated concept as a whole system, this would be inappropriate for application to a range of different vessels even if their function was similar.

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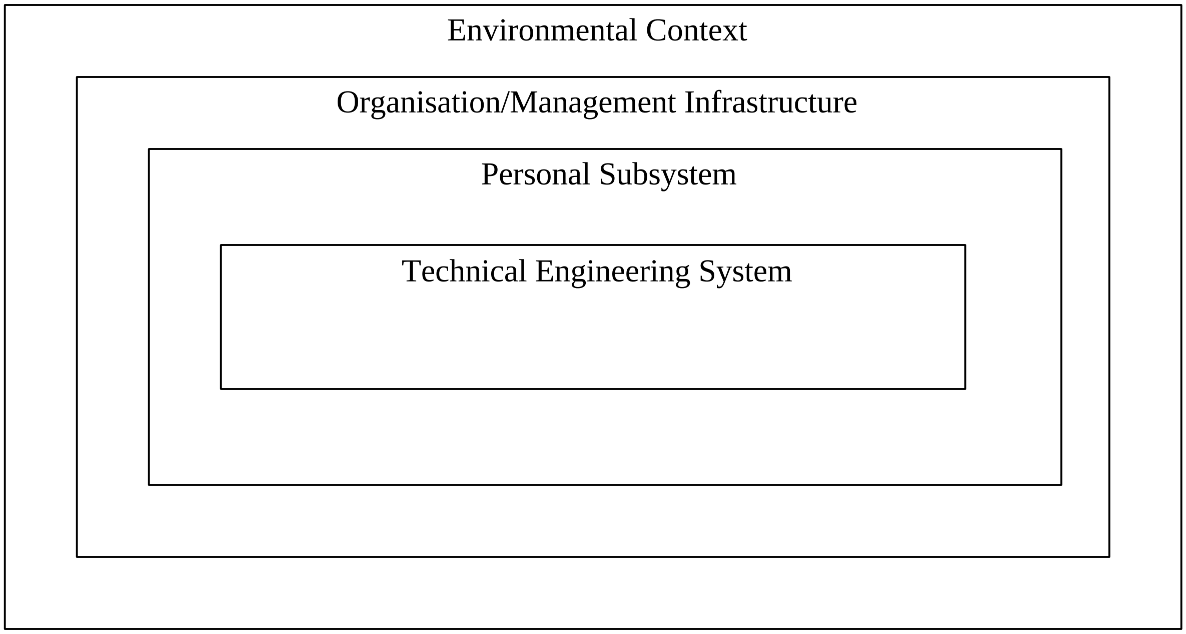
[3] IMO, ´MSA P404 – D5 Final Application Report, p. 15

Fig. 3.2 Generic ship concept model.



With the generic concept structure, it is possible to rapidly focus on the main relevant elements within the integrated ship operation concept.
The three elements of the generic concept are as follows:

Technical: this covers the required technical functions, features, systems and human aspects of the hardware associated with undertaking the main function
Managerial: this covers the required management functions, systems and human aspects associated with operating the hardware and undertaking the main function
Physical: this covers the physical, regulatory, social and political environments associated with all aspects of undertaking the main function

3.4 Impacts of the environmental context in integrated concepts

Within the globalisation process, which took place the last years, work allocation and production led to an increased demand on intercontinental transport, mainly by ship. Just in time production and integrated door-to-door concepts required high quality liner shipping services either as a container or bulk cargo.

The following considerations refer to the leading integrated door-to-door liner shipping services principally engaged in the high volume east west global trades.

- Technological development of ships and their operating characteristics
- Demand for and provision of throughout internal services
- Costs, profitability and ownership of container shipping
- Port requirements and facilities
- Trends in global trade and in service provision

These factors have resulted in high quality intermodal services at steadily falling cost to users. The operating economics of such a vessels are likely to lead to a priority of maximum utilisation and minimum port time and at least increased workload for the crew in terms of controlling the loading and unloading process, and the whole ship operation during the stay in the harbour, particularly for the crews on board integrated operated ships.

Big harbours as so called hub centers with integrated hinterland connections have been created. Within the intermodal chain, several tasks in the transport have their impacts also on board as one entity in this chain.

The 4 European mega-ports handle a large number (= > 1 million TEUs) of containers.

One of the impacts of these processes is the change of the tasks of the operators on board. Integrated ship operators increasingly understand their role not restricted to waterborne transport but considering this mode just as one important link of the whole transport chain composed by intermodal transport services. This requires mainly:

- a wider service understanding of seafarers and maritime transport operators which needs to be supported by improved knowledge and skills. The dramatically increased role of telematics to marked transport services and realise those will need special emphasis in the conception of new MET modules.
- Appropriate organisation of operating procedures in line with the ISM code
- Development of high sophisticated systems as decision support for the bridge operator

3.5 Trends in integrated ship operation; the human element situation on board

The development of technology and the increasing costs of personnel have led the 1980's to a revolution in the ship operation. New ergonomical, technical and operational concepts had been developed towards the integrated ship operation.
Modern bridges, that are integrated bridges including integrated navigation systems, have become quite common in the last 5 years. Rather than distinct functions being manually controlled by several persons the trend was towards a single person supervising all main functions/tasks as shown in the following table 3.3 :

Table 3.3 Main ship functions to be supervised by a single person.

Route planning	Monitoring and Control of Propulsion System
Collision Avoidance	Communication (Internal and External)
Ship Safety Control	
Track Piloting and Control	

One important role in the integrated decision support systems is the transfer of the holistic view to the operator.

Intelligence and effectiveness of the presentation of all above information needs to be tuned with the limitations of the observation and processing capacity of the operator (Watch officer).

3.5.1 Human behaviour and workload

In achieving significantly reduced manning levels in advanced ships, the primary methodology being employed is to automate activities that are performed manually on present ships. The rationale is that increasing the level of automation will reduce human workload, enhance human performance, and reduce the incidence of human error. In reviewing what is known concerning the actual benefits of automation in advanced aircraft flightdecks, researchers have cited a number of problems with the interaction between humans and automation, such as:

- *Automation results in human workload that are unevenly distributed, not reduced* - automated systems will support the pilots most in traditionally low-workload phases of flight but are of little use, or actually get in the way when help is needed the most, in time-critical highly dynamic circumstances. This failure of automation is attributed to a lack of access on the part of automation to all flight-relevant data in the outside world. This leads to the requirement that the pilots provide the automation with more information, to decide how automation will use this information, to communicate appropriate instructions to the automation, and to monitor the automation closely to ensure that commands have been received and implemented as intended. The result of these requirements is additional workload, and, consequently, increased potential for error.

- *New attentional and knowledge demands* – the introduction of automation creates new knowledge and attentional requirements. Operators must be aware of the many different elements of a highly complex system, and about the interactions among these elements. The development of an accurate mental model of what is happening in the system, and in the outside world is critical for reliable human performance. A major factor in the development of an accurate mental model is the need for adequate feedback. Operators need to know when and where to look for information concerning changes in the status and behaviour of automation.
- *Problems with mode awareness and automation surprises* – an anticipated benefit of automation was a reduction in human error. However, operational experience and empirical research have proven otherwise. Instead of reducing the overall amount of errors, automation provides new opportunities for different kinds of errors, one of which is mode error. A mode error is defined as the confusion of operating modes that the system can be in. It is explained as a situation wherein a procedure is performed in one way in one mode, and in another way in a different mode, resulting in an intention being executed in a way that is appropriate for one mode while the system is actually in a different mode. A case in point is the confusion of system modes reported in conjunction with the automation of aircraft flight decks. In studies of mode error in "glass cockpit" aircraft it has been reported that 55% of pilots state that they are still experiencing automation surprises, defined as situations where the human is surprised by the behaviour of the automation, and asks questions such as, what is it (the automated system) doing now, why is it doing that, and what is it going to do next?

Since long years has been recognised that humans are not very good at process monitoring in order to detect very infrequent signals.

The 'Human Factor' can be divided into "situation-caused errors" and "human errors". Situation-caused errors arise from the working environment, design of the workstation (bridge), organisational matters, range and quality of instrumentation and the so-called Man-Machine Interface (MMI) or Human Machine Interface (HMI). Human errors arise from professional qualifications and personal quality of the operator.
A highly automated working process, which can be found on modern ship systems, is marked by an especially high demand of human information processing and ability of decision-making. The flow of information between man and technical system components should accommodate human attributes and abilities. Only then is the operator on the bridge capable of executing safely and efficiently the tasks of supervision and decision attributed to him. In the case of an integrated ship, operational concept the working place on the bridge is built as a ship control center. The working task in the propulsion area thus includes tasks of manual control, supervision, and fault diagnosis as well as tasks of fault elimination. Fault diagnosis and correction have the highest priority, supervision of the instruments has to be continued permanently and the human intervention is only executed when required. A well organised display of instruments and screens in a small area is necessary as all the tasks are overlooked and dealt with from one position, which on the

one hand assures a certain clearness, on the other hand increases the levels of concentration and reception of information required from the officer of the watch.

Workload are all outside demands of a task resulting from the way in which the work is done and the work environment. *Demand* describes the specific reaction of the individual to a given workload. Thus, the work demand can be expressed as a function of workload independent from person and individual capacity and ability of the operator:

Demand = f (workload, individual capacity, ability).

Human workload and demand are valued in four hierarchical levels 1) workability, 2) tolerability 3) expectancy and 4) satisfaction. We can distinguish between tasks, which are mainly physically demanding, and tasks, which are mainly mentally demanding. Mentally demanding tasks are generally tasks of information change in a broad spectrum; the navigation task can be classified in this category.

All four tasks described in the following, each of which is a part of the mechanism of human information processing in different combinations, can be integrated in the complex working task of bridge command:

1. *Mental tasks* mean the human demand to deduct decisions from presented information while connecting facts stored in the memory and learnt and the solution of momentary appearing problems. With this task, the workload consists of forced compulsion in the form of long-term strain, the fixation on the task contents, of decision-making as well as the pressure of permanent self-control.
   Nautical example: Track-keeping.

2. *Surveillance tasks* are given when the individual is asked to constantly monitor the functioning of a system and to intervene if necessary. The pressure of permanent awareness resulting from this, the weight of responsibility and limited human contact adequately describe the demanding nature of this task.
   Nautical example: Warning system control.

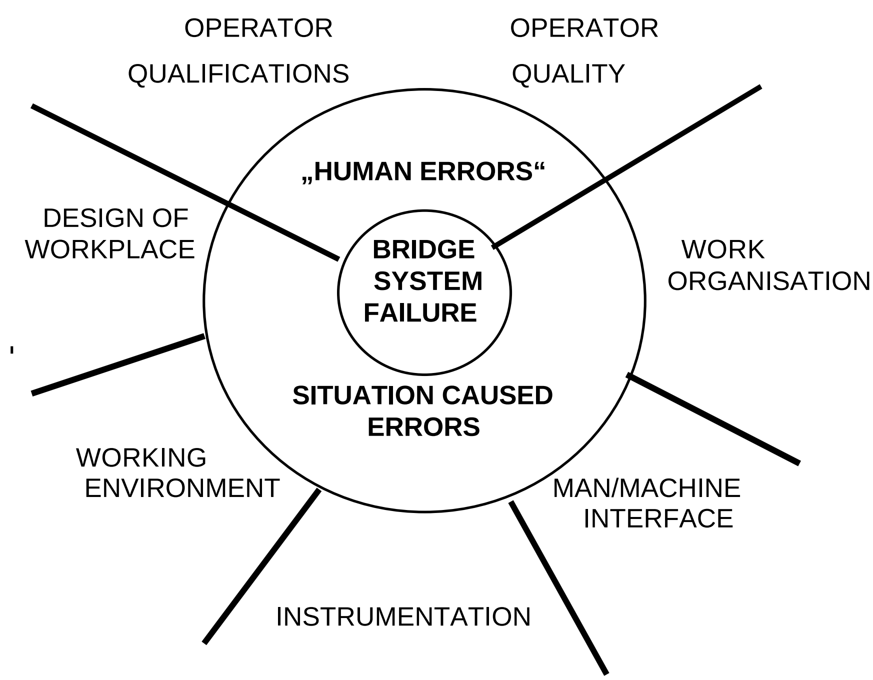
3. *Monitoring tasks* are tasks during which the individual has to compare quality and quantity of a product with given production norms and to make decisions concerning for example the classification of production in levels of value if necessary. Referring to the navigational tasks, the work with ECDIS can also be mentioned in this category. The main stress factors of monitoring tasks are compulsion in the form of permanent awareness, decision-making under time pressure, the fight against monotonous influences and a permanent change in the fixation of the eyes.

4. *Operational tasks* are given when the individual has to decide directly or indirectly on the course of production oriented at a given program set in advance or on the optimal use of a production line or the leadership of a dynamic system. An example from the nautical sector would be the active leadership of the technodynamic system “ship”. The stress factors related to this task are the compulsion towards permanent awareness, the weight of

responsibility as well as unspecific effects which may result in vegetative reactions, easy fatigue, aggressiveness and higher sensitivity towards outside influences.

Concerning the conception of a technical system, which has to be controlled or monitored by man, e.g. the integrated bridge system as a bridge control centre, it is necessary to find a fine balance between technical design characteristics - which can be influenced by ergonomical factors - and demand characteristics - the requirements of human performance.

Fig. 3.3 Bridge System failure – Influence factors



3.5.2 The ISM code and relation to the "new" ship operation

"International Safety Management (ISM) Code" means the International Management Code for the Safe Operation of Ships and for Pollution Prevention.[4]
The introduction of the ISM Code as Chapter IX of SOLAS marks a significant change in the approach to maritime safety. Through the requirement of a safety management system for the company as well as for all ships, the importance of the shore –based operations for

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[4] IMO, MSC66/INF.3, October 1995

the overall safety of shipping operations has been clearly recognised. However, the ship plays also the important role.

The International Safety Management Code is since 1998 mandatory (for passenger ships, tanker, and chemical tankers, gas carriers and bulk carriers. The ISM code lays down various issues relating to safety management and pollution prevention.

It claims to ensure:

- Safety at sea
- Prevention of human accidents or loss of life
- Avoidance of damage to the environment
- Avoidance of damage to property.

Speaking about new integrated operation concepts the Safety Culture has to be considered within the implementation process. Resulted changes have also the impacts on the shipboard working culture. Discussions about the ISM Code so far mainly focussed on the practical implementation issues for ships and shipping companies. The main problems raised were:

- Increased workload onboard and ashore
- Be developed largely by consultants without the involvement of the shipboard personnel. (Schulte-Strathaus, Dr. R.,1999)

3.6 New trends in innovative integrated navigation support systems Integrative aspects of navigation

The IMO[5] says that an integrated bridge system is
"a combination of [technical] *systems which are interconnected in order to allow centralised access to sensor information or command/control from workstations, with the aim of increasing safe and efficient ship's management by suitably qualified personnel"*

Since the IMO has agreed on relevant Performance Standards IBS (Integrated Bridge systems) and INS (Integrated Navigation Systems) are now so quite well defined designations, although the range of functions covered by such systems is very much differing between manufactures and classification societies. In practical terms the designation IBS is only used if at least an INS is part of it, and an INS is not designated as such, if it incorporates the functions to electronically support the planning, storage, monitoring and automatic execution of the voyage. (Wentzell, H.F., 1999)

[5] IMO, Performance standards for integrated bridge systems", IMO, 1997

The bridge concept must be seen as a whole including equipment, bridge layout and design, crew training, qualification and motivations bridge team organisation and passage planning, nautical procedures and preferably also any manoeuvring performance enhancement aids such as thrusters etc.

More generally spoken, any combination of systems, which are interconnected to allow centralised access to data and/or command/control to fulfil a particular task or purpose, can be called an *integrated system*.
However, these definitions are still quite global. A better understanding of what is behind all that can be given by distinguishing the following three aspects of (technical) integration[6].

- Physical/Spatial Integration
  This means the integration of physical components (i.e. hardware). For instance, the cabling of "boxes" by wires or the discussion of plug standards belong to this area. Here, the early days of integration started when most systems consisted of proprietary, stand-alone hardware.

- Functional integration
  The functional integration refers to the use of the same functions from different systems. Functional integration allows different systems to access functions provided by only one system. The different functions and their input and output values are addressed here. By combining functions from different systems the integrated system becomes able to provide more and advanced functionality that the single components can.

- Operational integration
  Operational integration addresses the integration of information displays and process controls according to the tasks the user want to solve with the integrated system. The design of the human-machine-interface (HMI) and its technical implementation constrains are belonging to this area.

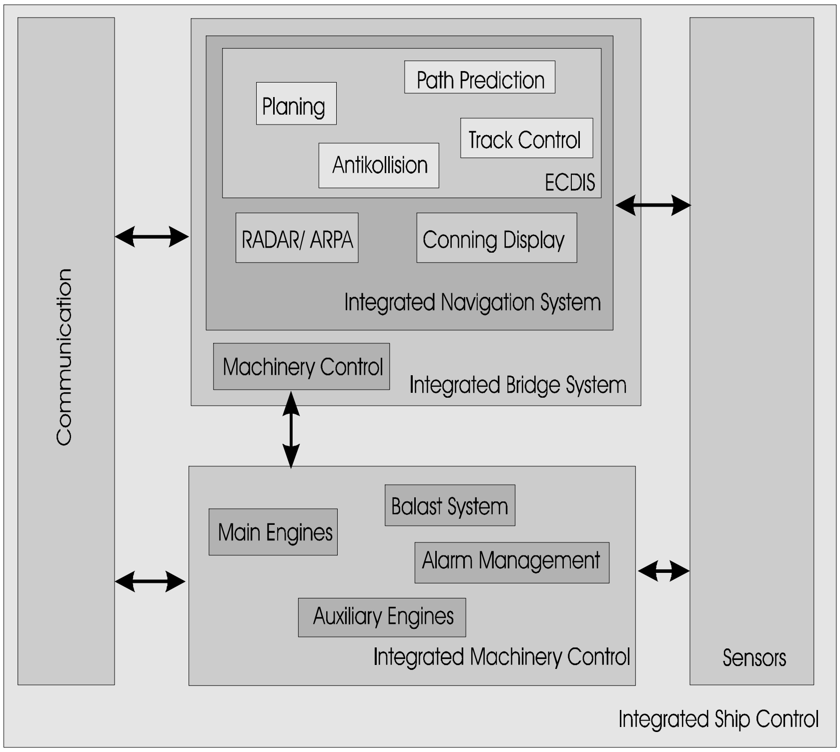
Physical integration is a prerequisite for the functional integration. Easily spoken, you cannot use functions of another system if you are not at least physically connected to it. Operational integration again requires functional integration for an enhanced HMI-design. A good human-machine-interface should allow the user to apply the functions of the different systems together on one (or several) multipurpose workstation(s). By means of the functional integration, the system's functionality is accessible by so called function blocks.

All three areas have been playing an important role for the products of the maritime industry during the last 30 years. The fast developments in computer technology have drastically changed the appearance of modern bridges and control rooms. The just coming up communication technology will probably do this once again.

[6] Note: Because this chapter is referring to the technical view, we understand the term *integration* below as *technical integration*.

The idea of integrated systems on board is to enable one man on the bridge the control of the entire vessel, under both normal and special conditions. The background is the strong tendency to reducing the personnel on board and thus saving money.
Figure 3.4 shows the important system areas, which are affected by today's integration efforts on board. Nearly all technical systems, which are relevant for the ship operation and handling processes, have been involved into integration efforts during the recent years.

Figure 3.4 Integrated ship control



Several systems are already integrated systems by themselves but could again become a component of the further integration, like for instance the Main Engine Control System. Figure 3.4 shows the three main areas *Integrated Bridge System*, *Integrated Machinery Control* and *Sensors*, which are traditionally items for integration on board. The fourth area (*Communication*) represents all aspects of ship-shore and ship-ship-communication and is going to be integrated in future systems, due to the current development of communication technology.
The ship handling and the ship operation are two most important task areas on board of a vessel. Traditionally, both areas use technically and physically separated systems. The bridge is the centre for all ship operation tasks while the machinery control room is the place where most of the ship operation takes place. Due to the spatial distance between bridge and machinery but also due to the very different tasks and required skills, both areas cannot easily be integrated into one system.

During the last ten years, several approaches have been made to merge these two into one control centre on the bridge. Actually, a mariner (if trained) is able to control the entire ship handling and ship operation process from the bridge today. Special education programs were set up to train officers for such an integrated working environment. Latest tendencies look like that both areas will (at least technically) be integrated further into the integrated bridge system. Most of the machinery systems do already have their place on today's bridges.

The *Integrated Bridge System* and the *Integrated Machinery Control* are related to the *Sensor* area. Again, there are strong differences in type and number of sensors for both parts. Conventionally, the ship handling requires some few parameters, which are provided by a handful of navigational sensors (e.g. positioning sensors, gyros). The ship operation (and thus the machinery) requires a significant amount of sensors and actuators controlling values like cooling water temperatures, air pressures, fuel consumption, etc.
The *Communication* is going to become the most innovative part for future system integration due to the enormously development speed in communication technology. Most of the data is exchanged by radio or fax via satellite today. However, new means like GSM or low orbit satellites in combination with the growing Internet techniques (email, world wide web) and an increasing bandwidth forces the conversion of the former "isolated" vessel to a single communication node in a world-wide control network.
In what follows special focus is given to Integrated Bridge System the impacts of the Integrated Navigation Systems on STCW78 as amended, the ECDIS training as well as the impacts of the ISD concept on MET.

3.6.1 Integrated Bridge System (IBS)

An integrated bridge system is "a combination of [technical] systems which are interconnected in order to allow centralised access to sensor information or command/control from workstations. Its aim is to increase safe and efficient ship's management by suitably qualified personnel" An IBS should be able to perform two or more of the following operations: Passage execution, communication, machinery control, loading, discharging and cargo control, safety and security [IMO].
The IBS is the "heart" of the ship's bridge. This definition does not state which kind of systems are parts of an IBS and which are not. Actually, there are a significant and growing number of systems on the bridge, which support the mariner while operating the vessel.

Ideally, it physically, functionally and operationally integrates all systems required by the mariner for managing the vessel under all conditions. In practice today, several particular systems exist on the bridge like e.g. the cargo management system, the machinery control, the integrated navigation system or the alarm management system. Most of these are not exchanging many data today and are not integrated into an overall IBS so far.
Below, some examples for systems on the bridge are described like the Fire Alarm and Monitoring System or the Administrative and Logistics Systems. The important system for the ship control is the Integrated Navigation System (INS), which is already an

integrated system. It implements the different basic ship handling functions route planning and track control and contains all means for passage planning and execution.

A typical Integrated Navigation System consists according to the International Electrotechnical Commission (IEC)[7] of three types of elements: Sensors, displays and controls. Sensors are normally likewise GPS, gyro, log, weather sensors and radar scanners. Displays include RADAR (ARPA), an electronic chart, and a conning display on which the relevant data like heading, course and speed over ground, thruster and machinery power will be displayed. The controls are basically used to set rudder and propulsion. The autopilot and the speed control are further part of an INS.

However, the electronic chart or ECDIS (Electronic Chart Display and Information System) is going to become the most important part of a future INS. It is the ideal platform to integrate (again, functionally and operationally) the important navigational sensor information, the hydrographic data, the planning data and additional geographical information to give the user all data on hand he needs for a safe and efficient voyage.

3.6.2 Impacts on STCW 78, as amended code

In the STCW78, as amended-code the term "Integrated Navigation Systems" (INS) was never used but terms, which may be a link to the INS are mentioned.

In Table A-II/1 in the Function: *Navigation at operational level*
Competence: Plan and conduct a passage and determine position the words used in column 3 are "electronic equipment, echo sounding equipment, compass".

In Table A-II/2 in the Function: *Navigation at management level*
Competence: Plan and conduct Navigation the words used in column 4 are "navigational equipment".

This demonstrates that the time is going on and a development of systems happened which combine several parts of the navigational equipment to electronic and complex navigation systems. Such systems are in use in special trades and on some modern ships. Within these systems, the sensors and their limitations play an important role. The production of the systems is far ahead of the standardisation of the systems. A lack of standards for the construction and testing of the complex systems has to be seen as a warning to all users of the systems. The complexity of these computing systems requires a new way of handling the equipment and there is a need to train the masters and officers accordingly.

The use of integrated navigation systems requires a good knowledge and understanding of the systems, the subsystems and their limitation, the influence of the different parameters used, the flow of information, the dynamic and time factor.

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[7] IEC; International Electrotechnical Commission, Technical Committee No. 80: Integrated Bridge Systems (IBS) Operational and performance requirements, methods of testing and test results. IEC Future Publication 1209 7th Working Draft (1997).

Following general training objectives can be seen up to now, that the trainee has to be able to:

- demonstrate knowledge and understanding of the basic system,
- operate the basic system,
- demonstrate the knowledge and understanding of the basic functions of the system,
- operate the basic functions,
- demonstrate the knowledge and understanding of the sensor fundamentals of the system,
- demonstrate the knowledge and understanding of the sensor limitations,
- demonstrate the knowledge and understanding of the warnings issued by the system,
- demonstrate the way to handle failure coming up within the system,
- demonstrate the way the plausibility check of the information issued may be carried out,
- demonstrate how to react when system break down occurs.

This list is not complete and requires further replenishment when standards are developed. Since the systems will be different, the training should be done in three steps:

Step 1: Theoretical knowledge about the system / classroom training

Step 2: Operation of the system in a part-task simulation training

Step 3: Training in the complexity of a full mission simulator using the INS in situations close to the real life.

For an on board training a computer based training (CBT) tool, as part task simulation is recommendable.

3.6.3 Exemplary model course for ECDIS

ECDIS systems offer numerous benefits compared to conventional navigation (automatic display of own ship's position, automatic updating, potential radar overlay etc.) and are considered a significant step towards safer navigation. They will eventually replace paper charts on board many ships.

ECDIS must be able to provide at least the same navigational functions as a conventional paper chart. Unlike charts, ECDIS is a complex navigation system of a highly sophisticated level which includes not only a large number of navigational functions, but also components of a complex computer-based information system such as hardware, software, sensor inputs, specific ECDIS data and their presentation rules, status indications and alarms, man-machine interface, etc. Therefore, care must be taken when navigating with ECDIS and using its navigational functions to avoid misinformation and malfunctions. Although the minimum performance standards for ECDIS have been laid down, no real standards for hardware, data presentation software (ECDIS kernel) and man-machine interface exist. Consequently, it is expected that a variety of different equipment types will be installed on board of ships.

In the STCW 78, as amended, Convention, no particular formal emphasis is placed on ECDIS systems. Instead, they are considered to be included under the term "charts" (Table A-II/1). It remains though a permanent item in the STCW Sub-committee agenda and IMO proposed also model courses. Following the functional approach, the officer of a navigational watch must have "thorough knowledge of and ability to use navigational charts and publications...”. The methods for demonstrating competence are "using chart catalogues, charts, navigational publications, ... electronic navigation equipment...”. Criteria for evaluating competency are stated as: "The charts selected are the largest scale suitable for the area of navigation and charts and publications are corrected in accordance with the latest information available". In Section B-II/1 (Assessment of abilities and skills in navigational watchkeeping), a candidate for certification must provide evidence of skills and ability to prepare for and conduct a passage, "including interpretation and applying information from charts."

In the framework of THALASSES, ISSUS produced an exemplary model course for ECDIS following the IMO guidelines “Guidance on the implementation of IMO model courses”. As with all other IMO model courses, the purpose of the proposed course to IMO (which has now been accepted) is to assist maritime training institutes and their technical staff in organising and introducing new courses on ECDIS. The model course may also be used to enhance, update or supplement existing training material in order to improve quality and effectiveness of the training courses offered by the institutes.

3.6.4 General aims of ECDIS training

The general objective of an ECDIS training course is to enhance navigation safety by safe operation of ECDIS equipment, by proper use of ECDIS-related information and by knowledge of the limitations of ECDIS equipment used. For this purpose, the mariner is required :

- to acquire and develop a knowledge and understanding of the basic principles governing ECDIS data and their presentation as well as ECDIS-related limitations and potential dangers;
- to be able to operate the ECDIS equipment, use the navigational functions of ECDIS, select and assess all relevant information and take proper action in the case of a malfunction;
- to be aware of potential errors of displayed data, errors of interpretation and the risk of over-reliance on ECDIS.

Potential problems
The implementation and running of ECDIS training courses may face a couple of specific problems:

- Due to a lack of standardised ECDIS user interfaces, there is considerable product differentiation.
- Trainees on an ECDIS course may have differing experience in the use of chart work, standard navigational procedures and equipment, and in the use of computers including standard MMIs.
- For exercises in real time navigation, full-mission navigation simulators or multi-mode marine training systems are preferable to stand-alone ECDIS sets, but the facilities of the training institutions might not include such equipment.
- Specific textbooks dealing with ECDIS at the required depth are hardly available at all for the first phase of ECDIS training.

3.6.5 Application impacts on MET

On standard vessels (conventional ships), when the integrated concept/technology has been installed it is necessary to be careful with the reduction of crew numbers in order to maintain ship/crew members integrity and safety.

Although maintenance work on hull and engine is carried out by shore gangs, on board personnel has to be sufficient in number and qualification, not only for navigation, loading/unloading, but also to cover emergency situations like fire, leaks, collisions, groundings etc. Consequently, the composition of crew must be decided keeping in consideration to fulfil the legal requirements and keep the main functions on board in operation.
The latest implemented technology on modern and “future” ships demand a familiarisation with the computers automation (decision support systems). New training concepts on board (CBT) and on shore (simulators) have to be designed in order to prepare to crewmembers with the new tasks on board.

As a consequence of this situation it would seem necessary to carefully plan maritime studies, defining criteria for training – education, standardisation and specialised training centres.
The problem in this field is that the distance between education programmes at Nautical Schools and technological reality on board has increased dramatically in only few years: most of the subjects learnt by the students are becoming more and more obsolete as technology runs ahead of education programmes.

Operative systems on board ships with Integrated Ship Control Centres are so different that operators have to do specific courses for each ship.
This implies the need to standardise these operative systems on integrated bridges by means of a standard computer programme/ interface, adaptable to the different applications and systems installed on board.

The different manufactures should come to an agreement designing and developing standardised systems. Continuous investigation into how to improve the seafarers’ social level and standard of living and working on board should be carried out.

Integrated ship operators increasingly understand their role not restricted to waterborne transport but considering this mode just as one important link of the whole transport chain composed by intermodal transport services. This requires a wider service understanding of seafarers and maritime transport operators, which needs to be supported by improved knowledge and skills. The dramatically increased role of telematics to marked transport services and realise them will need special emphasis in the conception of new MET modules.

4. Utilisation Of New Technology In Ship Registration

4.1 Methodological approach

This part of the THALASSES work aims to explore the possibilities how new Information and Communication Technologies (ICT) can be utilised by European Registers and also how this utilisation may influence positively the human element, mainly seafarers and shipowners.

Initially, a review of international competition with regard to Registers was performed using also a series of SWOT analyses aiming to define areas where new ICT can help registers for enhancing the registered ship's competitiveness in regard to safety, cost effectiveness and seafarers' welfare and satisfaction.

Next, the possibilities offered by new ICT in order to enhance the competitiveness of a register have been explored. Various interviews have been performed and the information requirements of various maritime actors have been defined in relation to a Register.

The proposed Register's provisions (utilising new ICT) are based on the needs and the aims but also the duties of the maritime actors from the owner, and his shore and board staff, to the customer and authorities.

Thus taking into consideration the above, a system architecture of a register information system is proposed based on the concept of an Internet-based prototype Register information system, named Vessel Register Communication Manager (VRCM).

The proposed system has been presented to certain categories of shipping actors, who are the potential users, in order to evaluate the applicability and advantages of this new tool in ship Registers. The prototype developed is accessible, for demonstration purposes in the AUTh's WWW-site.

4.2 Results of a SWOT analysis of registers and identification of their main characteristics

4.2.1 Register categories and their competitive conditions

The ship's management depends on the legal, safety, technological, taxation and social provisions of the Register in which it is registered. Therefore worldwide competition between the numerous registers concerning the provisions they offer is critical both for the shipping business, for the seafarers' employment, welfare, also especially for the European Maritime skill as a whole.

The main objective of this part is to review and analyse Register's competition at an international level in order to define how a Register can use new technologies for enhancing the registered ships' competitiveness in regard to safety, cost effectiveness and seafarers welfare and satisfaction.

The national Registers

As defined by the national law and the international conventions, every Register is national. However, a Register is named "national" when it registers exclusively the national ships and also when the whole national set of laws applies to those ships. Every traditional maritime nation has a "national" Register, i.e. the main European countries, U.S.A., Canada, Japan, Australia, New Zealand, etc. Due to the high standards of those nations in industrial safety, social welfare, labour earnings, taxation and to their complete conformity to the international conventions, the management of the national registered ships, subject to a constant technical, social and administrative control, is generally good, but their running costs are high. Due to high costs, the national registration is more and more limited to the coastal sailing in territorial waters whereas the ocean ship owners incline to transfer their ships to more liberal Registers.

The international registers

When the old maritime nations' ship-owners suffered a rapid increase of their charges, the young states born from the independence of the colonies needed resources of all kinds. Both met on the opportunity to make a good bargain by creating new but flexible Registers that would be open to foreign owners. This way the "Flags of Convenience" (FOC) were born. The definition of flags of convenience is given by the International Transport Federation (ITF):

"Countries which offer their maritime flag registration to owners from another country are considered flag of convenience countries".

A FOC register offers mainly an easy and flexible registration, very low or non-existent taxes. It also offers light fees, no restrictions on the nationality of the crew, and compatibility with the international rules on design, technical, safety, ownership, liability, manning, social welfare, and any other matters relating to shipping.

The second national Registers

When numerous shipowners flagged out their vessels, for enjoying a cheaper and more flexible ship management against the national register's stiffness, the national maritime countries loosed their maritime know-how and the mastership of their own fleet and of their whole maritime sector.

As the national cohesion did not allow infinite waivers to the national laws, for the only benefit of the national shipping, the old maritime countries' governments were brought to research a solution: they created a second national Register.

The objective of such a Register is to provide to national deep-sea ship owners, the possibility to fight against the Flag Of Convenience (F.O.C.) owners, but also the other countries' national or second national Registers. Its provisions are lightened compared to those of the actual national register. More than the ability to flag the national ensign, the national nature of the second Register can be found in the design, technical and safety provisions which are generally in accordance to most international conventions adopted by the flag state.

The main difference between the second and national Register of a country lies in the taxation system and in its manning provisions. Instead of the compulsory number of nationals, the ship may also embark foreign seafarers. Systematically and for a strategic purpose the captain, often part of the officers, have to be nationals. Nevertheless, ratings may be foreign and their wages and social welfare are rated at their own country's rules if any. If not they are rated according to the I.T.F schedule or lower.

Examples of second national Registers are: the French T.A.A.F. (Territory Australes Autonomous Territory – i.e. Kerguelen) in 1986 which was the first "second national register" to be created, following this the Norwegian (N.I.S.), the Danish (D.I.S.), the German (I.S.R.), the Portuguese (Madeira), the Luxembourg for Belgium, the Spanish Canaries Islands, etc.

The EUROS register effort

The European Union has tried to provide an answer to the flagging out of ships from European Registers with all their negative consequences. Thus the European Commission tried to create a virtual European Register named "EUROS". The objectives of EUROS were:

- to concentrate the use by all the European states of a single legal shipping instrument, able to enhance the European fleets' competitiveness
- to improve the number of seagoing and shipping workers and to save the old European maritime know-how
- to build a high quality Register which will be the warranty for the world shipping safety.

EUROS was meant to be a common Register reserved for European owned vessels, each European vessel flying its national flag. The registrations' technical conditions would be quite similar to those of the national registers with strict conformation of the international conventions on safety, technical and rescue items.

Concerning manning and social provisions the EUROS provisions were: all the officers and half the ratings had to be of European origin. The remaining half of the ratings would be subject to collective agreements with national foreign unions, their social welfare provisions conforming to the seafarer's country. Moreover if EUROS disposed the relief of taxes paid by the owner, it did not include neither any tax reduction nor help for investments.

The owners' resistance to the imposed crew composition, the variety of European social features and financial public aids, of taxation rates and in short, the variety of European maritime cultures, generated a large opposition to EUROS. As the international Registers were extending, EUROS was not yet able to efficiently support the European shipping industry. The European Commission suspended the effort in 1996, under the legal motive that under the present stage of the Union, Europe had no national character, and thus has no rights to bestow a nationality upon a person or a vessel.

The register competitive conditions

The ship registration has nowadays become a matter of policy for all states and a good bargain for some of them. The various Registers action on the shipping industry involves the whole world trade, thus involves all maritime and continental states too. A certain normalisation is necessary. The international bodies endeavour to build international rules in this matter. On the legislative point of view, three main conventions establish the International Maritime Law.

The 1958 Convention on High Sea
The 1982 Montego Bay Convention
The 1986 the CNUCED Convention

On the regulation point of view the specialised international bodies of the United Nations (UN) brought about numerous conventions that regulates the sailing items: the International Maritime Organisation, (IMO) on ship design, safety, pollution, salvage, liability, information, etc. the International Labour Organisation (ILO) on seafarers' employment, wages, crew composition, welfare, representation, etc.

Thus, the collation of the Registers may be done by scrutinising their submission to the International Maritime Law, i.e. to the provisions of the High Sea, Montego Bay, CNUCED convention and their submission for the implementation of that law, i.e. to the provisions of the IMO and ILO conventions.

However, those legal submissions are not sufficient: the financial provisions of the register induce an important part of the ship's competitiveness and the owner has to scrutinise those provisions for his choice between the numerous Registers.

In what follows the three main submissions are discussed i.e.

- to the International Maritime Law
- to the implementation of the Low – Public controls
- to financial provisions

Submission to the International Maritime Law

The main features of the International Maritime Law are that a ship must in any case have a nationality and that a substantial bond or link must exist between the flag state and the registered ship. Furthermore, the Maritime Law states that the flag state must exercise its jurisdiction and its control on the vessels flying its flag.

That prescript is detailed and unfolds in the UNCTAD Convention. Article 5 claims a national maritime administration qualified for controlling and enforcing the international regulations, particularly on ship and passenger safety and on sea pollution. Article 8 binds the flag state to lay down regulations on the ownership of the vessels under its flag, the liability of which must be assumed by either nationals or a liable local representative.

If the first and second national Registers are in accordance with the control provisions, the second national Registers often release the ownership conditions, thus relax their link with the ship. Most international open flags do not care for the ship/state link. In fact, they are powerless to run an administration able to conduct their national fleet. For example, the state of Liberia, which has been involved in a deep civil war with no legal power, was nevertheless still able to manage the second merchant fleet in the world.

Lastly, the UNCTAD Convention deals with the crew composition: the registering state has to abide by a satisfactory part of skilled national seafarers in the ships crew. Within its requirements is the planning of the training and education of its nationals and residents. It also has to arrange the manning, employment, working and living conditions in accordance with the international rules. If foreign seafarers are engaged, collective bargaining agreements have to be concluded with the foreign states and/or unions. If most second registers are in accordance with those provisions, but not as a compulsory clause, the international open registers are not.

Submission to the implementation of the law – Public controls

The specialised bodies of the UN, IMO and ILO achieve the lay down of the International Maritime Law. Both enact numerous conventions submitted to the adoption of each state; they enjoy a legal qualification and implementation as soon as a certain number of states ratify.

Each old maritime state has its own means for controlling its national fleet and the foreign vessels calling at their country's ports. In the USA, e.g., shipping police is in charge of the U.S. Coast Guard.

Every year they make a list stating the flags with which they had problems with hull, crew, machinery, security and pollution equipment. The U.S. Coast Guard and the E.U. responsible Authorities are considered to be the world reference in the matter of shipping regulation control.

Due to the lack of resources of many of the young states and the lax character of their register, the vessels registered under young states' flags are not submitted to any actual national control. Thus on the traditional hand the regulations are enforced with all the constraints and the costs they involve, whereas on the young hand it is a complete laxity.

For palliating that lack of balance, the maritime states, both traditional and young, established an international agreement, a Memorandum Of Understanding (M.O.U.) laying down the principle of control for every vessel by the state of the port of call over the flag state control. The MOU also lays down the gathering and the diffusion of the results of those controls by a common office, and the option of the banishment from the MOU countries ports of the contravening ships even her owner. Such deeds are regional; the first one, the European one, was signed in Paris; others were created in South America, Far East, Mediterranean Sea, and Caribbean basin.

Aside the flag and the port controls on the whole sailing capacity of the ships, the International Transport Federation (I.T.F.), a Non Governmental Organisation, is watching over the manning, working and living conditions of the seafarers. Due to their laxity in manning and in the ILO rules enforcement, ITF is focusing on the international open flags (F.O.C.) and publishes every year a list of the ships of which are to be supervised by its inspectors, and, if offending, to be detained until conformation. One must remember that the conventions' provisions are the minimum conditions in their items, in the worst case. The ILO conventions are adopted by all open registers and second nationals.

Submission to financial provisions

If the legal, technical and manning provisions of the Register have a strong influence on the registered ship's competitiveness the financial ones have the same determinative. They condition indeed essential matters of the ship management:

- The access to the capital market for investment and day-to-day management of the company.
- The orderliness of the warrant and liens rules are essential for a fair access to the loan market.
- The taxation, mainly the corporate and income taxes including the seafarers' and the depreciation scheme. Attention must be paid to the possible double taxation between the Register is and the home countries.
- The Register's fees and charges, the basis and rates of which much vary from one Register to the other.

Globally those provisions allow the shipping company to build a financial strength thus to gain the trust of bankers, suppliers and most of customers.

On a general point of view:
open Registers offer good financial conditions even no tax burden except fees,
second national Registers' tax rules are rather flexible

national tax legislation is mainly heavy but at the present some change of the old maritime states' policy is observed aiming to a better competitiveness of their shipping sector.

Main cost factors influencing open Registers competition with national E.U. Registers

The development of open Registers answered to the needs of the industrial states' ship owners to reduce their companies' costs by lightening the conditions, which their ship management was subject to.

Therefore, the main provisions of the open Registers state on the main ship cost factors are:

Taxation: the states' finances have a tendency to complicate and to burden the system of taxation. Corporate tax rates may amount by the EU registers to more than 50 % of the profits.

Manning costs: they include wages, social contributions and all the seafarer's welfare demands. Such a way the manning costs vary from 7 % in the more manning flexible register to 30 % of the total ship costs under some E.U. national flags.

Safety costs: determined by safety and environmental regulations on the ship's building fitting and repair but also on the crew number and skill in regard to the ship safety.

When choosing a register for his vessels the European shipowner plays with those factors referring to his national Register's provisions and to his own strategy.

4.2.2 Results of a S.W.O.T. analysis of the Registers in relation to new technologies

The previous analysis proposes the classification of the Registers in three main categories: national, second national and international.
That classification is somewhat arbitrary but the Registers collation shows that from the more traditional national one to the worst F.O.C. there are scales of various values that are often hard to disclose.
The technological provisions are however generally more or less in accordance with the IMO Regulations, at least the basic ones. The main difference lies between the ownership and manning provisions. Nevertheless it is interesting to carry out a S.W.O.T. (Strengths, Weaknesses, Opportunities and Threats) analysis for the three Register categories comparing their strengths and weaknesses, referring to the current state of the Registers' situation, opportunities and threats of possible development of new markets and of endangering situations. In THALASSES this has been done in a series of SWOT analysis tables two of which are presented here:
Table 4.1 where new technologies are considered.
Table 4.2 where the maritime working culture is considered.

Some general conclusions resulted from the above analysis are :

Every register is national from the legal point of view. But if the Register is not open to foreigners (or foreign legal entities) it is most often easy to find a national representative or partner, or establish a local legal entity in order to fulfil the ownership's nationality requirements.

For the owners, the financial side of the ship management prevails, i.e. the accessibility to the international investment market, the taxation structure and rates, but also the incidence of the manning and safety provisions on the ship's costs.

The Register's character is mainly based not so much on its provisions, but on their enforcement. Many registers include numerous clauses concerning waivers easy to play with and on the other hand many flag states suffer a weak control staff.

Until the present time the open Registers remain attractive for European shipowners with no or low taxation, with a quite freedom in manning, with weak constraints in safety provisions.

Such advantages have a cost: repairs, bad image, lack of confidence from customers and authorities, controls, etc., at the owner's expense. Above all the open Register's laxity, even the second national flexibility, induce the loss of maritime skill on board ships as ashore. If the maritime industry, especially the European one, wish to keep the maritime competency, which is essential for the industry's effectiveness, for the whole world trade and for the marine environment, it is most important to protect and to promote the seamen's skill.

4.3 Identification of necessary conditions and requirements in developing a register information system

In the modern world new systems are continuously invented and usually their industrial implementation follows as soon. The maritime industry offers many specific and adapted systems innovations. The problem is to convince ship owners, provide them with appropriate incentives to build and to fit their vessels with such technologies. That should be the register's role to promote new technologies when they can improve the ship effectiveness and help the participation of all the shipping actors in that improvement.

Table 4.1:Global Swot Analysis Of The Ships Registers With Regard To Technology Implementation In The Maritime Industry

	National Registers	Second National Registers	International Registers
STRENGTHS	Conformity to regulations, quality	Technical conformity to regulations Savings on human element for price competitiveness Technology supplementing labour costs cut down	Immediate scrapings Flexibility
WEAKNESSES	Costs Dependence on public funds	Risks and overcosts due to the human factor weakness	Costs of unsafety resulting from insufficient application of regulations. Customers' complaint Technical lagging
OPPORTUNITIES	Profits of new technologies, of conformity with regulation, of yield capacity	Ability to avail of innovation and of new Maritime policy' provisions	Technical and human progress under compulsion
THREATS	Risks of technical over outfit Risks of shelving by costs, by competency shortage, by taxes and by overregulation	Risks of unbalance towards laxity	The worst is always possible Risks of shelving by increasing lagging in modern ship management and by a more hardly enforcement of a more severe maritime order

Table 4.2: Global Swot Analyses With Regard To <u>The Maritime Culture</u>

	National Registers	Second National Registers	International Registers
STRENGTHS	Balanced traditional working order Savings on crew number shortage	Technical safety Savings on officers' shortage and on unskilled ratings	Flexibility
WEAKNESSES	Rigidity Costs Seafarers' work and life degradation	Multicultural crews problems Risks of skilled mates lack of interest	Works poorness negative results
OPPORTUNITIES	Scientific work organisation allowing exact crew number, convenient technological tools, better seafarers' welfare Higher recruitment	Scientific work organisation Improvement of skill	Compulsive labour and social improvement
THREATS	Higher costs Ships and employment shortage Lack of skill, diluting liability and hindering the technological improvement	Risk of surrender to laxity Liability dilution Technological emphasis rather than seamanship	Worst is always possible More severe controls and detentions Industrial actions

4.3.1 How the New technologies can help the European Registers to be more competitive

The shipping business is a collective bargain. Any progress therein implies numerous professionals abroad and ashore i.e. shipowners, ship crews, harbours' workers, transport and trade clerks, public servants, etc.
Thus the improvement of the European ship's competitiveness through new technologies should be based on a common strong willingness of every actor which should be expressed in every personal work. The proposed registers' provisions here help to spur this willingness.

The owners' affair

The main aim of the shipowner is how to increase profits and this may involve both increasing the ship's returns and reducing ship's costs.

Increasing ship's return

The owner's aim must be supported by an efficient management, which will be favoured by appropriate register's provisions, which contribute in the provision of:

- Access to financial resources and reduced taxation
- A ship in accordance with the market demand and the maritime safety
- Recruitment of competent personnel

Adjusting the manning cost to the ship's yield

The open and second national Registers allow some solutions for reducing the manning costs. However these solutions may have negative consequences on the safety, the shipwork and at last the ship effectiveness.
Reducing manning costs is a solution for immediate yields but this reduces also the seafarer's job satisfaction and contributes to the seafarer's shortage. Most important it reduces the maritime skill thus endangering immediately the shipping safety and the ship's yield.
The enactment of the I.S.M code made the owner, or operator, fully liable for a safety ship management imposing named principals on board ship and ashore.
When the flag states cooperation in the regional MOU will more and more intensify the controls against offences to the maritime law it is quite probable that owners will pay more attention to the crew synthesis and work organisation. Utilising appropriately the new technologies they can plan a good work organisation, a fair environment with also credible wages thus securing seafarer's job satisfaction.
The technological evolution imposes permanent call in question knowledge. Remote teaching allows the updating of the seafarer's competency. It is the owner's duty to arrange further training on board his vessel. Registers provide appropriate provisions utilising new technologies.

The Seafarer's affair

If it is the owners' duty to build an improving ship and to fit her with modern gears and appliances, it is the crews' business to conduct the ship and to perform her fittings to their best.

As the ship technologically improves, the crew must be well skilled. And as the functions' tasks are lightened, the seafarers have to complete various tasks and thus have to be multi-skilled.
Thus, it is the seafarers' first duty to be trained to, not only the usual maritime branches but to most of the new technologies that will be used on board. In addition, they must further be trained for keeping an updated competency with every day emerging technologies and for being awake to any technological improvement, even for initiating a new application. Complementary they should have to help training apprentices and fellow mates, the more as teaching is always somewhat learning.

The ship's work organisation share

When the owner plans a scientific organisation of the ships' work the seafarers of any rank must be a party to its tasks' measurements, to its practical performance, to any change or adaptation the individual or collective work requires. Calling in question his work is an improving and responsible behaviour.

The quality of life improvement

Due to the high value of a performing ship and of her management such behaviour must be exercised in all the ships activities:
Instead a rigid work time table the European seafarers' working time may benefit by the lightening of work burden and by the variation of the tasks for extending and making more flexible the daily routine in exchange of longer and/or near in time leaves and/or better wages.
Likewise, the seafarer may enjoy a more enlarging and enriching work and more relaxing rest time in more entertaining accommodations with more sedate and friendly fellows.
For the seafarer that is a turn far from the traditional hierarchical ships organisation. It will be hard for old sailors but the young mates will agree, as they are open to initiative and innovation thanks to a broader education and a permanent access to media and information nets.

The maritime sector affair

As shipping is carrying influence on the whole maritime industry sector that last influences inversely the ship management.
Generally, that influence owes to the public interference in the maritime business: taxation on ships and cargo, subsidies, navigation regulations and mainly the port services regulated tariffs and practices.

That influence derives from the maritime tradition but most burden born from it can be lighten even abolished with using the new Information and Communication Technologies (ICT), with duly skilled staffs. The compulsory navigation routes in crowded waters compel short sea vessels to time/fuel wasting and risky detours. Coasters with convenient navigational and communication devices and skilled mates could sail safe the shortest and sheltered routes.

Duly patented masters and mates are able to handle their ship towards the harbour and inside the basins without a pilot neither tugs.
A duly geared and cargo handling qualified crew can handle his ship's cargo without or with just few stevedores. The custom and administrative procedures are made easy and faster with the new technologies in information and communication. Every operation can be preliminary written and broadcasted to the concerned services for an immediate clearance as soon the ship's arrival and the cargo's availability.
Some of these improvements may look trifle but all together they should bring important savings to the ship costs due to New Technologies.

4.3.2 Possibilities and opportunities offered by new Information and Communication Technologies (ICT) for the registers.

The real progress made in the recent years for the benefit of the shipping world had been realised above all in the field of communication and information. There is no other sector in which the evolution of new technologies has had such an impact as on the maritime domain. The different impact of new I.C.T in the maritime sector could be summarised as follows, on:

- communication between ships
- communications between ship and shore and vice versa.
- tracking ships from the shore or from other's ships
- tracing goods, in or outside the containers
- the knowledge of the depth and the streams (sonar)
- the navigation tools on ship's bridge
- the knowledge of weather from the ship and from the seat of the ship owner
- the safety through the GMDSS regulation
- the ship management
- the development of vessel traffic services
- the development of safety at sea.

And at last it seems that there is also a <u>real impact</u> of new I.C.T. on <u>International Maritime Registers, and on second national and national Registers</u>.

Table 4.3 provides and overview of the possibilities and opportunities provided by key new I.C.T to enhance ship's Registers conditions and services.

Table 4.3 Possibilities and opportunities offered by new ICT for the Registers

Type of New Information and Communication Technologies for Registers	Possibilities and opportunities provided by new I.C.T to enhance ship's Register's conditions and services
e-mail	Diffusion of information for a low cost between : Vessel Register Office and Ship's owner and vice versa Vessel Register Office and Vessel and vice versa Vessel Register Office and Port of Call and vice versa Vessel Register Office and National authorities and vice versa Vessel Register Office and V.T.S. and V.T.M.I.S Center and vice versa Communication between Vessel Register office and ship's crew for a low cost. Dissemination of legal information from United Nations Institutions (IMO) to Vessel Registers Office. Communication between Vessel Register office and ship's owner office
(F.T.P.) File Transfer Protocol	Exchange of important files through a specific protocol F.T.P. Site to store Data, to be exchanged between Vessel Registers offices ship's owner's and other actors Technical description of ships to be exchanged for a low cost and way with F.T.P. Exchange of software through F.T.P.

Internet Web Site	Registration facilities accessible from every place of the world, connected to the Internet . Advertisement facilities on Internet, with numerous and precise data available, if needed, by the potential customers. Description facilities of the fiscal and legal aspects of the registers conditions Safety and confidentiality of the payment for the registration fees through an encoded system provided by the main banks and credit card operators on Internet Updating the information on the Web site by the potential users (ship's owner, crew- each with a different level of access) Links to major Websites providing a pertinent information on the register matter I.M.O (International Maritime Organisation), U.N (United Nations), I.T.F. (International Transport Workers Federation), E.C. (European Commission) Communication and discussion between the Web Master and the potential users in order to increase the user-friendly interface of the Website
Satellite Communications System **G.P.S./ Global Positioning System** **Inmarsat – Argos** **GM.D.S.S. / Global Maritime Distress and Safety System**	Communication at sea between the ships registered and the outer world via the Vessel Register Web Site. Secure transfer of the ship's position to the ship's owner if requested Secure transfer of the ship's position to interested authorities in collaboration with the owner Better efficiency on board
Video conference facilities	Checking the registered ships by exchange of video images in real time Control of the modification realised by ship's owner on a ship registered during it's time life Tele-medecine and tele-education facilities Better exchange and better knowledge between ship's owner, crew members and vessel register office's staff Conferences between vessel register's office and partners on a regular basis

Storage of technical data on digital storage means	Storage of very large and costly data at the computer system of the Vessel Register Office Linkage of the data stored by the Vessel Register Office with the classification societies ones (Bureau Veritas, Lloyd's register, Registro Italio Navale, Deutsch B.V, etc…), in order to have an efficient database in the Vessel Register Office Possibility to provide quickly the necessary information about the ships registered in case of emergency, by the electronic tool's able to extract the technical data from the digital storage facilities
Storage of social, financial and environmental data on digital storage means	Storage of very huge and confidential data at the computer system of the Vessel Register Office Linkage of the data stored with the Social, Financial and Environmental authorities of the states, which crews are coming from.
Voice phone facilities	Possibilities to use new phone interface and services in order for the crew, the ship's owner, the port of call, the local authorities to communicate with the Vessel Register Office The phone with it's new digital services is easier to use for non skilled workers than personal computer The new phone facilities could so offer new services to the users; the Vessel Register Office will have to be fitted with the adapted interface.
E.D.I. Facilities	Exchange of Edifact Messages between the Vessel Register office and the E.D.I. System connected users.

4.3.3 Information requirements among Registers and various actors

The various actors’ involvement in the shipping business requires the exchange of a lot of information among them.
These exchanges of information are numerous and justify the use of information and communication technologies. Registers can facilitate the exchange of this information utilising new technologies. Such “new Registers” will have to be more transparent and more informed than the “classical vessel Register”, national, second national or open registers in order to be efficient and to bring something to the European Union shipping competitiveness.
The concerned maritime actors’ needs who, in reality are the potential users’ were captured during a series of interviews. The following table 4.4 provides a list of the type of this information exchange requirements, between a “new register” and customers/users and of the specific information system.

Concerning the information requirements of the Administration these are listed next in “National Authorities” and/or “New Register” (especially where such a body is an integral part of a National Authority). Of primary importance are the requirements related to safety e.g. in the case of ERIKA accident the French administration should require to have immediate access to information such as : ship’s characteristics, surveys’ and repairs’ reports, captain’s profile and references, owner’s, operator’s and ISM principals identification, fuel cargo’s characteristics, salvage and rescue vessels and companies available close to the area. An appropriate operation of the VRCM tool would have been able to provide all the above information updated in real time and grouped in a single WWW site. One has to state though that the issue of public availability (to the Administration or to other actors) of such type of information has to be agreed first by the shipowners’ and operators’ community.

Table 4.4. Information exchange requirements between new Register and customers/users through new information and communication technologies

INFORMATION EXCHANGE BETWEEN NEW REGISTER AND CUSTOMERS/USERS THROUGH NEW INFORMATION AND COMMUNICATION TECHNOLOGIES				
SUBJECT	**FROM**	**TO**	**CONTENTS**	**SERVICE**
New Register	New Register	Anybody	New Register status, structures, services	Email
information			New Register provisions	
	New Register <	> Shipowners	Registration fees & charges	
			Remote registration facilities/procedures/formalities	Web site
			Remote registration fees payment	
	New Register <	> Representative	New Register administrative information	Web site
		Nat auths.		
Vessel's	Nat. Auths <	> New Register	Building certif., bill of sale, former register's cancellation certif.	Email
ownership				
	New Register <	> anyone (restrict)		
			Companies, incorporation, explicit board, executive staff, ISM Code principals	Email
	Owner	New Register	Mortgages & liens certif.	Email, News
Company's			Solvency certif.	WWW, Video Conf.
ability	Former Reg.	New Register	Insurance certif.	Email
	Banker	New Register	All above	
	Insurer	New Register		Email,WWW,news
	New Register	Due partners (restrict)	Name, type, call sign, sizes, tonnages, energy, gears, speed, …	WWW, Email, News
	Owner	New Register	Fittings, accommodation, …	
	New Register	Anybody	Plans, photos, videos	
				Email,Edifact
				Email,Edifact
				Email,Edifact
Vessel's	Owner <	> New Register	Class certif.	
characters	Class Cies	New Register	Vessel's life's record (owners, surveys, changes, accidents, repairs)	

INFORMATION EXCHANGE BETWEEN NEW REGISTER AND CUSTOMERS/USERS THROUGH NEW INFORMATION AND COMMUNICATION TECHNOLOGIES				
SUBJECT	**FROM**	**TO**	**CONTENTS**	**SERVICE**
	MOU, USCG insurer owner other reg.	New Register New Register	Controls, detentions Hull & cargo insurance certif. Bareboat charter's documents	Email,Edifact
Seafarers' affairs	Owner < New Register <	> New Register > Seafarer	Seafarers' identify, nationality, cursus Qualification certif, (STCW, SMDSM, …), specific skill Personal insurance scheme	Email,Edifact Email,Edifact
Ship crew	Owner < Ship crew	> New Register Everybody	SMD (Safe Manning Document) MPF (Manning Proposal Form) Working agreements Working time, wages, leave schedule Pension fonds Personal communication	Email,Edifact Email,Edifact Email, news Email, news, voice phone
Navigation	Seafarer New Register	New Register Due partners Owners	Tracking & tracing the registered vessels Harbours information Serious navigational emergency warnings Possible assistance & salvage information & procedures	Satellite Edifact Satellite Satellite
Legal information	New Register	Owners Ships Due partners Everybody Owners Ships	Legal information regarding shipping from IMO, ILO, IFT, MOU, USCG Legal information regarding shipping from European states & EU Legal information regarding shipping from other states	WWW, news WWW, news WWW, news

INFORMATION EXCHANGE BETWEEN NEW REGISTER AND CUSTOMERS/USERS THROUGH NEW INFORMATION AND COMMUNICATION TECHNOLOGIES				
SUBJECT	**FROM**	**TO**	**CONTENTS**	**SERVICE**
Financial information	New Register Everyone New Register, Authorities Everyone < New Register	Owners Crew Everyone >Everyone Owners	Exchange rates Seafarers transfers Maritime states' financial regulations Funding opportunities Possible investment funds & bankers' advertising	Email,Edifact WWW,email WWW WWW,news WWW,news
Training	New Register <	> Owners	General training schemes Support to specific training Work Organisation scheme (method, standards) Classification sites documentation Information on maritime New Technologies in regard to technical, implementation, economy, savings. Possible suppliers advertising.	Video Conf. Video Conf., WWW, Email, news, Edifact
Technical information	New Register < New Register Crew	> Owner Ships Crew	Technical information on ports, vessels, equipment	WWW, Email, news
Ship handling	New Register <	>Owners	Possible ship handlers advertising	WWW, news
Health			Health information Telemedicine Possible laboratories advertising	WWW, news Video Conf. WWW,news
Social information			Seamen associations advertising Social Regulations followed	WWW,news Email,Edifact

4.4 A framework for the development of a human oriented application for a Register utilising new technologies

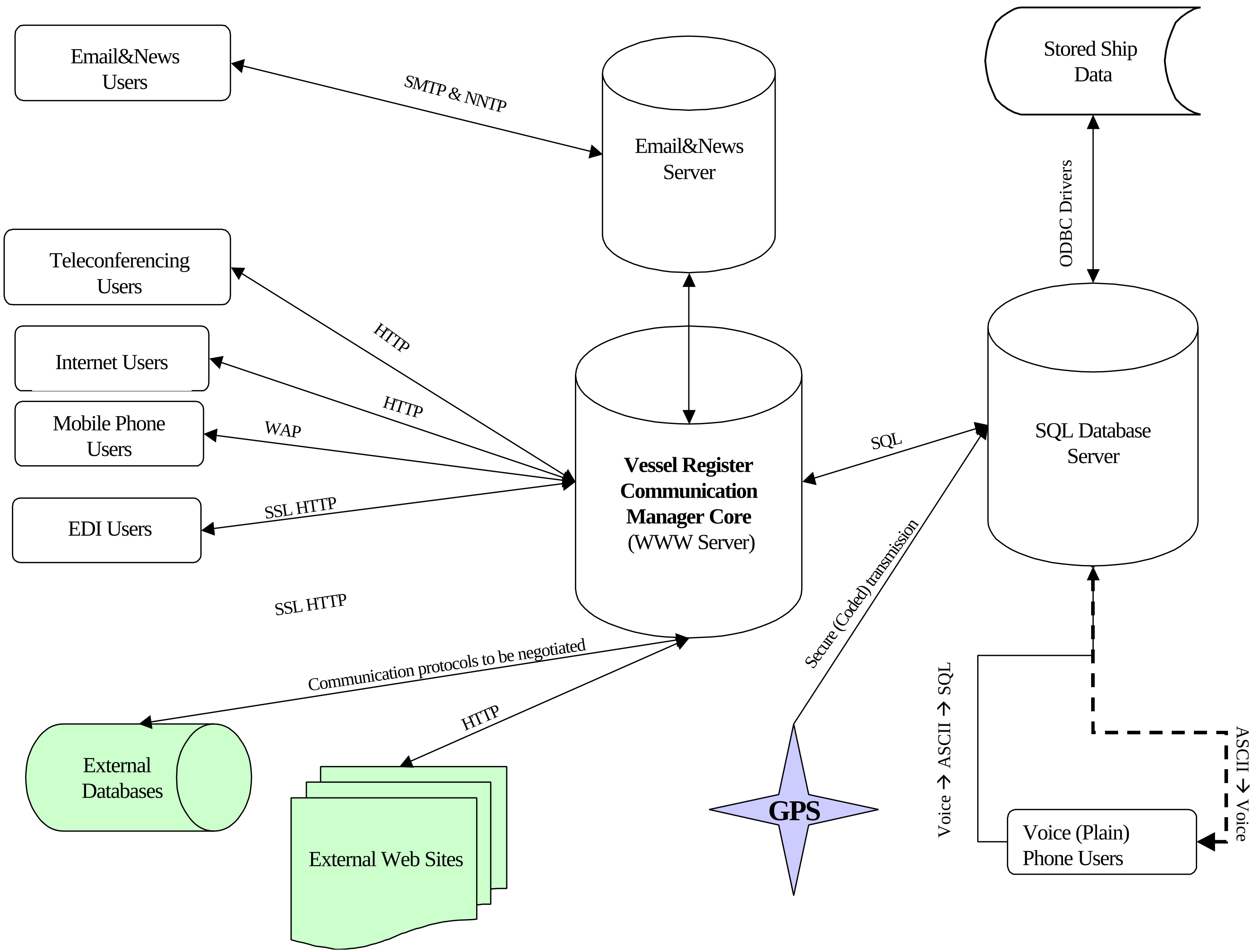
4.4.1 The "Vessel Register Communication Manager" (VRCM) proposal of a new tool for a new type of Register.

The opportunities offered by new ICT to enhance ship's Registers condition and services can be utilised if the different ICT systems are integrated. Their integration can be facilitated by the creation of a sophisticated WWW site. Such a WWW site should be able to integrate many ICT technologies via specific user-friendly interfaces. The basic principle to be applied in the proposed WWW site by THALASSES is its capability to manage various channels and communication means via dedicated communication interfaces. Such a WWW site allows vessel Registers to promote new services and increase their efficiency and transparency. Such a tool is named here web site "Vessel Register Communication Manager" (VRCM).

The Web site "Vessel Register Communication Manager" is not simply a series of HTML pages but the core of the new type of Register system, having the responsibility to manage the communications that it will facilitate or generate for the benefit of the users.

Figure 4-1 presents the basic components of the VRCM.

Figure 4-1 Components of the Vessel Register Communication Manager (VRCM)



4.4.2 Technical description of the core of the system. The "Vessel Register Communication Manager"

The technologies that the VRCM will have to implement will be described here

1) Database under Oracle or S.Q.L. with a large storage capacity
2) User-friendly interface between :
   i. The web site Vessel Register Communication Manager and Netscape or Internet Explorer or any other Web browser
   ii. The Web site Vessel Register Communication Manager and the portable phones with the wireless application protocol technology

   A highly usable interface will allow the communication with the core of the system in different languages English, French, Spanish, Italian, German, Dutch, Danish etc. This has to be done in a manner that will be easy to learn following any widely accepted Internet and Maritime interaction conventions and notations.
3) E.D.I. Interface between the Web site and the shipping actors (ports, shippers, customs, authorities, police authorities, etc. The E.D.I. interface will have to be able to communicate with Edifact protocols and non-Edifact protocols depending on the Edifact's recipient.
4) Digital Audio Phone Interface between the Web site and the voice/phone messages. The digital audio interface will have to treat the voice messages transmitted by digital phones in order to be understood and answered by the Web site VRCM. This operation will need sophisticated software able to translate the digital Voice messages and to manage these demands through the different databases and Web pages accessible on the VRCM.
5) Providing Internet users with sources of relevant information. The Web site will have to provide links to different Web sites such as the I.M.O. Web site, I.T.F. Web site, European legislation, Web site, etc.
6) A communication system to collect the position of the ships through their Inmarsat and GPS connection even if this a functionality is not publicly available (i.e. is restricted) through the WWW Site. The system will be based on the Inmarsat and the GPS technologies and a specific software to extract at specified intervals the position of ships at sea by this satellites systems. It will be an important investment for the Vessel Register Communication Manager. Resources will also have to be spent on securing this information.
7) An Ethernet Network at a speed of 100 MB/S connecting the different servers of the Web site. This Ethernet network will connect the databases used by the Vessel Register Communication Manager in order to provide in a few seconds the information requested by customers and users.

4.5 Implementation of a prototype "Vessel Register Communication Manager" Web Application

A "Web application" is a software application designed to run over the Internet. This implies that it cannot be run as a standalone application.

4.5.1 Application Model

Such an application follows the "three-tier" model:

1. The **upper tier** is the client application, in our case the Internet browser
2. The **middle tier** is the logical Web Server (i.e. An application such as Microsoft's Internet Information Server, Apache etc.) that commands the processing (running) of the application on the server and acts by sending the necessary information to the upper tier.
3. The **lower tier** is the physical Server (i.e. the computer/network/RAID system) where the files reside and where the actual processing is taking place

When a user requests information through his/her Web browser the following events in chronological order happen:

1. The client browser (client side) communicates with the Web Server (tier 2) and requests the page.
2. The Web server loads the page and requests the execution of any application scripts from the server (server side).
3. The server computer executes the scripts and returns the results to the Web server.
4. The Web decides which data to send back and sends it to the client.
5. The client browser displays the application data. The result is the picture displayed above.

If on an implemented Active Server Page (ASP) the information that the browser displays is *x* bytes, the **physical** file on the server computer is 4 times *x* bytes. The server processes the file and transmits only the information that should be displayed to the client. As expected the client side of the application contains less data (is *thinner*).

In reality this is an oversimplified explanation of how a Web application runs. In reality each of the three tiers and especially the middle tier can be subdivided to more than a few sub-tiers (sublevels).

The necessity of this approach is dictated by two very real restrictions.

1. **Bandwidth**: The Vessel Register Communication Manager (VRCM) components take about 25Mb of data space. It would take more than an hour to send all this data assuming that the client has a 56Kbs modem and the transmission is 100% error free. In most cases this is not show and an average connection with a 56bs modem rarely exceeds a transfer rate of 4.5Kb per second.
2. **Application specific libraries**: The VRCM application has 25Mb of data. Not all of them are HTML pages and database elements. Application libraries occupy more than 90% of this space. For example the Web server communicates with the Database server to recall the requested data. The communication-specific instructions are provided by these dynamic link libraries (dlls). If the execution took place on the client side then the client

computer ought to be equipped with all of these applications and their associated libraries.

4.5.2 Integration versus Compatibility

Although, at first, it may appear that the hardest part of such a project would be to integrate all the different aforementioned components into a single system, in reality the real issue is to integrate them **and** make them compatible to all potential users. Today's Internet application should be accessible from all over the world using any computer hardware, operating system and browser software. This produces an infinite number of possible configuration and therefore an infinite number of possible compatibility problems.

4.5.3 Security

One of the requirements that the potential users and especially ship owners emphasised is the need for securing information (data).
There are two types of security, both should be implemented especially on sensitive information, such as vessel position:

1. Hardware security, which involves using a proxy server (service) and a firewall server (service).
2. Software security, which incorporates technologies such as software encryption (using encryption algorithms, public/private keys, personal certificates etc.), secure transmission using Secure Server Lines (SSL), virtual/on-the-fly network addressing and detection agent software.

Potential users have to be convinced that regardless of the "doomsday predictions" made by the media (the Year 2000 "virus" is an excellent example), computer information can be stored at least as safely as any other form of information.

4.5.4 Conclusion

The development of a Web application incorporating new information and communication technologies is feasible and can provide the competitive edge on "New Registers", but requires a lot of resources to be allocated to it especially with regard to the testing and deployment phase. It is also necessary to take into serious consideration the security concerns as they were expressed by the potential users in order to create a tool that will be easy to use and above all, acceptable by all actors involved.

While the European Union has a worldwide lead in shipping, it lags behind on Internet related ICT applications. The proposed VRCM. tool is such an innovative application opportunity with promising potential.

5. New Technologies And MET

5.1 Methodological approach

The part of the THALASSES work to be presented in this chapter aimed at providing an overview of requirements for MET resulting from the introduction of new technologies in the maritime sector and also to investigate the application of new methods of training on new technologies. The results are based on literature review, documentation from former and ongoing European and national research projects, Consortium discussions as well as interviews and a workshop with external experts.

The work was organised in three distinctive parts the first providing an overview of the impacts on MET following the introduction of new technologies and the other two concerned with the investigation of use in MET of new tools such as the SHIP-MATE tool and simulators (especially the one of SUSAN-ISSUS).

5.2 An overview of impacts of new technology on MET

Present Maritime Industry faces the problem of shortage of skilled seafarers but also the requirement to readjust Maritime Education and Training (MET) due to the introduction of new technologies.

As human performance is the key to the general performance of the industry, one has to consider how the reorganisation of MET and the supply of qualified labour is linked with the reorganisation of the maritime transport industry.

As M. Mazzarino and E. Maggi concluded in the METHAR/I.S.T.E.E. report(87), the main technological developments onboard can not imply a sort of “self sufficient” Education and Training (E&T) for the maritime personnel. On the contrary a suitable general framework of E & T must be developed and it must be implemented through MET institutions.

A task model of work organisation onboard ship was adopted by the THALASSES Consortium to identify in each task the involved new technologies, the relevant human needs and the MET technological means/methods.

The main ship tasks considered are : *Navigation, Ship handling/ship birthing, communication/management support, ship safety, maintenance and repairs, energy, administration, catering-cooking, cargo care, health & care/welfare, attendance.*

Various new technologies have been introduced or are under introduction having a lesser or greater impact on MET. Some main conclusions resulted from this exercise are :

Automation and computerisation on the ship’s functions have arguably reduced the seafarer’s work to repetitive and tedious duties. On the other hand evolutions in telecommunications and information create new opportunities for reducing the isolation and also spend the free time in a more creative, useful and interesting way.

Innovations that are not yet widely used should not concern MET in its general context. Depending on particular countries/areas MET adjustments concerning the use of new introduced technologies can be made by local MET institutions.

The navigation of the newly introduced fast ships should concern MET. Fast ships require special training, due to the decrease in the reaction time, which is inhibited from the substantial increase in the speed under which they travel.

The modern ship machinery reaches a high level of down scaling, power increase, reliability and monitoring. The operation of engines is controlled by the integrated bridge system; the engineers' part is limited to watch and maintenance. In spite the higher level of machinery automation and air conditioning, the subordinate technical mates' work is still essential due to possible break-down of the electronic systems.

Thus, MET for technical mates should without doubt give extensive emphasis on these processes, and on the importance of thorough maintenance and correct use of tools relating to the operation of the engine. Suggestions that came out of the workshop focus on the introduction on board of an electronic engineer. A crewmember with this knowledge seems to be necessary in order to cope with problems related to the electronic systems.

MET should continuously observe evolutions and be readjusted accordingly to the demands. The establishment of a strategy in order for MET institutions keep track of changes and upgrade their organisational structures in order to cope with new training needs, is of primary importance.

5.3 Review of impacts and use of simulator on MET

5.3.1 Simulator use of today

In the market of industry and transport, as explained in chapter 3, a high level of automation combined with an equally high level of technical reliability has resulted in changing the training and familiarisation methods. One of the main reasons for carrying out simulations refers to the aspects of time, cost and ecological (environmental) considerations. Besides that, the simulation essentially offers a greater range and easier realisation of possibilities to record and reproduce training sequences, which can also be interrupted at any time without problems.

The following overview presented in Table 5.1 elucidates the advantages and disadvantages of the simulator use:

Table 5.1 – Advantages and disadvantages of the simulator use

Advantages:	**Disadvantages:**
Time-cost benefit	Validation of the courses, standardisation and convention need to be certified
Easily to fill the gap between theory and application	Lack of educational methodology, there is mismatch between the acquisition of skills from the training and the application of those skill to real situation
Possible to train those aspects which are not frequently met on board ship	Limited ability to simulate in shallow and restricted waterways and ship-ship interactions
Multi-task of training many kinds of ship handling	Credibility must be insured
Comprehensive way to assess mariner competency, skill and ability	Not sufficiently detailed compared to onboard training
No great damage is done	No measurement of success
Repeated exercises can enhance any particular skill	Time equivalence need to assess
Renewing and refreshing existing skills, acquiring new skill to new technology	Traditional method neglected, but its very important because even electronic system can fail, especially in emergency

5.3.2 SHIP-MATE tool and chances for adaptation; Towards interactive simulator sessions, assessment tools

The SHIP-MATE tool set developed by CARLOW ASSOCIATES and considered in THALASSES consists of a standardized and formalized human factor processes, 9 automated human factor tools, and a number of automated human factors data bases. The SHIP-MATE tool has been appropriately adapted to meet requirements of bridge development process on board commercial ships (where THALASSES focuses).

The guiding principle behind the design of the SHIP-MATE software is that the human factors manager/analyst should have at his or her fingertips all of the requirements, guidance, instructions, processes, procedures, methods, tools, and data needed to plan and conduct a timely and complete human factors effort.

The process and several of the tools have been validated in a number of efforts for the U.S. Navy, specifically addressing how human factors can result in reduced ship ownership costs, through reduced manning, improved training, and reduced human error potential. Ownership costs are reduced through human factors application since 50% of operational costs are associated with the manpower required for ship systems, and the training associated with these systems, and also since human error accounts for 80% of ship accidents, according to the International Maritime Organization. The process and tools have also been validated by being successfully applied in a number of other systems, including:

- BP/AMOCO

- U.S. Coast Guard
- Air and the Airline Pilots Association (ALPA)
- Brookhaven National Laboratory/Nuclear Regulatory Commission etc.

The process followed by SHIP-MATE represents a standardization of the methods, procedures, and activities required to integrate human factors into each phase of a system acquisition and development process, and to apply human factors to the design, development, test and evaluation of complex systems. The purpose for developing and standardizing the human factors process was to reduce the time, effort, and cost of applying human factors in system development, and to improve the results of process application by providing guidelines for each step of the process. The adequacy of the process is evident in the fact that it has been successfully applied to navy ships and systems, petrochemical systems, space systems, electric power control systems, aircraft systems, air traffic control systems, pharmaceutical systems, manufacturing systems, information systems, communications systems, and assistive technology for the elderly and disabled, in the U.S. and in Europe.

Some of the tools used in industry are comparable to SHIP-MATE. The SIMWAM task network simulation tool is comparable with a number of Monte Carlow tasks network tools, such as Micro Saint. The other automated tools and databases are unique to SHIP-MATE. The human factors process resident in SHIP-MATE is unique in its breadth and depth of application. There are other human factors processes on the market but they either fail to span the entire systems development process, or they fail to address steps in the process to the depth evident in SHIP-MATE.

The SHIP-MATE tool set does not adequately address the costs associated with alternate design concepts, nor the cost savings, in absolute monetary terms, for human factors application.

The major requirements imposed on human factors which are inherent in the SHIP-MATE system, are:

- personnel considerations and requirements must influence system design;
- human factors must have a central role in the affordability assessment;
- human factors must drive the system risk assessment;
- human factors must maximize the quality of acquired products;
- the human factors process must emphasize use of commercial products and standards;
- the human factors process must include requirements for prototyping, simulation and modelling; and
- human factors must include requirements for specifying system operational performance objectives.

SHIP-MATE includes a standardized and formalized human factors process and incorporates an integrated set of automated tools and databases to support the application of individual steps of the human factors process.

The elements of the SHIP-MATE system are:

- a standard and formalized human factors process integrated with the activities, events, products and milestones of the ship/system acquisition process;
- automated human factors tools;
- human factors databases;
- a report generator for producing human factors plans and reports.
- Integrated SHIP-MATE tools include:
    - IMAGE - a mission and function analysis tool;
    - ICAN - integrated comparability analysis tool for identifying high driver functions and conditions, as well human factors lessons learned;
    - ROMAN - an allocation of function tool for defining the required roles of the human in performance of system functions and relying on the collaboration of the human engineer, system engineer, and operations specialist;
    - I-TASK - integrated task analysis tool for identifying task requirements, with emphasis on cognitive requirements;
    - SIMWAM - a network simulation tool for assessing human workloads and performance capabilities for individuals and teams;
    - ASSESS - a tool to support assessments of risk reduction and affordability for alternative design concepts;
    - I-PLAN - an integrated human factor planning tool;
    - IMPACT - an integrated manning modelling tool;
    - INDI - integrated non development item (NDI) human factors assessment tool;
- Databases currently available in the SHIP-MATE system include:
    - hypertext versions of human factors design standards;
    - lessons learned databases for ships;
    - ship damage control functions, tasks, and workload assessments;
    - ship air operations functions, tasks, and workload assessments;
    - ship engineering, machinery control, and auxiliaries concepts, functions, tasks, and workload assessments;
    - ship bridge concepts, functions, tasks, and workload assessments;
    - total ship reduced manning concepts, functions, tasks, and workload assessments;

SHIP-MATE Process Requirements

- The SHIP-MATE process identifies how job-tasks and how job skills and knowledge will change with introduction of automated technology in a reduced ship manning configuration. For identified job tasks to be performed with advanced technology and in the reduced manning configuration, task skills and knowledge must be identified. These skills and knowledge use the skills and knowledge in existing ship systems as the point of reference. The analysis should identify to what extent skills and knowledge will change due to the new technology and reduction in manning. The analysis will also identify how training methods and media will change in the more automated, reduced manning environment.

- The major change expected in training methods and media will include ship bridge resources management (BRM). BRM is designed to train ship crews in cognitive and interpersonal skills, and demonstrate how to utilize these skills in conjunction with technical job skills to result in safe and more efficient ship operations. The strategy of BRM is to focus on developing a team-centered approach to problem identification. Carlow has a wealth of experience in developing and evaluating crew resource management (CRM) concepts for commercial aviation flight crew training. The SHIP-MATE process will define requirements for evaluating existing training media, curricula, and systems as well as changes required to support the reduced-manning ship.
- The process will also address implementation of advanced ship crew training technology, including:
- embedded/organic trainers, simulators, stimulators;
- part task trainers
- embedded training
- intelligent tutoring;
- virtual environments for high fidelity training;
- automated authoring of instructional materials;
- team training techniques such as crew resources management;
- On-board training requirements identified in the SHIP-MATE process include:
- requirements for training of all operators and maintainers at all workstations and duty positions
- requirements for training devices, trainers, and part-task and full task simulators
- training requirements must be based on job-task requirements
- training requirements for the new system should be consistent with the requirements for similar systems
- training requirements must be consistent with required operator and maintainer skills and knowledge
- training device requirements should be based on specific skills to be acquired
- training device requirements should be based on criteria for judging/demonstrating that requisite skills are learned
- training device performance measures should be identified.
- the level of fidelity required in a trainer should be specified.
- training device requirements should include an indication of the degree to which extraneous factors must be controlled

5.4 New approach for innovative MET concepts based on the higher requirements on board

Continuous education and training for seafarers is nowadays increasingly required and least due to the introduction of high sophisticated decision support systems.

Using the new computer generated and electronic training methods based on WEB technology, onboard learning is available. Offering also the availability of further education models to qualify seafarers for positions in the shipping industry ashore personalised learning in a collaborative environment should be the focus for the future.

Using new WEB based MET concepts as a generic virtual education tool other generated MET related information can be managed and distributed as well (shore base training offers etc.). The operability, scalability, reusability and accessibility by the users (officers, mariners) allows flexibility to increase.

Objectives

- Standardised course and assessment modules as a basis for common European seafarers licences.
- Wide scope of further education services accessible from all over the world at low cost.
- Active learning concept integrating multimedia tools in the WEB.

Based on up-to-date user needs and integrated transport service concept a training programme and test procedures have to be developed and offered through internet and on CD-ROM. Interlinking distributed sources by internet is an essential feature.

- ➢ The human factors need is to identify, develop, and training and decision support technologies that will reduce human error and operator cognitive workload while enhancing the decision-making capabilities of ship personnel. The need is to effectively integrate information and provide information products to users so as to minimize reaction time and the probability of human error. The leading cause of human error is unavailability and/or inadequacy of needed information in an environment of information overload.
- ➢ There is a critical need to improve the skills of personnel in the processing and handling of shipboard information. Ship systems of today are characterized by a number of training problems, including the fact that training is routinely used to compensate for poor human-machine interface design. Training requirements do not usually influence system design; training is generally too much concerned with knowledge acquisition rather than information management skills acquisition. Too little emphasis is placed on measurement of human performance as a result of training; and too little training systems development attention is given to team training as opposed to individualized training. The effects of these problems are: excessive training costs, excessive training pipelines, reduced training effectiveness, and reduced system performance.

6. Main Conclusions And Suggestions

- **The impact of new technologies on the human element seems to be more context specific than one would think.**

A Stated Preference Analysis with 50 respondents was conducted in 4 countries, indicating the importance, which is attached to each identified human factor element (organisational structure, mental work demand, physical conditions, etc.) and the impact of new technologies on each of those human factor elements. The outcomes differed very much between officers and students, but results also indicated differences per country. Also, the different identified groups of new technologies each had different impacts on the human factor elements.

- **The risk to life arising from shipping accidents is predicted to increase due to changes in maritime operations that have the potential to erode the safety benefits of new technology.**

Human factor costs were assessed using historical accident data collected over a period of 9 years. The review of the assessment of the safety impact of new technology was thorough involving experts in risk assessment and mariners with some 200 man-years of shipping experience. The experiences of the experts indicated that ON BALANCE the risk of accidents has increased by 37 per cent. Given the data were collected in the period 1985 to 1994, the data were also assessed as sufficiently contemporaneous to be of relevance to the assessment of human factor elements costs following the introduction of technology. New technology has the potential to make operations safer. However, factors such as the non-standardisation of design or perhaps non appropriate training erode this potential safety benefit.

- **Analysing the effects of new technologies on the human element the main ones seem to be caused by navigation and communication related technologies**.

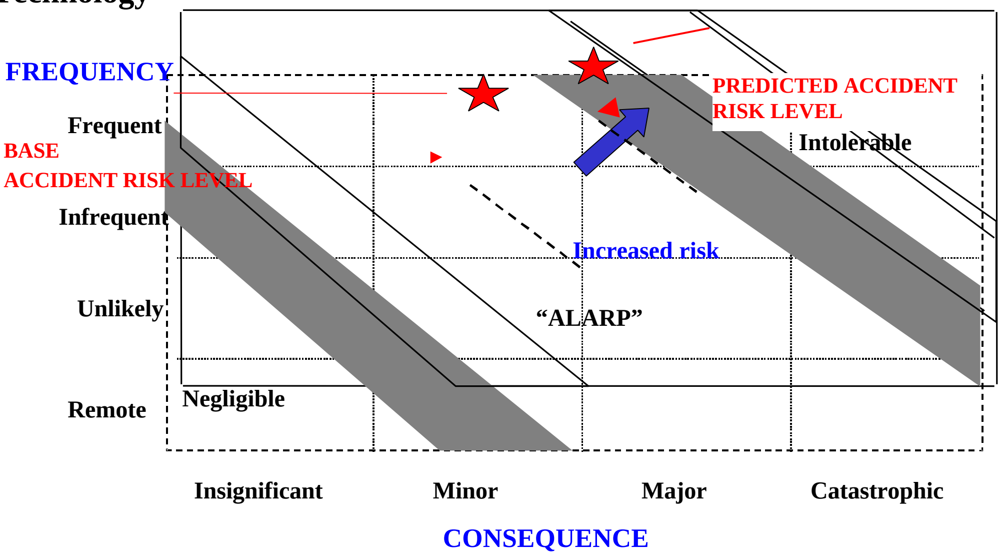
Based on the literature review, the main effect of the introduction of key technologies on the human factor were shown to be caused by the introduction of navigation, communication and management support technologies. The effects of technologies related to navigation support and communication & management support are very similar. The main difference is that the development in information systems on board a ship for navigation support may lead to more decision-making on board, while the development of external information systems may lead to less individual decision-making per ship. New technologies in general show the most effect on the number of crewmembers, the job profiles, the workload, the work organisation on board a ship, the safety on board the ship and the necessity of training. New technologies related to navigation, communication and management support are increasingly being implemented, to a larger extent in integrated bridge systems, and the effects these technologies have –contrary to other identified new technologies- on the human working culture are very well visible. The literature review results were confirmed by the results of the framework tool (Stated Preference, Multi Criteria Analysis, Social

Impact Table) showing that the largest impact on the human factor elements was driven by navigation, communication technologies development.

- **There is a trade-off between costs of safety measures and levels of risk avoidance**.

The influence diagram enables not only the pattern of influence of new technology on safety to be modelled, as required for the THALASSES project, it also allows an assessment of the impact of new technology, by assessing the change in quality of the influencing factors. Thus the cost, in terms of change in risk, is also modelled (see figure below), showing that the level of risk avoidance (with a relationship to the level of costs) can be chosen.

Figure 6.1 Diagrammatic Representation of the increased Risk Cost of New Technology



- **It seems that new Information and Communication Technologies offer a great potential to strengthen the efficiency and above all transparency of vessel register.**

The proposed Vessel Register Communication Manager (VRCM) tool can facilitate the exchange of information among various maritime actors via the Registers providing to them competitive advantages and also information services.

- **Integrated concepts and their application have impact on M.E.T**
- New familiarisation methods with new technologies on board
- CBT based training on board
- Team oriented training

- **Simulators are used today mainly for MET though could be used also in other areas**
- The use of simulators could be summarised as following:
- Motivation of certain types of participants (Pilots, officers)
- Monitor and assessment of objective skills

- Training of competence in environments with special operational requirements (ports, restricted sea areas, river)
- Familiarisation with new technologies on the bridge

Impact on education and training using simulators

Watchkeeping Procedures
Increasing emphasis on watchkeeping standards in STCW Chapter VIII and the Codes and consequent need for trainees to demonstrate their competence will require simulator operators to re-develop many of their programs and exercises in order to achieve such objectives.

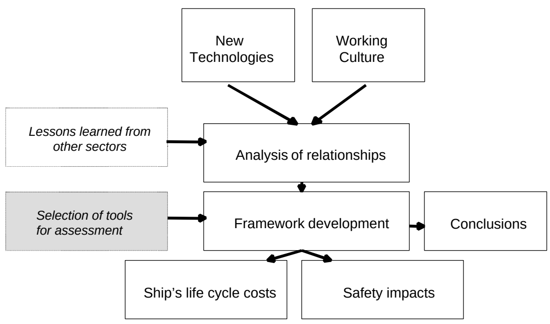
Training by simulator:
It is evident that there remains considerable diversity in both equipment standards and in operational capability of listed simulators, both at the ship handling level and the radar/navigation only level. Secondly, examination of the competency tables in Part A of the STCW Code reveals that there are many functional tasks at master and watchkeeper level that can be covered by the use of simulators.
However limits of student numbers, trained instructors, time and cost force a compromise in program objectives.
The effectiveness and role of the instructor must also not be overlooked and the STCW convention now places an obligation on administrations to ensure that instructors and assessors are both appropriately qualified and experienced for the tasks for which the training is being conducted.

Assessment by Simulator
Changes in equipment and navigation technology will also have an increasing affect upon the use of simulators for assessment. STCW 78 as amended, places new emphasis upon the trainee to demonstrate an ability to perform functions and tasks to the required standards of competency. If simulators are to be used to assess any competency required by Code A, or to establish continuing proficiency, then assessors must establish assessment criteria in relation to the selected functions and tasks. The development of assessment programs on simulators will need to consider the manner in which skills to use new equipment effectively and safely such as ECDIS, Radar/ARPA, GMDSS within the bridge watchkeeping role can be measured.

Other areas of use for maritime simulators
- Port planning
- Port management
- Pilotage Training
- Bridge team training

- New technologies need to be evaluated by specific instrument during their implementation in the overall maritime sector

The assessment framework development actually provides the background for core of the THALASSES research on assessment of impacts: the tool for assessing the



socio-economic impacts of new technological concepts in maritime transport on the human factor elements. For this purpose, THALASSES has made a selection of tools, which were then operationalised and tested in a trial application.

After careful consideration, a combination of three (of which two already existing) tools have been selected to meet the objective of the framework assessment. These tools are the Stated Preference Analysis, the Multi Criteria Analysis and the Social Impact Table:

- With the help of the Stated Preference Analysis (SPA) the elements of the human working culture have been ranked according to their importance for the job satisfaction of the seafarer. This way, quantitative insight could be given into the value of non-quantitative elements.
- The Multi Criteria Analysis (MCA) was selected to contribute to the tool because of its ability to take inputs on a micro (respondent) level and translate these to a macro level.
- Finally, the development of the Social Impact Table (SIT) was necessary to link the preferences in human factors to the selected new technologies and thus show the importance of specific new technology categories to the human factor.

These three applications together constitute the framework tool. With the help of this flexible framework tool, THALASSES research results allow the quantifiable measurement and assessment of human factors impacts from the implementation of new technologies.

- **Maritime students and officers have different opinions on the socio-economic impacts of specific types of new technology.**

The results of Multi Criteria Analysis and Social Impact Table show that students think that computer communications innovations have the highest impact on the maritime working culture, whereas officers and captains think the (un) loading technologies show the highest impact, closely followed by navigation support technologies. Students may be more aware of new computer-to-computer communications such as EDI as a result of the training that they currently receive at their schools. Captains and officers might be inclined to think of (un) loading technologies as having the main impact because they have seen the rapid evolution of container technology in the last decades and the results this has had on ship turn-around time and sailing patterns. Both groups clearly agree in assuming that increased ship size has had the smallest impact on the maritime working culture. This might be explained by the fact that the biggest reduction in crew numbers is already some years in the past.

- **One of the main things that have become clear from the experience in other industries is that human-centred system design can have a positive impact on the job satisfaction of the seafarer, when a new technology is being implemented.**

Human-centred system design explicitly promotes “the development and introduction of more skill-based, humanised, or anthropocentric systems” where consideration is given to the implications of technological characteristics and capabilities for organisational outcomes extending well beyond the traditional “human factor elements" concerned with the physiology of individual employees. For example, ergonomic design principles are advocated which involve:

- σ The design and use of technology in a way which complements rather than replaces human skills;
- σ Provision of a work environment that maximises social communication and promotes healthy, safe and efficient working.

- **The impact of new technologies on safety standards was modelled using the influence diagram approach. This approach developed as part of the FSA methodology, enables assessment of all the factors that influence the likelihood of accidents occurring.**

It is widely accepted in the maritime community that human actions contribute significantly more to system failure than technical elements, yet there has been an over-reliance on methodologies, which examine solely the technical contribution. The Influence Diagram approach within the FSA methodology, is described in reference 29 and enables a systematic review of human and non-human failure mechanisms, as well as their interaction with each other, and their interaction with external elements.

▲ In order to model the impact of new technology, it was first necessary to determine which factors influence safety standards. A total of 37 influencing factors were defined: four at the societal level, seven at the policy level, ten at the organisational level, and thirteen at the direct level.

▲ In much the same way as it is necessary to determine the frequency and consequence of accidents to determine risk, it is necessary to define the weight and quality of the influencing factors in order to establish causal chains. Subject matter experts with approximately 200 man-years of shipping operation experience assessed the weight and quality of the influencing factors for the pre and post implementation of technology. This enabled a model to be drawn of the impact of new technology on safety standards, i.e. the pattern of sway the influencing factors have on accident events.

▲ Essentially, the pattern of influence on generic shipping operations remains constant, for example, the influence TRAINING will always influence the direct level influence COMPETENCE of employees. The variation occurs in the quality of the influencing factors. The quality of the influencing factors is affected by changes in the generic shipping operation such as the introduction of new technology.

▲ The influence diagram enables not only the pattern of influence to be modelled, as required for the THALASSES project, it also allows an assessment of the impact of new technology, by assessing the change in quality of the influencing factors. Thus the cost, in terms of change in risk, is also modelled (see Figure 2-5).

- The following conclusions may be drawn about **the cost of the implementation of new technologies in relation to the safety standards of cargo shipping operating in EU territorial waters:**

▲ For generic cargo shipping, according to historical accident data, the largest risk to human life arises from the collision of vessels. The second and third events with high risk of loss of life are flooding/foundering followed by hull and machinery failure.

▲ Casual chains indicate that the key initiating events preceding a collision are operational error and system failure leading to the vessel being set on an inappropriate

course. For the purposes of the THALASSES project, a causal chain was used whereby all the principal accident events were modelled in one diagram.
▲ The assessment of risks carried out in Step 3 (Post Implementation Assessment) predicted risk levels in terms of potential loss of life per vessel operating year as shown in the Table below.

Table 6.1 Predicted Risk Levels for each Accident Category following the Implementation of Technology.

Accident Category	**Risk Pre Implementation**	**Risk Post Implementation**
Collision	0.0061	0.0084
Foundering / Flooding	0.0041	0.0056
Hull & Machinery	0.0041	0.0056
ALL CATEGORIES	**0.01842**	**0.0253**

The risk of loss of life has increased because of the implementation of new technologies in the context of a changing international maritime industry. Accordingly, the human costs associated with generic cargo shipping operations are likely to be experienced in terms of increasing fatalities in a given time period.

- **The level of user acceptance is very much dependent on the reasons why the new technology will be implemented.**

The following motivations can be found for implementation of new technologies in the maritime industry:

1. *Safety considerations*: contributing to disaster prevention and pollution;
2. *Regulatory requirements*: a minimum level of technological equipment is required by regulatory institutions;
3. *Cost-effectiveness* (cost-push): the intense global competition stimulates the use of new technology as a contribution to the reduction of operational costs;
4. *Customer demands*: some technological concepts are developed to (better) fulfil customer needs such as faster or more environmentally friendly transport;
5. *Technological innovation* (technology-pull): new designs fresh from the drawing table may create their own demand;
6. *Improvement of working conditions and quality of life* on board ships: in order to attract appropriate personnel, ship owners may want to invest in technology applications which provide for instance better ergonomics or workload reductions.

New technologies that have been implemented for reasons of safety and improvement of working conditions have a much bigger chance of immediate user acceptance than for instance new technologies based on customer demands or cost effectiveness because the relationship with the crew’s interest is more direct.

- **Technology innovations have significant impacts on different elements of the cost structure of ships**

Based on table 2.2 it is not possible to make an analysis of the costs and benefits of the implementation of a specific investment in new technology. This should be done on a case-by-case basis. The merit of the general table above is that it gives insight into the various cost elements that can be affected by new technologies and into the relative average importance of the mentioned elements.

- **New ICT may offer significant potential to strengthen the efficiency and above all transparency of vessel Registers.**

The explanatory research within THALASSES has shown the potential of utilising new ICT in the development of a new tool the “Vessel Register Communication Manager” (VRCM), which can contribute to a register’s efficiency and transparency.

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ANNEX I –

Main Innovative aspects of THALASSES

Main Innovative Aspects

Name of Innovative Aspect : 1	
	Summary structure of new technology examples
Description	
• Objective	To classify new technologies into coherent groups
• Feature	• Classification based on value added of new technology to ship functioning • Socio-economic impact assessment more applicable to clustered technologies rather than to technology each • Current 5 groups are open ended, technologies not yet covered can be added (both individual technologies and groups of these) • Clusters are close to mutually exclusivity
• Item	Overview, result
• Source	Work Package 1
Validation Proof	
	• Based on extensive literature review and expert interviews • Proved to be applicable during further THALASSES research
Value Added to THALASSES Objectives	
	Development of the summary structure is a first stepping stone needed to socio-economic impact assessment of new technologies
Value Added to EU Policy	
	None
Potential Future Applicability	
	• New technologies not yet covered in summary structure can easily be added • Classification provides a basis for adapted clustering in case of new evidence or insights
Linkage to THALASSES Work Packages	
	Input for Work Packages 2, 3, 4, 5, and 6

Name of Innovative Aspect : 2	
	Summary structure of human factor examples
Description	
• Objective	To classify human factor element into coherent groups
• Feature	• Classification based on value added of human factor element to onboard working culture • Direct linkage between impact of new technologies and clustered human factor elements • Current 10 groups are open ended, human factor elements not yet covered can be added (both individual elements and groups of these) • Clusters are close to mutually exclusivity, although strong relationships exist
• Item	Overview, result
• Source	Work Package 1
Validation Proof	
	• Based on extensive literature review, expert interviews and elaboration on WORKFRET project results • Proved to be applicable during further THALASSES research
Value Added to THALASSES Objectives	
	Development of the summary structure is a first stepping stone needed to socio-economic impact assessment of new technologies
Value Added to EU Policy	
	Summary structure provides further insight in human factor components onboard ship on general level
Potential Future Applicability	
	• Human factor elements not yet covered in summary structure can easily be added • Classification provides a basis for adapted clustering in case of new evidence or insights
Linkage to THALASSES Work Packages	
	Input for Work Packages 2, 3, 4, 5, and 6

Name of Innovative Aspect : 3	
	Two-way socio-economic approach to new technology
Description	
• Objective	To interrelate human factors and new technologies from different angles (looking to human factors from technology perspective versus looking to technology from human factor perspective)
• Feature	• Two-way approach turned out to lead to convergent results • Each angle has it's own unique contribution to final result • Two-way approach is a combination of two diverse assumption sets
• Item	Methodological
• Source	Work Package 1
Validation Proof	
	• Extensive literature survey on both sides showed convergence • Researched lessons learned from other, non-maritime sectors proved similarities in results of the methodology application
Value Added to THALASSES Objectives	
	The results of this methodological approach performed as first-step assessment of socio-economic impact of new technologies
Value Added to EU Policy	
	None
Potential Future Applicability	
	The mindset provided by the two-way approach can be of use in other research fields
Linkage to THALASSES Work Packages	
	Input for Work Package 5

Name of Innovative Aspect : 4	
	Structured impact assessment framework
Description	
• Objective	To provide a tool for socio-economic assessment of new technologies
• Feature	• New developed combination of various existing tools further elaborated on (Stated Preference, Multi Criteria) and structured interview technique (Social Impact Table) into one coherent assessment framework • Assessment framework built-up by methodologically sound tools allows for measurement of interrelationships between new technologies and human factor • Possibility for measuring non-quantitative impacts and for combining these with quantitative aspects • Ability of aggregation of micro level individual opinions (seafarers) towards macro level assessed impact • Flexibility to expanded/changed new technology and/or human factor clusters • Allows for unlimited multi-dimensional analysis • Allows for incorporating specific results on a specific detailed aspect (like safety or ship's life cycle costs)
• Item	Methodological
• Source	Work Package 5
Validation Proof	
	• Successful technical testing by use of over 50 interviews, with a predominantly enthusiastic reaction concerning tool practicality for non-trained use • Despite limited significance of results due to invalid sample, outcome interpretation was converging to expectations of consulted experts
Value Added to THALASSES Objectives	
	The assessment framework is one of the core results as it is in the centre of THALASSES mission statement
Value Added to EU Policy	
	None
Potential Future Applicability	
	• The assessment framework can be used for extensive, in-depth analyses to get significant outcomes on the socio-economic impact of new technologies • The framework is open for generating tailor-made results according to function on board, flag of Register, ship type, age, etc.
Linkage to THALASSES Work Packages	
	All Work Packages

Name of Innovative Aspect : 5	
	Integrated ship's life cycle cost approach
Description	
• Objective	To integrate ship's life cycle cost in impact assessment of new technology
• Feature	• Further elaboration on existing ship's life cycle cost model, including detailed cost segmentation • Approach directly relates ship's cost change to new technology implementation, but various relationships between cost and technology are modelled indirectly via human factor elements • Approach promotes life cycle costs as reasonable component in socio-economic impacts assessment of new technologies • Allows for dedicated analyses by taking into account ship type, ship size, crew composition, fuel type and number of operational days
• Item	Methodological
• Source	Work Package 5
Validation Proof	
	• The integrated ship's life cycle cost approach is a further extension around a well-tested core cost model that has been applied in various other researches • Outcome interpretation was in line to expectations of consulted experts
Value Added to THALASSES Objectives	
	Further insight in relationship human factor –new technologies via cost elements
Value Added to EU Policy	
	The approach provides the opportunity to take impact of new technologies on ship's life cycle cost more explicitly into account
Potential Future Applicability	
	A methodology is available to assess technology's impact on ship cost on beforehand In a case by case way this methodology may be applied to various new technologies
Linkage to THALASSES Work Packages	
	None

Name of Innovative Aspect : 6	
	Thorough analysis of all interrelationships in a maritime context
Description	
• Objective	To provide a complete analysis of new technology without isolating it from all other facets that it influences and is influenced by.
• Feature	• Assessment of new technology in context • Assessment based on subject matter experts' experience • Assessment based on real data rather than hypothetical data
• Item	Methodological
• Source	Work Package 5
Validation Proof	
	Thorough validation involving experts in risk assessment and mariners with some 200 man-years of shipping experience. In addition, reliable and comprehensive data from Lloyds Casualty Archives were used containing accident information on some 143,830 vessel years of operations.
Value Added to THALASSES Objectives	
	Triangular validation of the results of the impact of new technology on the human element: social, economic and safety
Value Added to EU Policy	
	Key areas of maritime operations identified as particularly sensitive to environmental, social and policy changes
Potential Future Applicability	
	The FSA method is a flexible tool that can be used to monitor further developments in technology as well as the impact of any control measures put in place to regulate new technology applications
Linkage to THALASSES Work Packages	
	Work Packages 1,2,3

Name of Innovative Aspect : 7	
	Modelling of risk changes using the Influence Diagram Approach
Description	
• Objective	Enabling the modelling of human, hardware and external events in risk assessment
• Feature	• A tool that enables an holistic assessment of the maritime environment from social policy to technology design • An approach that links together societal actions to accident events in a time independent manner thus allowing policy makers to understand their influence on accidents • A quantification tool that provides qualitative answers such as 'how much' impact technology is likely to have on safety and why
• Item	Methodological
• Source	Work Package 5
Validation Proof	
	• The influence diagram approach has been developed in the context of the formal FSA development process as ratified by IMO • The application of the methodology to assess the impact of technology on safety is not drastically different
Value Added to THALASSES Objectives	
	A validation of the findings of the social and economic impact assessments
Value Added to EU Policy	
	Areas of policy that need to be considered in the maritime context have been identified A technique that allows policy makers to predict the outcome of policy decisions on activities remote in time and place has been further refined
Potential Future Applicability	
	Any regulatory changes brought in to control risks associated with the implementation of new technology can be modelled
Linkage to THALASSES Work Packages	
	Work Packages 1,2,3

Name of Innovative Aspect : 8	
	Holistic view of the system Ship
Description	
• Objective	To provide a holistic view of the system ship in the intermodal transport chain
• Item	Methodological
• Source	Work Package 3
Validation Proof	
Value Added to THALASSES Objectives	
	Further insight in relationship human factor – environment and new technologies Better overview of operational and technical interfaces on board (functional analysis)
Value Added to EU Policy	
	Improvement of the TransEuropean networks with new systems view system architecture approach Improved approach for the interfaces specification within the intermodal chain (ship/cargo/other nodes)
Potential Future Applicability	
	Development and further research in the intermodal transport chain area Application of (IST) Intelligent Transport Systems System architecture and IST
Linkage to THALASSES Work Packages	
	Work Packages 1, 2 and 3

Name of Innovative Aspect : 9 Computer Based Training (CBT)
Description • Objective — To suggest innovative methods of training • Item — Educational • Source — Work Package 3
Validation Proof Based on up-to-date user needs and integrated transport service concept a training programme and test procedures will be developed and offered through internet and on CD-ROM. The training programme should be composed by modules developed by institutions. Thus interlinking distributed sources by internet is an essential feature.
Value Added to THALASSES Objectives New MET concepts Self training assessment Capability for "portable" ECDIS training on Board, based on the ECDIS model course
Value Added to EU Policy Improved safety on board due to high level education Better EU seafarers competition based on the high level of education and training
Potential Future Applicability Transport training modules based on computer based training and distant learning via internet will result in a very cost efficient offer for seafarers and other interested parties to further qualify themselves to better meet the rapidly changing transport service requirements.
Linkage to THALASSES Work Packages Work Packages 1, 2 and 3

Name of Innovative Aspect : 10 A new tool for registers “The Web Site Vessel Register Communication Manager (VRCM)"	
Description	
• Objective	To provide to ships registers a new tool in order to manage more efficiently their fleet and offer new services to all actors involved with new information and communications technologies
• Feature	• New developed integration of various existing electronic tools further elaborated (G.M.D.S.S., G.P.S., Mobile, File Transfer Protocol, digital audio, …) into one coherent efficient and easy to use framework • Enhancement and adaptation of the information and communication technologies tools for the seafarers, the ship’s owner the administrative and international authorities, involved in the daily management of a ship register • Promotion of new information and communications technologies among ship’s registers authorities in order to be safer in their day to day management of their fleet. • Opening the Maritime Information Society to the ship’s registers authorities and the seafarers. • Increasing the transparency of the management of ship’s by ship’s registers
• Item	Overview, result, promotion
• Source	Work Package 4.
Validation Proof	
	• Extensive literature survey on this problematic, both on a legal point of view and on information and telematic one • Successful technical testing by use of ten interviews with an enthusiastic reaction from the crew concerning the digital audio voice facilities • Thorough validation involving seafarers and ship’s owner with experience in the use of flag of convenience • Technical testing of the VRCM. concept by experts in the Web business
Value Added to THALASSES objectives	
	A demonstration of the impact of new communication and information technologies on the human element through ship’s registration.
Value Added to E.U. Policy	
	• A new tool to allow a better efficiency of the ship’s registers policy wished by the E.U. policy in maritime transport. • A proof of the interest of the maritime information society concept supported by the European Commission for European seafarers and ship’s owner • A proactive possibility of promoting new information and communication technologies in the shipping sector by the European Commission • A technical mean to persuade ship’s owner to use new information and communication technologies in their daily

	management
Potential Future Applicability	
	• Vessel Register Communication Manager Concept • The Web Site Vessel Register Communication Manager concept is usable by the main European Registers authorities, above all if the European Commission is supporting it.
Linkage to THALASSES Work Package	
	Work Packages 1-2-5

Name of Innovative Aspect : 11	A quite exhaustive review of the registers' world competition
Description	
• Objective	• To provide to the maritime community and the policy makers a comprehensive view of the numerous ship registers analysing their provisions
• Feature	• Grading of the ship registers • Classification in three categories: national, second national, open international • Weighing of the registers provisions in regard the maritime law and the financial conditions • SWOT analysis of the registers 3 categories in regard to new technologies and human element
• Item	Scrutinizing, analysis, synthesis
• Source	Registers' states specific literature
Validation Proof	• Outcome interpretation in line with the registers' experts
Value Added to THALASSES objectives	• Accounting of the actual situation of the world's and European registers in regard to new technologies and human element • Trading elements for a new technology and human friendly register
Value Added to E.U. Policy	• Better knowledge of the ship registers' competition • Focusing on the main headings in register's elaboration and management
Potential Future Applicability	Essential features for creating a safe and human friendly register
Linkage to THALASSES Work Package	Work Package 4

ANNEX II–

List of Deliverables

THALASSES Deliverables

The project produced the following Deliverables :

D1: New technology and the human element in maritime transport

D2: New technologies and their impact on education and training

D3: The integrated ship operation concept

D4: Utilisation of new Information & Communication technology by European registers

D5: Development of a framework for the assessment of the impact of new technologies in maritime transport : impacts on the human element

ANNEX III–

Partners' contact details

THALASSES project

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