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CREATE3S: AN OUTLINE OF THE CONCEPT AND OVERVIEW OF POSSIBLE SOLUTION ROUTES FOR THE HULL FORM

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Abstract

This paper reviews the work done at the early concept and preliminary design stages for an innovative new class of short sea vessel. This work is part of a new EU-funded project CREATE3S that will develop new ship design concepts aimed at improving the efficiency of short sea shipping. CREATE3S aims to develop a new generation of short sea vessels utilising advanced design and manufacturing techniques, enabling Europe to strengthen its shipping and shipbuilding competitiveness. With trade between European countries increasing rapidly year on year, great demands are being made on Europe's transport infrastructure. The only freight transport mode that has virtually unlimited potential for expansion, and which is considered environmentally friendly, is coastal shipping, hence the current EU focus on encouraging more cargo to move by water. However, the increasing volumes of cargo being shipped over relatively short distances require major rethinking on the part of shipping companies and ports. More or larger ships are required and for them to be efficient, faster cargo handling concepts are needed to ensure that port turnaround time does not exceed sailing time. The CREATE3S concept envisages a vessel consisting of two principal modules: a ship hull module and one or more large cargo modules. The CREATE3S concept is intended to be equally applicable to container, dry bulk and liquid cargoes. When the vessel arrives in port, it will be possible to quickly separate the cargo modules from the ship section, plac-

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ing them on the quay. The ship module is then coupled with other cargo modules for the return voyage. The cargo units can then be unloaded and made ready for the next vessel call. This approach will combine the ability for a 'standard ship design' to be tuned to very different trades and commodities whilst using advanced construction techniques. The most revolutionary feature of the CREATE3S concept is the potential to transfer the complete cargo load in just one move. However, for certain vessel applications, it is possible that there may be more than one cargo module: more than one commodity may be moving on the same vessel or it may even be practical to mix bulk and container modules on the same sailing. The key feature remains that the individual cargo unit being discharged in one move will be far bigger than today where the maximum size unit is typically a 45ft container or 20ft ISO tank. Safety and sustainability are investigated and accommodated through a comprehensive risk assessment and integration of solutions that facilitate reduced energy consumption, emissions and waste. The new generation vessels will be assessed on their operational environmental and economic performance, in relation to total cost of ownership (including production, operation and end of life cost) utilising advanced design and simulation techniques.

Keywors: ship design, advanced construction techniques, simulation techniques

INTRODUCTION

Short Sea Shipping (SSS) has great strategic importance for the European maritime sector: it is a crucial home market for waterborne transportation, for the shipbuilding and ship repair industry, for the supply chain, ports, and for the research community. SSS is seen as key to increasing competitiveness and solving transport problems in an enlarging European Community. Market opportunities for modern SSS and the expected need for fleet replacement provide opportunities for EU shipbuilders and their supply chain; of the circa 180 cargo-carrying ships delivered by the Community of European Shipbuilders in the year 2004, more than 40% were short sea ships (CREATE3S, 2006). It is not certain however, that current transport and logistic systems can cope with the expected volume growth. Ships will have to compete with road transport on cost, reliability and flexibility without jeopardising safety or the environment. This requires, amongst many other factors, maximum fuel efficiency, low maintenance, support and operating costs achieved through the optimum use of technology and crew training. More and/or larger and faster ships will also have to be matched by improved ship-shore interfaces; shorter turn-around cycles in ports and improved cargo distribution to the hinterland. CREATE3S aims to develop a new modular ship concept consisting of two basic modules: a ship platform module; and interchangeable cargo-containing modules. For both modules a limited number of variants will be developed, corresponding with variations in trades and operational requirements. Several critical technologies arise from the required ship concept. Firstly, from a performance point of view, the ship design will have to take a broad operational spectrum into account. Traditionally, a ship would be designed for one (trial) speed and draft, here a wider range of parameters must be considered and optimised. This paper considers the organisational set-up of the project, the top level requirements on cargo transport, and the current concepts being regarded. It then briefly elaborates on the critical ship technologies, and finally considers the evaluation of environmental performance.

LOGISTICS REQUIREMENTS

CREATE3S work programme follows an end-user driven, problem solving approach. The project's starting point is the "cargo movement" along the entire logistic chain; so the cargo transport has been defined as the highest system level, at which top level requirements are set. The second system level defines the harbour cargo handling infrastructure system and the ship itself. Finally the third system level deals with the components, which build up the ship and harbour system. Therefore the requirements from the top level system flow down to the lower system levels; each level additionally takes into account its own requirements set by varying constraints (e.g. safety). Initially the logistic concept is determined in line with the logistic operator's requirements; in the same way, required capabilities on cargo carrying at sea and cargo handling in port will be the starting point for the development of the new ship concepts. The logistic operator will identify and quantify the economic/operational and technical parameters. This approach will ensure that the resulting ship concepts are economically efficient and attractive "transport vehicles'. Regarding the transport patterns for the European Short Sea fleet, the possibilities to develop an Intermodal solution based on the cargo envelope solution of Create3S must reduce turnaround time and be competitive regarding lead time (reduced or unchanged). Any solution that cannot cope with this requirement will be unacceptable. Thus, if cargo handling (terminal) operations linked directly and indirectly to the envelope are not adequately efficient, the total cost of the provided service will most likely remain unchanged. Hence, both terminal and vessel operations must be accounted for in order to obtain the optimal solution. The entire logistics chain must be considered when answering the overall question and analysing SSS operations in a consistent manner. In a *door-to-door* scenario, the total cost of transport and logistics consists of:

— Pre carriage cost from factory to port
— Terminal Handling cost
— Sea Transport costs
— Terminal Handling costs
— Hinterland distribution and port costs

Sea transport costs are closely related to the amount of cargo transported. Terminal handling costs are also affected, to a lesser degree, by the total volume to be processed. *Port-to-port* cost elements related to waterborne transport can be summarised as follows:

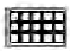
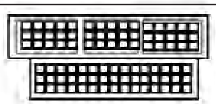
— **Capital cost**: determined by the delivery/purchase price of a vessel plus interest
— **Operating cost**: determined by crew wages, consumables and social benefits, maintenance and repair, insurance, administration
— **Voyage cost**: related to a specific voyage and include bunker, port cost, commissions, and other ancillary disbursements such as canal and seaway charges.

So a key success factor will be the ability to develop concepts which will contribute to both lead time and cost reductions on a door to door basis. Significant reductions of 20-25 % will secure the realisation of the concepts, but even with less significant savings of 10-15 % it might be possible to realise a concept. Apart from cost and lead time also other requirements are important in order to have an improved cargo transport. These are addressed in the following.

Availability of a transport mode means ensuring that transport is available when needed. While a truck may be called upon at short notice, for SSS, availability of sea transport means high frequency of operations. Further, availability may also means availability for all the cargo that is being transported by road, i.e. volume capacity of vessels and cargo type capability. To enhance availability in SSS, focus is seen on smaller vessels enabling a higher voyage frequency and therefore also higher flexibility. For SSS to be competitive against road only solutions, frequency is a critical parameter. More smaller ships with more regular departures will provide a more optimal solution than less frequent departures of larger vessels. This increase in flexibility and availability will result in reduced cargo transport lead time. The services provided must also be reliable, achieving an equivalent, if not better, level of reliability when compared with road only solutions. Cargo must be delivered according to schedule (on-time and right place), and without any damage. For the logistics chain, this implies: reliable sailing, despite weather, traffic, time slots, equipment failure, etc.; and reliable cargo handling, despite time slots, equipment failure, etc. An additional criterion for choosing a transport mode is the avoidance of physical damage. Cargo must be protected while transported as well as handled. Example of measures that can improve cargo safety (but add to the cost of transport) are conscientious scanning and inspections, ensuring cargo integrity, securing cargo environment, securing cargo tracking, and updating cargo and trade documentation and data. In the case of container freight, the risk of cargo loss or damage is reduced when using multimodal solution, because cargo is not handled when transferred from one mode of transport to another (e.g. from road trailer to vessel). This implies that improvement efforts must target the packing and unpacking of the "cargo envelope" to be transported. Therefore attention must be directed not only toward the safety of the vessels, but also to the loading/unloading of the cargo envelope. Cargo safety can also be security against damage to cargo from the transport itself that it is more protected and are transported more 'gently' at sea. Finally, since the ships need to be able to enter most European harbours, length, breadth and draft restrictions exist.

SHIP TYPES

The aim of the Create3S project is to develop a new concept of short sea ship. The use of this new ship should reduce costs e.g. by reducing the time spent during loading and unloading, reducing fuel consumption during the trip. But a brand new idea is not necessary for this new ship, it could be a new solution of using existing vessel concept. The concept which will utilise the existing infrastructure will without any doubts be easier to introduce than concepts which requires significant investment in new terminal infrastructure. But if a new vessel concept gives significant cost reduction it will in most cases be able to pay the price for the required infrastructure. Definitions of a cargo unit, package and envelope were deemed necessary to prevent confusion over terminology, these were agreed as follows (Newcastle University, 2007):

	Cargo Unit: A fundamental unit of cargo, e.g. ISO/ non-ISO/ cube max/ reefer container, tank container etc., or a new 'cargo unit' to meet the needs of how a new cargo might be unitised.
	Cargo Package: A number of cargo units handled together to facilitate loading and unloading. Minimum size is a single 'cargo unit' and the maximum size is a 'cargo envelope'. Maximum package size (number of cargo units) is set by cargo handling and logistic constraints
	Cargo envelope: A number of 'cargo packages' onboard the ship in a particular loaded condition or the nominal total capacity of the vessel assuming a specified weight per 'cargo unit' or 'cargo package'.

There are four types of ship which are the target of Create3S project:

— **Container ship:** Most relevant in SSS, it should be able to take a range of intermodal units such as standard ISO containers, 45 ft containers and swap bodies in the same envelope or package, increasing ability to sail with fully utilised capacity.

— **Dry bulk cargo ship:** Size of the ship is dependent on the operating distance and cargo volume available for transport; as well as port draft, fairway width, quay length and cargo handling facilities. Create3S is concerned with ships that can accommodate 2000-8000T dry bulk cargo, and meet vessel size restrictions of small Baltic/North Sea ports.

— **LPG/LNG ship:** Most demanding to outfit. LNG must be pressurized and transported at -163°C. Propane, butane, ethylene or propylene must be transported at -51°C. The target is to accommodate 1000m³ to 3000m³ LNG, on 100-2000 nm routes.

— **Petroleum products ship:** Typically 10-50+ compartments (product tanker - chemical tanker). Stainless steel chemical tank construction is standard. Recommendations for Create3S would be to develop concepts that can accommodate from 2000-8000T cargo.

It is not considered possible to develop one ship type which will economically operate with all cargo types. It is also not viable to develop one generic hull design for all types of ship, due to different outfitting necessities, cargo dimensions and volume/deadweight ratios.

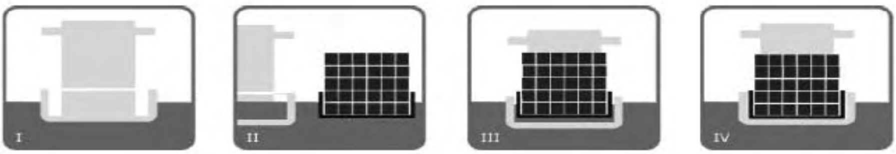
DIFFERENT SOLUTIONS FOR CARGO TRANSPORT

Transporting the cargo from ship to dock and vice versa can have a large impact on delivery time for short sea cargoes. The ideal solution would load and unload the cargo envelope in one move or as a few packages with a continuous transfer process. Create3S focuses on the best available solutions for every type of cargo considered in the project. Four existing solutions were presented for cargo handling (TU Delft, 2007a):

Lift on - Lift off [lo-lo]: This solution is designed for transport of containerized cargo. The crane can be either quay or ship mounted. This type of transport not allows to transfer the entire cargo in one move, but the continuous loading and unloading is possible.

Roll on - Roll off [ro-ro]: The solution used first of all in the ferry sector. The ramps can be mounted in the ship and on the quay. This type of transport is not efficient in terms of maximizing payload, but fast turnaround times can be achieved.

Float on - Float off [flo-flo]: This solution is appropriated to loading a buoyant cargo envelope. Special port infrastructure is not necessary. The ship fills its ballast tanks to adjust the draft, a buoyant envelope floats over the deck, where after the ballast tanks are emptied. This type of transport allows to transfer the entire cargo in one move.



Ballast on - Ballast off [bo-bo]: The ship's ballast tanks are used like in flo-flo, but the cargo envelope is non-buoyant. The entire cargo envelope can be transported in one move. The critical part of this solution is the maintenance of stability during the envelope transfer.

CARGO TRANSFER SYSTEM AND SHIP PLATFORM

The initial stages of the CREATE3S project have contributed 4 novel potential solutions to the issue of cargo transfer; these are being developed at the concept level to ensure that an informed decision can be made over which solution to take forward into the detailed stages of development. These can be categorised as:

1. Truck-Trailer: A sea-going push or pull barge concept. The ship consists of two parts, the 'engine' and the 'cargo', the latter defined as the envelope. The envelope is buoyant and could act as a floating warehouse; this can optimise terminal handling. Dividing the envelope into multiple packages is possible, but is not so relevant for the ship concepts. The envelope can be loaded independently of the engine, and should be compatible with existing lo-lo terminal infrastructure. Other loading variants are also possible, but may require a different envelope layout. The critical components of this concept are the link between the 'engine' and 'cargo' modules; and whether the engine unit should be capable of solo operation.
2. Modular Ship: Similar to Concept 1, this design also features a buoyant cargo envelope, but consists of multiple packages. Minimising ballast draft is a key feature of this solution. The ballast draft is minimal, because the packages are buoyant. The package adds buoyancy to the ship, and is an integral part of the vessel. The ship must be able to operate without any packages onboard. The 'engine' is a platform for the buoyant cargo packages. Direct inland barging of the packages is an essential part of this system (TU Delft, 2007a).
3. 'Flo-Bo': A hybrid float and ballast on/off system. The cargo is transferred between the ship platform and barges by means of an encompassing floating dock. The cargo is stacked onto pallet-frames, either on the barges or possibly directly onto the dock itself by conventional lo-lo means. The barges transfer their cargo packages to the dock through a ballasting operating which is repeating by the ship; it enters the dock, is loaded by way of ballasting down the dock, and then sails. The ship platform does not need to be in port whilst the barges are loaded, significantly reducing loading time, it also does not need the capability to ballast itself down as required for Flo-Flo or Bo-Bo. Turnaround time could potentially be reduced further by having two docks, allowing the ship to offload cargo in one dock and be loaded from the second dock rather than waiting for the complete loading and unloading cycle to be completed.

4. 'Mega pallet': The idea of this concept is a scale increase in transfer operation. By the introduction of a 'mega pallet', i.e. a bundling of containers or bulk tanks, a reduction in ship loading and unloading time should be achieved through heavier but fewer lifts. The concept is based on a conventional ship, and cargo transfer could be a LoLo or RoRo operation. This concept could also be used to transfer cargo from quay to envelope for the concepts described above.

CRITICAL TECHNOLOGIES: PERFORMANCE ANALYSIS OF SHIPS

The performance parameters of the ship design must take its broad operational spectrum into account. Traditionally, a ship would be designed for one trial speed and draught; however, the nature of this concept means that a much wider range of operating conditions must be considered and optimised. The use of modular components will also contribute to the wider application of the concept. The operational life cycle spectrum must be established during the hydrodynamic design of the vessel; for Create3S it is foreseen to establish such data with voyage simulations. The balance of the investments and operational revenues and costs can be addressed in scenario simulation, using the program Gulliver developed at MARIN. This software allows the user to simulate several years of operational service, including encountered weather conditions. A key element of this analysis is the way the master

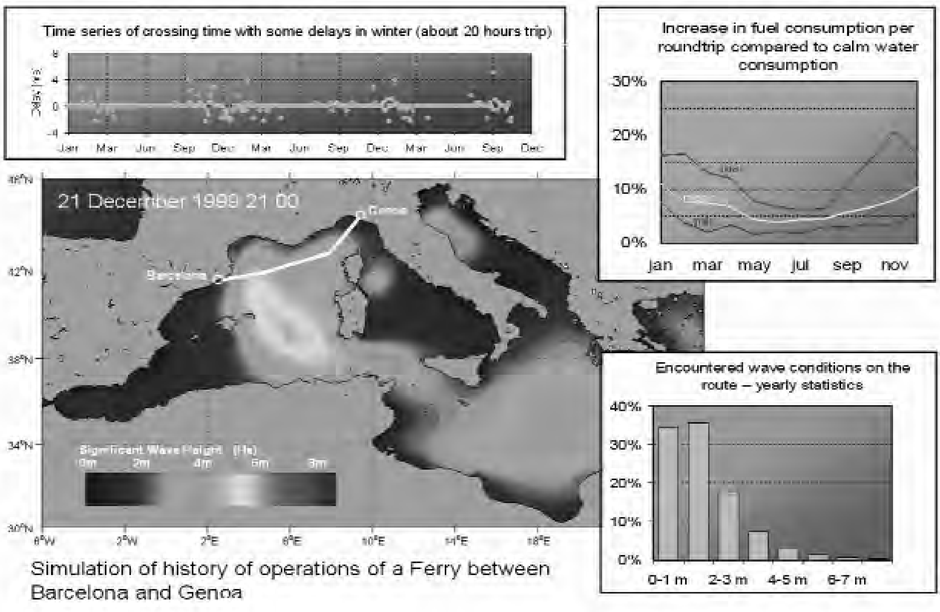


Figure 1: Voyage simulations example.

handles the ship in adverse weather: giving priority to short-term revenue (speed, reliability) or long term cost reduction (careful sailing without damage). Figure 1 gives an example for a ferry operation between Barcelona and Genoa; voyage simulations offer opportunities to develop short sea shipping, providing statistics on a roundtrip schedule, or analysing which vessel has the lowest fuel consumption and highest reliability. It is the authors' view that there is much to be gained by evaluating future operational performance in advance; therefore this 'design for service' will be carried out at the preliminary stage of the design.

ENVIRONMENTAL SUITABILITY

The requirements for the vessels being developed throughout this project cannot solely focus on becoming cost effective. As environmental laws and regulations continue to evolve and become increasingly complex, new and challenging considerations need to be implemented in order to ensure compliance. Consequently, knowing and understanding how multimodality will affect the environment becomes of prime importance when producing the desired services without incurring unnecessary costs, and avoiding doing damage to the environment. Therefore, the project will also look at the environmental impact of the new modular concept that has been previously explained. Generally speaking, short sea shipping appears to be the most environmentally friendly transport mode (Benvenuto & Figari, 1999). In addition, accounting external costs of transport due to such as noise, accidents and congestion, shipping outperforms road transport to an even greater degree (IWW/INFRAS, 2004). Environmental impacts of shipping can be sorted into six main categories (Cabezas-Basurko et al., 2007):

— Airborne emissions from consumed hydrocarbon fuels, cargo emissions and noise.
— Waterborne emissions as a consequence of underwater noise, antifouling coating leakage and illegal spills and discharges.
— Operational spills: routine discharges of oily waste, ballast water from marine shipping and wastes.
— Accidental spills of oil, toxics or other cargo or fuel at ports and while underway.
— Invasions of invasive species due to mainly ballast water in marine shipping and fouling on hull and anchor.
— Other emission, such as wash due to waves produced by the movement of the ship. Usually, the wash is more predominant on high-speed craft.

SSS will also generate environmental impacts of a different nature; the increase of SSS will enlarge and increase the construction of more port and inland channel infrastructures. Life Cycle Assessment (LCA) is the most popular technology for assessing the environmental impact and there are good examples of its used in shipping (Fet, 2002). Therefore, this will be the mean that the project will use for analysing the environmental impacts of the proposed multimodality idea. Resources consumption, waste production and environmental impacts of different solution presented on the project will be investigated. There will be also a comparison with the conventional transport modes in order to see whether in reality SSS is the best solution for sustainable development. The commercial LCA tool SimaPro will be used on the project for this aim. Environmental benefits, jointly with the life cycle cost analysis and the risk assessment of the alternatives will give a clear idea of the benefits of using this innovative ship concept and their contribution towards a sustainable future.

CONCLUSIONS

This paper outlines the work at the early concept and preliminary design stages for an innovative new class of short sea vessel, part of an EU-funded project, CREATE3S. Within this project setting the starting point at the cargo logistic chain has been explained; from this requirements for the harbour and ship will be deduced. The concepts considered so far have briefly been described, and critical technologies have been addressed. Incorporating operational conditions and environmental impacts of the vessel into the design at an early will ensure holistic whole life design of a useful, fit for purpose vessel.

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REFERENCES

Benvenuto G & Figari M. (1999)¨: Environmental impacts of land and maritime transport in urban areas. *Urban Transport and the Environment II*, Computational Mechanics Publications.

Cabezas-Basurko O., Mesbahi E, & Moloney S. (2007): Holistic analysis of ships' sustainability. *Proc. of MARSTRUCT 2007, the 1st International Conference on Marine Structures,* Glasgow, UK, 12-14th March, pp 513-521.

Create3s (2006): *Innovative Concepts realized by advanced design & production to improve the total efficiency of new generation Short Sea Shippings*. EU sixth Framework Programme, Proposal/Contract No. 031488/TST5 – CT –2006- 031488, ANNEX I.

Fet Am (2002); Environmental reporting in marine transport based on LCA. *Journal of Marine Design and Operations, Part B*, Proc. of the Institute of Marine Engineers, Science and Technology, No B1 2002, pp 17-25.

Iww/Infras (2004): *External cost of transport*, updated report. Zurich/Karlsruhe, October.

Newcastle University (2007): *Clarification of Requirements,* Internal report to CREATE3S project, May.

TU Delft (2007): *Cargo Transfer Concepts*, Internal report to CREATE3S project. June.

TU Delft (2007): *Parameter Variation Study: Concepts I & II.* Internal report to CREATE3S project, August.

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INTERACTION DESIGN IN SHIP BUILDING: AN INVESTIGATION INTO THE INTEGRATION OF THE USER PERSPECTIVE INTO SHIP BRIDGE DESIGN

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Abstract:

This study investigates into the involvement of the user in the design process of ship bridges and navigational equipment as seen from the designers' perspective. Following a qualitative approach, designers were asked about their work habits and guidelines. Four different images of the navigator were identified, ranging from "servant to the engineering" to "power- and skilful bridge manager". These types evolved from surprisingly different notions on topics such as basics of ergonomic design, human factors and usability, feedback loops in design, and system knowledge of the user. While there was a general interest in usability, interaction design and human factors among designers, there was also evidently a lack of detailed, concrete knowledge. This leads to the conclusion that there are still a number of difficulties with respect to organizational structures and internal as well as external collaboration that hamper integration design. Some possible solutions to these problems are discussed.

Keywords: design study; ship bridge design; user participation; human factors; design practice.

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INTRODUCTION

The bridge of a modern ship is a highly complex system. This is not only true with respect to the nautical technology, but also with respect to the multitude of interactions between humans and technical systems that are required for safe navigation. We therefore can speak of a socio-technical system, a tightly knit network of modern technology and a host of human factors as well as prerequisites of interplay between these aspects.

Obviously, this interaction between humans and different soft- and hardware components offers numerous possibilities for difficulties. As in other complex and safety-related industries, it is practically impossible for the developers of technical ship bridge components to foresee all conceivable risks and hazards and minimize their likelihood through appropriate design features. But even if this were possible, nautical officers would still be "naturally vulnerable to designers designing in a way that impedes operators' reasonable intentions" (Busby and Hibberd, 2002 pp. 132-8).

It is therefore important that the process of developing technical devices and systems that are supposed to assist humans in such complex tasks be conducted in close exchange with the end-users of these developments (see Herczeg, 2005; Transportation Research Board, 2003; Scolari, 2001). When, some 25 years back, Gould and Lewis (1983, 1985) formulated their now often-cited principles for interface design, they put "early focus on users" at the top of their list. In everyday life, however, user involvement still often lies somewhere between "rare" and "absent" (see King, 1995) and "developers are therefore forced to, design in the dark' ", as Nandhakumar and Jones (1997) describe the problem.

Given the risks involved, ship bridges should be organized and designed in way that offers maximum safety and efficiency – not only under normal circumstances but also under conditions of rough seas, in emergencies, and during operation by stressed, fatigued, or overloaded mariners. If these aspects are ignored, work on a ship bridge would fall prey to the same observation Busby and Hibberd (2002, pp. 132-8) formulated as a result of their study on the misunderstandings between designers and users: "An important causal factor in many failures of complex engineered systems and the subsequent accident sequences is a mismatch between the intentions of the system designers and operators". To counter this mismatch it is critical that the design of complex systems is not only driven by the latest advances in technology. The user and his necessities under different working conditions require the same amount of attention as do the general principles of human information processing and action regulation. These are often subsumed under the label "human factors", meaning those special principles that determine human behaviour in dealing with complex sociotechnical systems (see, e.g., Cherns, 1976; Dörner, 1989, 1999; Hawkins, 1987; Reason, 1990; Vicente, 2004).

The integration of this claim into the design process has gained different levels of momentum in different industries. The merchant marine is most probably not among those leading the pack. Even the most modern ship bridges cannot deny their evolutionary past as they are still quite reminiscent of 19th century technology. Improvements in safety and efficiency are still mostly sought through purely technological solutions without proper recognition of the systemic character of the task of sailing a ship (Lützhöft, 2004; Lützhöft & Dekker, 2002). To avoid the problems other industries have encountered following this "technology philosophy" (see Dekker, 2005, for the example of civil aviation), new developments in ship bridge design require the integration of the views of the users (the nautical officers), the ship builders, the bridge designers, the hard- and software engineers, and human factor specialists.

This article reports some of the results of an interview study that was conducted as part of just such a collaborative project in ship bridge design. We made inquiries into the user models that are entertained by designers of ship bridge systems and we asked them about the ways in which the user perspective is integrated into the engineering process as well as the human factors knowledge they can use in the design process. From this material we could isolate some tendencies which in our opinion are not restricted to design for the merchant marine. They might also be valid for other industries that are not especially "high risk" but are still characterized by complex man-machine-interactions. This article, then, is also an attempt to intensify the debate on how communication between different stake holders in such developmental processes can be improved (see Dekker & Nyce, 2004).

BASIC PRINCIPLES IN USABILITY

Human factors research in the maritime area is still relatively rare (see Adams, 2006). However, human factors research in other operational fields which are similarly complex has revealed several conditions that a well-designed man-machine interface should meet (see. e.g., Herczeg, 2006; Mearns, Flin & O'Connor, 2001):

— *Situational Awareness*: The interface is designed in a way that makes it possible for the operator to generate (and constantly update) a complete and process-oriented overview of everything that is relevant for his ship.

— *Shared Mental Model*: The display patterns, the mode of presentation, and the handling of displays, software tools and manual controls support different operators in constructing a coherent, shared, and correct picture of the situation.

— *Development of scenarios:* The presentation of information is designed in a way that assists operators in the quick identification of developmental patterns (e.g., course information from other ships) thus enabling them to form an "expectation horizon" of what is going to happen in the future and construct different developmental scenarios.

— *Standardization and functionality*: With respect to information presentation and functionality, interfaces are standardized to an extent that allows operators to orient themselves quickly. The basic laws of ergonomics need to be taken into account, elementary components need to follow the same construction principles and all display-control-loops should follow the intuitive action patterns of the watchkeepers.

— *System understanding*: All systems on the bridge should be designed in a way that the nautical officer is able to easily understand and review the relationships and interactions between their different components. Only then is it possible to identify and control the consequences of a malfunction or component breakdown.

THE INTERVIEW STUDY

As mentioned above, we were interested (a) in learning about the ways in which the principles of ‚Interaction Design' are already safely anchored among those that are involved with the development of integrated ship guidance systems and (b) in investigating the human-factors principles that are considered and incorporated during the design process. We therefore conducted an interview study with engineers, designers and process supervisors from different nautical developmental units[1]. All in all, 13 men and one woman participated in the study. Seven interviewees were working in development departments of companies building advanced ship guidance systems such as radar, ECDIS (electronic chart display and information systems), or AIS (Automatic identification system). The remaining seven came from ship yards, either working as ship constructors, construction supervisors or yard captains, the latter both as test runners and construction advisors. All companies are located in Germany.

The interview process was designed to shed light on the complete design process – from the initial idea for a new device or bridge component to its final implementation. Special attention was paid to the question of how far and in what ways the developmental process was influenced by the concerns of the users and to the possible human factors-compatibility of the resulting man-machine interfaces. The interview scheme consisted of several pages and covered the topics we present in the results section.

The interviews themselves were conducted along the lines of an anthropological-observational research approach (see Hutchins, 1995). Here, the interview partner is considered the expert in the field and the interviewer takes a chary role of asking and observing. Accordingly, the interviewers left plenty of space for the personal experiences and opinions of the designers. All precautions were taken to establish an open atmosphere and not to influence the experts in any respect. The interviews last-

[1] For the sake of readibility we use the term "designer" throughout this paper.

ed between one and three hours and were conducted by well-trained psychologists who had earlier collected informal observational experiences sailing on the bridges of different vessels.

The interviews were tape recorded and later transcribed. All interviews were conducted in the German language; the translations for this article were prepared by the authors. In analyzing the transcripts we quickly found that the answers given and the stories told were far too diverse to be condensed into any narrow categorical system. Nevertheless, the interviews yielded a number of interesting insights. In the remainder of this article, we will discuss this material following the logic of qualitative research. We will therefore try to condense our interview partners' statements into the main propositions and illustrate these by quotes. The order of the presentation follows the different topics that allow us to sketch a complete, yet diverse picture of the current status of the integration of human-factor principles and interaction design into contemporary ship bridge design at least in some parts of Europe.

RESULTS

Many voices – many perspectives

A general feature of the results is the considerable variance in the statements and ideas of the experts (c.f. Sheridan, 2003). While some interviewees focussed their position on technological developments (to which the user must adapt), there are also representatives of the counter position who argue that it is necessary to base one's thinking on equipment and its improvement on the mariner and the conditions of his work. This range is exemplified in statements like "We try to produce a device that does everything by itself so that manual inputs are only the last resort" versus "One often sees people relying on technology without switching on their own head. I see this as a big danger".

Thus, the appraisal of the interaction between user and technical systems depends on the interview partner. Even with designers coming from the same company we found very diverse perspectives. This somewhat surprising observation indicates that user models might not be part of the corporate philosophy. One reason for this diversity could be the host of norms and regulations that determine forms, features, and functionalities of many details in ship design. Many designers complained about this over-regulation which limits possible solutions and hampers creativity: "Everything is predefined on a very detailed level outlining what we may or may not do"; "We develop new instruments if we need to fulfil new rules or specifications or if they need to be redesigned due to technology changes" – and even in the latter case, design work is limited by specifications in connection with compatibility requirements. One of the problems with all these norms is the lack of explanation of the ergonomic necessities behind them. The origin of the norms they have to adhere to is unclear to many designers: "I assume they're very old… I don't know what the origins are". Thus, each designer tries to find his individual way through this maze of norms, regulations, and specifications. Ergonomical considerations as well as the user perspective surface only temporarily: "To look into ergonomical issues gets relevant only batch-wise, depending on the thrust of new technological developments and regulations".

Guiding a ship: Craft or complex task?

In analyzing the interviews it becomes clear that there are highly divergent preconceptions about the user, in this case the mariner. We grouped them into four user models which represent a sort of typology of the designers' images of the users they design systems for. We briefly characterize these models and illustrate them with quotes made by designers during the interviews:

Technical Administrator

Basically, the user is seen as operator and administrator of the bridge systems. All important functions and tasks are autonomously dealt with and controlled by technical devices.

"From here to there… then he can fall asleep": Since everything else is taken care of by the automatic route planning system, it is sufficient to have one person on watch on the bridge.

"The navigator on a ship is no longer a navigator but only an email-receiver" who follows the "orders" of the ship owners. They are better able to control things from a distance.

Coordinator

The user primarily coordinates technical systems. He supervises their functions and adjusts these in accordance to the nautical situation and task at hand.

The main task is "to bring the steamer from A to B. Secondary tasks are saving fuel, saving time, avoiding bad weather, no collisions, no groundings, staying on course". In general, with respect to navigation, the user is relieved of many things but has been burdened with many side tasks that distract him from his primary nautical tasks.

"I can well imagine that it would be fun to deal with all these technical devices". (Note: This quote is especially interesting because it indicates that bridge systems are designed according to principles engineers and not necessarily mariners can find exciting or challenging.)

Integration Agent

Here the navigator is basically seen as the active user of technical systems. That is, he makes decisions and acts on the basis of an overall picture of the situation which he generates from the available information and technical support systems.

"Navigation is the use of tools which can be learned. The important aspects lie in how virtuosic somebody uses them and thus controls the ship guidance process as a whole".

The navigator "should be relieved in critical situations. In principle, it's the critical situation that counts. If everything comes together - then the technical systems should serve a support function".

Bridge Manager

The user is seen as an autonomous decision maker who uses bridge systems at his discretion if and only if they appear to be helpful for the generation of information, for filtering functions, as backup-devices, or for any other purpose.

"The navigator wants failure-free equipment which reduces his workload and his personal strain so as to give him freedom for the 'big issues'".

"Nowadays, ships can no longer be understood by pure feeling. Technical systems support the generation and maintenance of an overview".

As can be seen from the quotes, designers' user models differ very much with respect to the relationship between bridge systems and navigators. While some see the navigator as a controller and judge bridge equipment basically to be support systems, others feel their technical systems guide the ship and reduce the navigator's role to that of a bystander. This difference, of course, has far reaching consequences for the specification of devices and the question of what is considered "good design". In any case, however, ergonomic principles should be applied to the design of displays, software structures, and controls.

Ergonomics: Cumbersume duty or internalized quality pretension?

In all the interviews considerable time was spent discussing the question of ergonomic principles used in designing bridges and bridge equipment. We again found that the importance attached to *usability* varied between the companies to a considerable extent.

One designer spontaneously described the gap between technological euphoria and the simplicity demanded by the practitioners: "You want an honest answer? It's a nightmare for every engineer to have to deal with a device that has a user interface. This results from the fact that the functions lying behind it are in a black box – there, nobody can piffle. But from the moment when one can look at it, when one can press buttons, the engineer's fears increase dramatically that many people – regardless of whether they were asked for their opinion or not – want to join the discussion. At some time or another every display goes through these processes which are extremely cumbersome for the engineers". Here, it's the pure world of engineering that is contrasted with the cacophoneous voices of customers and users. Under such a perspective it is not unlikely that the "cumbersome" process of integrating user opinions is abbreviated as much as possible.

But even this designer, like most others, thinks that usability enjoys a high priority within his department since "everybody wants to build a nice good device". In his opinion, it is mainly the task of the management to securely anchor this thought in the process of designing but, at the same time, it is part of the engineer's self image: "one certainly tries to put one's heart and soul into the work in order to make it reasonable". And besides, "there are certain class norms relevant, and therefore this is also important".

Contrasting with this philosophical position is the vacuum that is apparent when designers were asked about their ergonomic basics, knowledge sources, or education. In most cases the answers vaguely refers to "experience" or the many regulatory requirements. Their origin, however, remains unclear: "Maybe we have a book, but I wouldn't know where it is".

The significance of usability lies more with the general claim than with its concrete realization. As one interviewee put it: "We don't have our own ergonomists". Sometimes they would ask for external counselling, sometimes an industrial designer "would have a look at it" – but there was no procedure for this. Another designer explains that they would try to implement the same input philosophy with all pieces of equipment that belong to one family and thus coordinate the devices. Basically, however, all important aspects were fixed in the regulations they had to observe. Still another engineer describes that in his field more important developments were made in the context of research projects with external institutes as partners which would then take care of the ergonomic part. There is no use made of domestic data, studies or literature regarding ergonomic topics.

The main problem in implementing ergonomic principles is the lack of background information for the designers. They often have no idea about the rationale underlying a specific ergonomic requirement, so it would be most helpful for the acceptance of ergonomics in design if there was more of this background knowledge available. Or, as one interviewee summarized, "One has to tell people why the things, one expects from them are necessary and what the background is. Otherwise they get frustrated" and the tendency "to wipe it off the table" increases rapidly.

Apart from this rather general treatment of ergonomics in design we also tried to discuss the more specific topic of "cognitive ergonomics" with our interview partners. We asked them about their judgement of the mental skills required for operating nautical devices; we wanted to know what sort of "cognitive endowment" was demanded from the user by the bridge components developed in their departments.

This is, of course, one of the hot topics of usability and it was therefore surprising to learn that there was no detailed knowledge nor were there specific opinions. Rather, the answers were quite general in scope and sometimes quite candid in tone: "The cognitive requirements a navigator has to meet on a modern bridge are rather moderate. In principle, everything repeats itself all the time. To formulate it heretically: If you would ask this question with a ship's Chief Engineer listening – he would laugh himself to death. […] He says, this little bit of navigation, come on, I can almost also handle".

If one takes a closer look at this "little bit of navigation" however, it becomes clear that it comprises highly complex processes of information processing, decision making, goal formation, and monitoring which are altogether functions of working memory (see Anderson, 1993; Kersandt, 2005). Therefore, these processes share the same limited resource and thus have to be balanced via reflection on one's own actions (Kanfer & Ackerman, 1989). As even this quick glance demonstrates, control of a complex system such as a ship's bridge relies heavily on the cognitive conditions of the user and should, therefore, be an issue for the designers.

Only three of our interview partners (after initially admitting that "this is a question one never really thought about") went into a discussion of this topic. This finally resulted in at least some ideas of designers' preconceptions of the cognitive demands to be met by navigators: "A ship is not a car. If I try to steer this ship there is an enormous lead time. One has to know that some things happen only in the future and this is very difficult. A captain, if he steers the ship manually, has to know this". Additionally, the reaction features of ships are quite different and adjusting to another ship requires "mental flexibility".

Another interviewee: "I can imagine that this still requires quite a lot. Because there is a great deal of information one has to receive, overview and process at the same time". "He (the navigator) must be able to work with full concentration. He has to be a person with good powers of deduction insofar as he must be able to say this alarm is not so important at the moment. He must be able to set priorities. And then he must be able to make clear, important decisions. Nowadays, he must be able to deal generally with modern engineering and communication devices. Also, he should be a practical person, able to quickly find out how to fix an error. He should master the English language. The navigator should have a human grasp of the other, a sense of collectivity, especially in dangerous situations".

As interesting and multifaceted as this is, the impression remains that many insights and theories of cognitive ergonomics and human factors research (e.g., the influence of the time of day on control and monitoring tasks, the negative consequences of background noise and informational overload, the benefits of multichannel information presentation, utilizing human strengths in pattern matching and pattern detection; see Cook, Read & Wilson, 2001, Sanders & McCormick, 1992; Vicente, 2004) do not belong to the actively-available knowledge repertoire of the interviewees.

Typical dead ends and the feedback-trap

Another question dealt with the typical dead ends one can stumble into while developing bridge equipment. Some designers actually described problems that resulted from insufficient integration of the user into the design process: "Sometimes you think you've done something really beautiful and then the navigator has even better ideas – that's something you have to recognize". Yet, most prominent among the dead ends is the problem of functional overload. Everything is too much and too complicated, however, "in 30 years of work in this company the main point of criticism, reduction of functionalities, has never worked". This problem may be a result of the rapid technological progress during the last decades. As Poltrock and Grudin (1994, pp 52-80) conclude from their study in the problems in Interface Design: "Computational power permits more media to be combined in more ways, and on the other side of the interface, the nature of user populations is changing just as rapidly. Finding an appropriate fit is a challenge".

One designer talks about the problem of reducing functions to simple logic and simple handling in a self-critical and reflexive manner: "There is a certain arrogance that develops over time: The developer is convinced of something, he says he has checked this thoroughly … and the others just don't understand it, they ought to read the manual, that's it. This then results in technical systems being more and more difficult to operate".

Yet, the existence of systematic feedback loops which would engage designers and practitioners was never mentioned. In some instances, the training departments provide feedback from instruction courses and trial runs with new ships; however, this feedback is not collected systematically and does not always reach the correct addressees. Feedback from experienced navigators, preferably after extended periods of use of an instrument, is the rare exception. Several interviewees mentioned private connections to one or another practitioner which would yield interesting feedback from time to time.

However, quite a number of interviewees fell into what has been called "feedback-trap" (Dörner, 1996) by maintaining that "as long as no feedback comes, everything is OK".

System Comprehension and Education

We also talked about the necessity of system comprehension: To what extent do navigators need insight into the devices and the relationship between all the bridge systems and functions? And to what extent does this insight actually exist?

Here again, the statements vary between "Any deeper insight into complex functionalities doesn't, in my opinion, help the crew" and "the user should definitely possess system understanding, however, this is not the case. One can do nothing more than to try to provide the user with an overall picture of the system, that is, to show him what this box over there is actually doing, where are the data transported, what happens to them". Some thought that system understanding was especially important in critical situations. Then, the navigator should know where his data are coming from, whether they are plausible or what would be the correct reaction to a device failure in the framework of the complete system.

Many designers find fault with the level of education that is insufficient for this degree of insight. Overall, the standard of nautical education has decreased, while at the same time, increased technological complexity would, in fact, require *better* education. Seen from the outside, one could argue that it was the developers' task to adjust to the circumstances prevalent in reality. However, it is also plausible that the manufacturers "always want to have this or that additional function which then justifies the price".

Almost all designers complain about the unwillingness to invest enough money in training and instruction. For them this aspect is very important since it is politically prudent to avoid any rumours of malfunctioning devices which are in fact due to handling errors. We heard many statements like "There is too little briefing during trial runs, these only last two days anyway"; "In most cases the acquisition works via trial and error which takes much time. Often, they change to another ship in between and as a result any increase in experience is interrupted again"; "It so happens that captains don't use a system to its full extent simply because they don't understand it completely".

Still, it appears to us that this criticizing of poor education on the side of the navigators is also meant to divert attention from the fact that many companies' attempts to improve on the users' system understanding are rather limited. Many developments seem to be technology-driven rather than user-driven. This, for instance, is true of the tendencies within several companies to design user interfaces as adaptive systems. Without any doubt this is "chic and trendy" although psychological studies have demonstrated as early as 1989 (Mitchell & Shneidermann) that this is highly dangerous for the development of system understanding.

Errors, Redundancies, Prevention

Navigation allows for errors that cannot be prevented by technical means. Most prominent among these is, according to our interviewees, poor communication with other vessels in the vicinity. On Russian ships, for instance, a navigator is obliged to ask his captain before he can change the course; something he tries to avoid at all costs. Second in importance are manoeuvres for which the ship is not rated but which are executed nevertheless because the navigator experiences severe time pressure.

However, there are many techniques available on the technical level to prevent errors by navigators. During the design process, possible errors are anticipated and appropriate techniques are implemented. For instance, certain operational sequences are protected by passwords and the input of digits is checked for plausibility. However, more complex activities cannot be safeguarded against error because "sometimes they are deliberate, sometimes not". In the same line of argument another designer states that error prevention in navigation is possible only on the level of the single device but not on the level of overall ship guidance: As a designer, "one would not scamp with the craft of the navigator if he puts the helm to the wrong side".

When asked where these ideas for preventive error control came from, we heard quite different answers. Some stressed direct interaction with the user. It was considered important that "things were lifted more on the interactive plane" since "having the manual is one thing, whether it is read and understood is something quite different". Others apparently relied more on their own intuition and creativity: "We then must switch on our brains a little bit and imagine what can happen".

User Adaptability, Culture

Another topic was devoted to the question of whether individual preferences, habits, or cultural differences were part of the thinking during the design process. We considered this to be an important topic; not only because individual differences can play a crucial role in critical situations (Hofinger, Rek & Strohschneider, 2006) but also because almost all merchant ships in the Western hemisphere are operated by multinational crews.

In general, our interviewees argued that there are indeed a number of individually adjustable parameters within bridge systems. This, however, is more due to relevant regulations and technical requirements than to the desire to provide every user with his or her "personal interface". Some designers consider the importance of individual adjustability to be high since this could greatly influence the acceptance of the products. And this was considered especially interesting since it was stated that "within the given structures we generally have great problems in integrating the user into the design process" - which means that individual adjustability is seen as a promising way of user integration.

However, user adaptability can produce critical effects also, especially during the change of watch. Relatively often, some designers argued, crew would manually change some settings and switch off the automatic regulation of a system, since they consider specific data to be false. If they do not relay this information to the next officer on watch, the replacement would be operating on incorrect assumptions. "Generally we solve this by saving error messages in the device and then one has the possibility to have a look". According to some designers, many navigators would also want to have a "Grandma Button" which, once pressed, resets all changes made by the earlier watch into the standard settings.

These arguments show that the designers have both understanding for the different idiosyncratic preferences of the navigators and, at the same time, awareness for the critical aspects of adaptability. As mentioned above, this again emphasizes that a definite position regarding the advantages and disadvantages of adaptability requires more comparative studies on board ships.

With respect to cultural differences among users we generally found little knowledge and also the prevalent feeling that this was not of top importance: The cultural background of a user was considered to be of little relevance for the design of bridge equipment. As is the case with a car: "If you don't like it you just leave it". And once more the organizational constraints were stressed: Basically, cultural context has little influence on the bridge design because every design change implies additional costs which nobody wants to bear. And even if one would think of realizing culture-related variations, legal requirements would make this almost impossible.

Some designers, however, were culturally more sensitive and discussed experiences with different cultural contexts: "We try to meet both the Western European – North Atlantic requirements and take precautions against erroneous inputs that might result from different approaches to certain problems". Examples given referred to certain menu positions which Asians did not even look at, to the stimulative nature of different colours, or to reading habits such as reading from left above versus right below. Even this interviewee, however, admits that the designers are very much bound by a great many regulations.

Technical Developments: Their Meaning and General Purpose

Finally, we asked our interview partners to summarize what, in their opinion, was the general use of their engineering; what was it that differentiates between a navigator on a modern ship with all its sophisticated equipment and his earlier predecessors. The answers can be grouped into two categories which clearly reflect two different philosophies towards technical advancements:

a) The developments of the last decade or so have somewhat lost the benefit for the user out of sight; they, in some ways, outpaced the user. The problem of boredom, for instance, increases with the improved reliability of the equipment. The navigator's tasks become increasingly routinized which makes him less competent in case of failures or problems. Therefore, one should not take all interesting activities away from the navigator: "He has learned something which he is proud of, he wants to utilize this knowledge and he doesn't want to only monitor processes". Designers should take care not to drive the navigator into boredom through advanced technology but rather should leave him to his skilled work.

b) "It finally comes down to the question of whether one really relieves him (the captain) as compared to former times when he had many men who took care of those tasks which nowadays are performed by such a system. As a captain, stress has increased, not as helmsman".

Other aspects mentioned related to the relief of the navigator, to the increase in information availability and therefore the simplification of his tasks with the result of his cognitive capacities not being bound by the "little things" but being free for the broad overview.

CONCLUSIONS

This interview study yielded a number of interesting insights with respect to the aspects that shape –and those that do not shape– current ship bridge design. It is our hope that a critical discussion of these aspects might help with the development of novel design concepts for ship bridges. After all, modularization, standardization and simplification of bridge equipment are generally agreed upon ways of improving safety and efficiency of ship guidance.

First, our discussions with designers from different companies and with different responsibilities generally demonstrated awareness of the importance of the integration of the user perspective in the design process. If there are problems with usability of bridge layout and bridge equipment, this can not be traced to a lack of interest on the part of the designers working in this area.

Second, there was a conspicuous lack of concrete knowledge and the resolution level of arguments deteriorated when the questions went into the details of usability. There was little to come out of the interviews when questions about specific usability-related concepts or workable methods of introducing the user perspective into their work were asked.

Based on this we conclude that there is indeed sensitivity to these concepts and their importance but that there are no structural or organizational systems in place that would allow for a systematic closed feedback loop between users and designers. A similar conclusion was drawn by Nandhakumar and Jones (1997) from their study on user-developer relationships: "Despite the wide acceptance of the importance and benefits of user involvement and the availability of methodologies and prescriptions to facilitate this, in practice the user-developer relationship appears to be less than useful".

Of course, the question arises why this might be so. A first answer can be found in the frequent complaints about the many legal, organizational, and financial restrictions that constrain designers' freedom. Interaction Design only makes sense when there are in fact several possibilities for design solutions. As of now, the conviction that usability and ergonomics may result in long term success and competitive advantages has not yet struck roots with all parties involved.

A second answer might be related to the fact that despite of all the openness to this topic, there is a considerable lack of background knowledge and the possibility to acquire it. Designers are forced to observe a broad set of standards and regulations. Were the rationales underlying them clear, this could open leeway for innovations in accordance with the regulations but still representing ergonomic improvements. However, as Dekker and Nyce (2004) point out, it is also the responsibility of researchers in human factors and ergonomics to phrase their insights in ways that are helpful to designers. Usability is a concept that is applicabe not only to applied design but also to "applied" research.

A third possible answer could be that, although the words "Human Factors" are used widely throughout organizations, this is more like a ritual gesture rather than deeply-rooted creed. "Human Factors" influence on design requires specific knowledge and the willingness to integrate the user's needs, prerequisites and limitations into every step that makes up a design process. It appears to us that in some cases ideas and insights about usability are hidden within the organizations. Occasionally they may surface, often they will not. In organizations designing for high-risk industries one can find specially designated persons or teams that have the responsibility of strengthening usability aspects from within and of integrating the user perspective through various tests and studies. For other industries it might be wortwhile to give such a structural solution a thought. This, however, requires a general strengthening of the visibility of Human-Factors topics and an intensified discussion and their benefit for safety and efficiency within the maritime community.

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REFERENCES

Adams, M. R. (2006): *Shipboard Bridge Resource Management*. Eastport, MA: Nor'Easter Press.

Anderson, J. R. (1993): *Rules of mind*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Busby, J. & Hibberd, E. (2002) Mutual misconceptions between designers and operators of hazardous systems. *Resarch in Engineering Design* 13, 132-138.

Cherns, A. (1976): The principles of sociotechnical design. *Human Relations* 29, 783-792.

Cook, M. J., Reid, E. & Wilson, K. (2001): The role of working memory in command and control tasks. *Engineering Psychology and Cognitive Ergonomics* 6, 277-284.

Dekker, S. (2005): *10 Questions about human error: A new view of human errors and system safety*. Hillsdale, NJ: Erlbaum, .

Dekker, S. & Nyce, J. M. (2004): How can ergonomics influence design? Moving from research findings to future systems.*Ergonomics* 47 (15), 1624-1639.

Dörner, D. (1996): *The logic of failure*. New York: Metropolitan Books.

Dörner, D. (1999): *Bauplan für eine Seele*. Reinbek: Rowohlt.

Gould, J. D. & Lewis, C. H. (1983): Designing for usability – key principles and what designers think. *Proceedings of the CHI '83 Conference on Human Factors in Computing Systems ACM,* New York, pp 50-83.

Gould, J. D. & Lewis, C. H. (1985): Designing for usability – key principles and what designers think. *Commun ACM 28*, 3, 300-311.

Hawkins, F. H. (1987): *Human factors in flight*. Aldershot, UK: Gower.

Herczeg, M. (2005): *Softwareergonomie*. München: Oldenbourg.

Herczeg, M. (2006): *Interaktionsdesign – Gestaltung interaktiver und multimedialer Systeme*. München: Oldenbourg.

Hofinger, G., Rek, U. & Strohschneider, S. (2006): Menschengemachte Umweltkatastrophen–Psychologische Hintergründe am Beispiel von Tschernobyl. *Umweltpsychologie* 10, 26-45.

Hutchins, E. (1995): *Cognition in the wild*. Cambridge, MA: MIT Press.

Kanfer, R. & Ackerman, P. L. (1989): Motivation and Cognitive Abilities: An Integrative Aptitude Treatment Interaction Approach to Skill Acquisition. *Journal of Applied Psychology* 74, 657-690.

Kersandt, D. (2005): NARIDAS: Assistenzsystem zur Erkennung und Abschätzung von Risiken in der Schiffsführung. *Hansa International Maritime Journal*. Available from http://www.hansa-online.de/artikel.asp?ArtikelID=540 [Accessed 25 July 2008].

King, J. (1995): Sketchy Plans, Politics Stall Software Development. *Computerworld* 19 (June), 81.

Lützhöft, M. (2004): *The Technology is great when it works: Maritime technology and human integration on the ship's bridge*. Linköping, S: Unitryck.

Lützhöft, M. and Dekker, S. (2002): On Your Watch: Automation on the Bridge. *The Journal of Navigation* 55, 83-96.

Mearns, K., Flin, Rh. & O'Connor, P. (2001): Sharing "worlds of risk": improving communication with crew resource management. *Journal of Risk Research* 4, 377-392.

Mitchell, J. and Shneiderman, B. (1989): Dynamic vs. static menus: An experimental comparison. *ACM SIGCHI Bulletin 29*, pp 33-36.

Nandhakumar, J. & Jones, M (1997): Designing in the dark: the changing user-developer relationship in information systems development. *Proceedings of the eighteenth international conference on information*, 14-17 December, Atlanta, Georgia, pp 75-88.

Poltrock, S. & Grudin, J. (1994): Organizational Obstacles to Interface Design and Development: Two Participant – Observer Studies. *ACM Transactions on Computer-Human Interaction* 1, 52-80.

Rasmussen, J. (1986): *Information processing and human-machine-interaction: an approach to cognitive engineering*. Amsterdam: Elsevier.

Rasmussen, J. (2000): Designing to support adaptation. *Ergonomics and Ergonomics Society Annual Meeting Proceedings* 44, 554-560.

Reason, J. (1990): *Human error*. Cambridge: Cambridge University Press.

Sanders, M. S. & McCormick, E. J. (1992): *Ergonomics in Engineering and Design*. New York: McGraw Hill.

Scolari, C. A. (2001): Towards a semio-cognitive theory of Human-Computer-Interaction. *CHI 2001 / Doctoral Consortium*, 2001, pp. 85-86.

Sheridan, T. B. (2002): *Humans and Automation: System Design and Research Issues*. New York: Wiley.

Transportation Research Board of the National Academies (2003). *Special Report 273: Shipboard Automatic Identification System Displays – Meeting the Needs of Mariners*. Available from http://trb.org/publications/sr/sr273.pdf [Accessed 25 July 2008]

Vicente, K. J. (2004): *The Human Factor: Revolutionizing the way people live with technology*. London: Routledge.

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THE SECURITY OF THE CITIZEN'S PORTS

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Abstract

One of the most important subjects in relation to the functioning of the ports is the conversion of the aged and unused port's spaces.

Entire societies can be developed and obtain the progress that they need when the ports stop ignoring the city and develop great areas, most of them abandoned, converting them into new spaces for the citizen's enjoyment and tourism.

With the come into force of the ISPS, a conflict appears. New "citizen's ports" must be incorporated to the Port facility security plan from the starting point of the project, until they are finished and implemented.

Determining the non-compatibility of these theories ("The theory of the relation between the port and the cities" and the "Security of the ports facilities") or finding a cohesion point where both theories can coexist is an important task that must be assumed.

All the agents involved must re-orientate their job in this kind of social projects, adding new security control systems on the converted spaces, because they are the principal economic sustentation in the urbanized areas of the port.
The social development of countries could depend on this.

Keywords: Port, ISPS, Port's security, Citizen's Ports, port- city interface, Society.

INTRODUCTION

As of 2001, important changes have come about in security matters, especially for the Western Hemisphere. Ports and vessels, given their vulnerability due to the internationalization they represent, are the target for all kinds of terrorist attacks.

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For years now, the International maritime Organisation (IMO) has been establishing measures to prevent acts of vandalism, such as piracy and attacks on vessels by insurgents in conflict zones.

However, considering a port a high-risk location which could be used to perpetrate an attack on society or the port itself is a concept that has gained strength since 9/11.

One of the most important issues nowadays in the context of port functioning is precisely "*the redevelopment of ports spaces*".

DEVELOPMENT

When the Security of the Port is object of a study, it must be considered the importance of all the spaces located within the port, as this represents a kind of economic complex.

These days, when everybody is talking about social development and environmental protection all around the world, the maritime investigators must also study what happens with the social benefits of the maritime economy and logistics, so it is time to ask how the ports can help the nearest cities to develop and find one way to achieve their own profit and better life's conditions.

This is an alternative to be explored if we are really convinced of the wellness and happiness that can be offered to the people, and if we really want to improve, at least, a little be, the actual world Regarding this matter, we must know that entire societies can develop and obtain the progress desired by their people when the port stops being apart from the city, and starts developing large areas transforming them into new spaces to give services to the citizens and attracting tourists, henceforth becoming socio-economic complexes, generating wealth for the society.

Once the port-city relationships have improved, it is a great alternative to elaborate an integrated management model that would take advantage of the favourable condition of both (port and city), and that would boost factors of endogenous growth for the port, the city and its broadest hinterland. Such an alternative would mean a development of any port city.

Revival, recycling, renovation, organisation, rehabilitation or remodelling of under-utilized port infrastructure can all be considered as restructured port space related concepts, where the objective is to develop new commercial, tourist, cultural and urban-like activities on the port- city interface, contributing to the overall socio-economic development of the city.

Huge fourth and fifth - generation port developments and its related infrastructure, require large areas to develop commercial and logistic activities, forcing the port to expand in search for these areas. This is how the oldest docks which are nearest the old part of cities come to be disused, leaving empty docks and port's stores. As a result, they leave certain areas under-utilized and in a derelict state.

Ambitious projects are often drawn up to re-convert these spaces by designing a Special Plan, approved by the port and local and government authorities.

These plans must orientate the remodelling of the berth and port's stores areas with the purpose of opening them up to the city, integrating these zones into the city's activity, creating areas for recreation, culture and entertainment in order to increase the richness of the metropolis, without taken the market segment of the previously established businesses.

Some of the more recurrent urban-territorial aspects taken into consideration in these plans are:

- To physically and visually integrate the port and the city to create a unified and dynamic relationship for the benefit of both.
- To renovate and open public access to the waterfront for citizens in an area of the port which, until now, has been totally restricted and solely utilized for port activity.
- To make the port more efficient consolidating the existing uses and allowing new development on the abandoned spaces.
- To promote an appropriate combination of uses to suit the needs of the local population, as well as the corresponding tourist population from any part of the world.
- To distribute the combined uses so as to facilitate a variety of activities in order to:
  - Produce activity in the zone during the daytime and night time.
  - Produce a variety of atmosphere both passive and active.
  - Offer a wide array of activities to attract people of all ages and encourage frequent visits.
- To establish designs for buildings, public spaces and urban property to incorporate unique elements especially planned for the setting. In some cases emphasis is placed on some element of the plan, which could be a building or adjacent boulevard as a tourist attraction, to make a lasting impression.
- In case of building or port elements considered to be of historic value or heritage, and analysis of suitability is carried out for its recovery or recycling, appointing a cultural or historic nature, to the project, with regulations for the intervention.

Every Port has been adequately restructured over the last three decades, which has contributed to finding the answer for the economic hardships of its surrounding urban area. Such is the case of Baltimore, where the prime objective of the changes undergone by the old port was to assuage the serious financial crisis and improve the derelict state of the city centre.

Today, these initiatives have created more that 30,000 jobs and the zone is the centre of attraction for some 7.5 million tourists a year. A similar case is happening now in other countries, for example: The Port of Barcelona in Spain, and Puerto Madero in Argentina.

It must be made clear that, according to the ISPS Code, not every facility located within the area of a port precinct can be referred to as a *"Port facility"*. This makes certain areas of the port vulnerable and susceptible to security alerts.

On the other hand, there is a possibility to extend the ISPS Code to any facility, when even if it is not pursuant to the Code.

The areas outside of the interface are not contemplated in the Code, even though they are located within the very port, they do not represent, to effects of the Code, risk or vulnerability. Legally, in security means, they are unprotected even though they represent the highest affluence of the people through the port.

At present, research is underway to determine the extent to which theses areas need to be safeguard or not, and subsequently propose actions that will guarantee safety and security to all developed areas of port with the aim of establishing a criteria to understanding whether the two trends – that of *citizen's ports* and security of port facilities- are fully compatible, and if not, to find a cohesion point whereby both principles may coexist.

The social development of ports cannot, under any circumstances, wane or be neglected, for the growth of surrounding communities could depend on this.

The Incorporation of the ISPS Code and the ensuing Port Facility Security Plan (PSP) must orient these social projects to incorporate, with the necessary preponderance, their own security and control management systems at shopping areas, museums, redeveloped spaces, recreational areas and existing leisure harbours, which are often linked to community ports.

"The Port Vell" of Barcelona is a good example of this kind of areas, as illustrated in the pictures below, which show urban areas inside port facilities.

Consider also one picture from Puerto Madero in Argentina, where it is possible to observe the renovation of the unused port's spaces, now a leisure space for the citizens, which is also unprotected by the implementation of the PSP.

Figure 1: Itaca Promenad, Barcelona.

Source: Port 2000

CONCLUSION

As can be appreciated on the previous images, all those areas of the port are not protected inside the ISPS. This issue should be analyzed.

Figure 2: Maritime Avenue, Barcelona.

Source: Port 2000

Figure 3: Werehouse Dock, Barcelona.

Source: Port 2000

Figure 4: Madero Port, old port stores converted in offices for the privates companies.

Source: Port 2000

The PSP must establish security measures based on the new concept of interface, to include "*all areas within the port where the facilities are associated with the enjoyment of individuals and are also linked to the development of the adjacent communities*". This will also include areas such as yacht harbours and marina and related activities, enabling adjustments in security issues to have a direct effect on the community ports, in term of increased security.

Once these measures are set in place, several measures should be taken into consideration. The facilities of the community port must be equipped with security cameras to facilitate greater control and surveillance in preventing terrorist attacks on the facilities from outside the interface.

Additionally, the conditions of ports security need to be constantly monitored based on the strategic planning for obtaining feedback, using their own experiences as well as those of others to meet this objective.

It is of great importance to formulate plans in conjunction with state security organisms and to monitor these zones, as well as to equip the far-off areas with the necessary technological systems. A fast response should be guaranteed, in the case of any threat that may arise in the community port.

For this, the entire security and safety platform in these zones must also be technologically updated, giving more control on the prevention and in the case of an emergency.

Finally, there must be concrete and complete emergency plans in addition to the *Port Facility Security Plan*, taking into consideration the overall vision of the port facilities. In this way, it is possible to achieve efficient monitoring levels in order to respect the minimum security measures needed to protect the inhabitants of the port's surrounding community.

REFERENCES

Alemany, Joan (1984): *El Puerto de Barcelona, Historia y actualidad.* Barcelona: Ediciones L'Avenç, S.A.

Alemany, Joan (2002): *El Puerto de Barcelona, Un pasado un futuro*. Barcelona: Lunwerg Editores.

International Maritime Organisation (2003): *ISPS Code.* London: IMO.

International Maritime Organisation (2003): *Ship Security Officer. Model course 3.19*, London: IMO.

International Maritime Organisation (2003): *Company Security Officer Model course 3.20.* London: IMO.

International Maritime Organisation (2003): *Port Facility Security Officer Model course 3.21.* London: IMO.

Marí, Ricard (2005): *The Port's Security*. Barcelona: ICG Marge.

Marí, Ricard (2006): *Security of the Port's Facilities*. Barcelona: ICG Marge.

LA SEGURIDAD Y PROTECCIÓN APLICADA A LA RELACIÓN PUERTO-CIUDAD

Las Instalaciones portuarias, se han visto sometidas a nuevas regulaciones en lo relacionado con la seguridad Internacional.

La aplicación del Código ISPS (en español PBIP) ha obligado a los puertos a convertirse en Puertos Seguros, lo que ocasiona un cambio radical en las políticas de los puertos para algunos, o un ajuste en protección para otros, según sea el caso.

La organización Marítima Internacional ha determinado dentro de los puertos las áreas consideradas como vulnerables; estas áreas reciben el nombre de Interfase.

Áreas portuarias dedicadas al turismo, recreación e incluso al ocio, han quedado fuera de la Interfase por lo que surge la pregunta ¿Están desprotegidas? ¿Son los puertos deportivos áreas seguras por si mismas? ¿No representan ningún riesgo para la seguridad de la vida humana de las personas que ahí se encuentran cuando son los sitios donde más personas conviven?

Se plantean estas preguntas cuya respuesta puede afectar por completo el desenvolvimiento de la aplicación del Código Internacional de protección del Buque e instalaciones Portuarias.

DESARROLLO

La seguridad internacional ha dado un giro importante a raíz de los sucesos ocurridos el 11 de Septiembre en New York, donde debido al terrorismo (enmascarado en el fanatismo religioso) perdieron la vida miles de personas, llevándose a cabo uno de los atentados terroristas más grandes en la historia reciente de la humanidad.

A partir de ese momento, sobrevienen cambios importantes en materia de seguridad, en especial para occidente, que se vio obligado a adoptar medidas para evitar por todos los medios, que una nueva catástrofe se fraguara en cualquier ámbito.

Los puertos y buques, dada su vulnerabilidad, gracias a la internacionalización que representan, son puntos de mira muy importantes para todo tipo de atentados terroristas, y precedentes recientes apuntan que siempre han estado en la mira de quienes comenten estos atentados.

La Organización Marítima Internacional (OMI) lleva años dictando medidas para prevenir actos vandálicos, como la piratería, y el ataque a los buques gracias a insurgentes en zonas de conflicto, sin embargo, el considerar a los puertos como un lugar de alto riesgo por medio de los cuales un atentado pudiese afectar a la sociedad y al puerto en si mismo, es un concepto que se ha reforzado con los sucesos del 11-S.

Desde el interés fanático- religioso al del narcotráfico, pasando por los desórdenes sociales, problemas entre naciones, conflictos entre Oriente y Occidente, todo ha dado origen a este fenómeno que actualmente cobra más vida que muchas enfermedades consideradas incurables.

Adicionalmente, los puertos han tenido una evolución social muy importante en los últimos años, re-direccionando su mercado y sus objetivos comerciales al ámbito de la ciudadanía para devolverle lo que por años fue un territorio usurpado, y en muchos casos arrancado de las manos de la población para pasar a integrar los espacios portuarios.

CONCLUSIONES

Las nuevas condiciones infraestructurales para responder al desarrollo del tráfico marítimo y la misma revolución de vapor del siglo XIX que impuso los nuevos barcos de casco de hierro y propulsión mecánica dándole origen a la ejecución de las grandes obras que eran necesarias en los puertos, como dragados, diques, muelles, pueden ser calificadas como unas de las razones apropiadas para la implementación de una reconversión de aquellos espacios que se han dejado de utilizar entre otras por sus restricciones de calado y que idealmente estén en contacto con la ciudad histórica y su patrimonio, transformándolos en espacios abiertos al público, con una gran variedad y calidad de actividades culturales y lúdicas. Estas transformaciones tienen objetivos que pueden ser de tipo urbanístico territorial, de tipo económicas.

Los grandes desarrollos portuarios y su infraestructura conexa en puertos de cuarta generación y en adelante, requieren de grandes superficies para el desarrollo de actividades logísticas y a veces comerciales, obligando al puerto a desplazarse en busca de dichas áreas y en consecuencia dejando estas áreas subutilizadas en estado de abandono. Es así como los muelles más viejos y a la vez más cercanos al casco antiguo de la ciudad, pasaron a estar en desuso, con tinglados y dársenas vacías.

Ambiciosos proyectos que se planifican a partir de un Plan Especial, consensuado por el Puerto, el Ayuntamiento o Municipio y el Gobierno Regional o de la Comunidad Autónoma, con el fin de revitalizar espacios para el uso ciudadano, sin embargo, la vulnerabilidad ante la amenaza de atentados terroristas, ha dado un giro al ya agitado negocio dentro de estos recintos.

En consecuencia se han elaborado planes protección de los sistemas portuarios, sin embargo estos no toman en cuenta las áreas ciudadanas del Puerto, estas áreas de ocio, ante los nuevos códigos internacionales de seguridad y protección (PBIP) se encuentran legalmente desprotegidas, no dejando cabida a las actuaciones preventivas que pueden llevarse a cabo para salvaguardar estas áreas tan sensibles de los puertos y lo más importante, a la vida de la gran cantidad de personas que visita estas areas de distracción y diversión de los puertos, y que representan precisamente un interés socio-económico beneficioso para la ciudad en si misma.

Finalmente destacar que es de amplio interés investigativo determinar cual es el mejor método a seguir para lograr la protección de estas áreas, la dotación de los equipos de seguridad necesarios, así como los acuerdos de las empresas urbanísticas que los gestionan con los cuerpos de seguridad del estado y la elaboración de planes de acción que garanticen la protección de estas instalaciones.

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EMISSIONS OF MARITIME TRANSPORT: A REFERENCE SYSTEM

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Abatract

This paper presents the methodology for a comprehensive maritime transport database of activity data, specific energy consumption, emission factors and total emissions that has been developed within the EX-TREMIS project. The model is built upon 3 modules: the fleet module, the transport activity module and the emission module.

The *fleet module* defines the ship categories, the loading capacities and the engine characteristics of the different vessels by using EUROSTAT data, Sea Web Lloyd's database and international literature. The *transport activity module* transforms total cargo and passenger traffic (main source here are EUROSTAT data and CEMT statistics) into ship-equivalents. These ship-equivalents are further transformed into ship-hours. The *emission module* calculates energy uses and CO_2, NO_X, SO_2, CO, HC, CH_4, NMHC, PM emissions from the resulting maritime activities. We used technology based emission factors to take into account the technological evolution of vessels.

To illustrate, we present some results (emissions, fuel consumption and NO_X emission factors) for Spain. The overall methodology and results as the country specific energy consumption and emission factors per ship type and size class can be extracted from the EX-TREMIS website (www.ex-tremis.eu) in January 2008.

Key words: O/D matrix goods/passengers, ship-equivalent traffic, maritime emissions, fuel consumption, emission factors

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INTRODUCTION

TRT Trasporti e Territorio and VITO (Flemish Institute for technological research) are developing a reference system on emission factors, energy consumption and total emissions for rail, maritime and air transport within the EX-TREMIS (Exploring non road TRansport EMISsions in Europe) project. The project is commissioned by the Institute for Prospective Technological Studies of the European Commission Directorate - General Joint Research Centre (JRC-IPTS).

One of the objectives of the EX-TREMIS project is to build a comprehensive maritime transport database of activity data, specific energy consumption, emission factors and total emissions covering the 27 EU member states for the years 1980-2005 and with projections for their development up to the year 2030. The database covers the pollutants CO_2, NO_X, SO_2, CO, HC, CH_4, NMHC, PM and presents detailed results for each EU country.

Most efforts to estimate ship emissions are currently based on bunker fuel sales (top-down approach). Bunker fuels are allocated to specific port cities and countries resulting in relatively high emission estimates for small countries hosting important sea ports. Other models used a bottom-up methodology based on vessel's characteristics, engine performances and, above all, real vessel traffic data provided by several government and private sector sources. Consistently with these recent developments in modelling ship's emissions, EX-TREMIS follows the bottom-up approach and derives information on ship's movements from a mixture of publicly available EUROSTAT and national data sources.

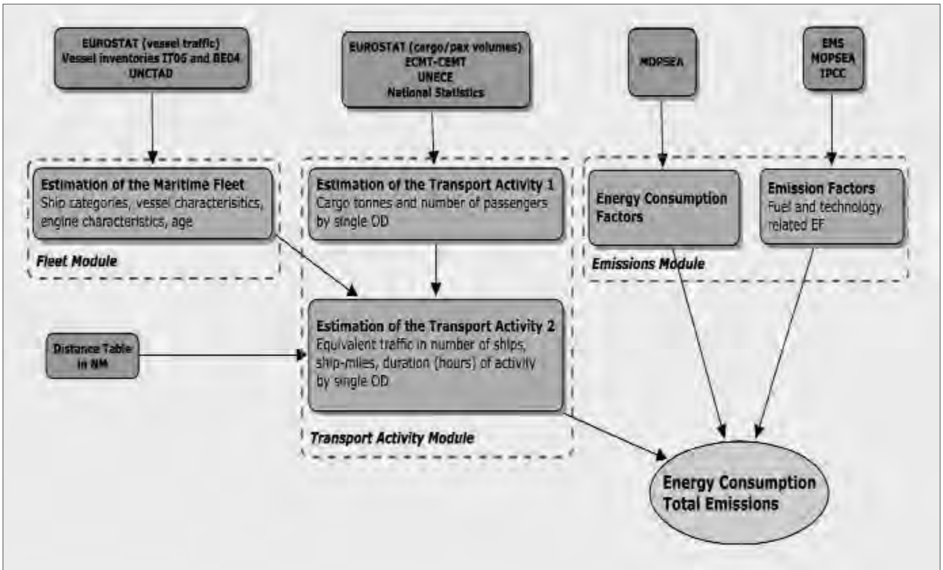

Figure 1: Overview of the main modules and sources in EX-TREMIS

We have developed a new "activity based" emission model for sea-going ships engaged in the EU seaborne trade, also taking into account relevant factors such as the technology evolution of maritime engines and the size of the vessels. The model is built upon three modules: the *fleet module* defines the ship categories and their segmentation, the *transport activity module* calculates the Origin-Destination (O/D) matrix of shipped cargo tonnes and passengers and converts such volumes in ship-equivalent traffic (in number of ships, ship-miles and hours of navigation for the different stages), the *emission module* provides energy consumption and emission factors for the final calculation to come up with total energy consumption and emission figures. The flow-chart (figure 1) describes the interaction of the modules and their main processes, and presents also the sources used for the model calibration.

METHODS

Fleet module

Ship categories for EX-TREMIS (table 1) are chosen according to the developed methodology for the estimation of emissions and energy consumption. The classification depends also on the availability of detailed EUROSTAT (2000) data.

Ship Type categories	Size classes (Length)	Main Engine classes	Age classes (Building year) and type of fuel
Oil Tanker	< 150 m	2-stroke	< 1974 (*Marine Diesel Oil - MDO*)
Chemical Tanker	150 – 250 m	4-stroke	1975-1979 (*MDO*)
LG Tanker (LPG and LNG Tanker)	> 250 m	Steam turbine	1980-1984 (*MDO*)
Bulk Carrier			1985-1989 (*Heavy Fuel Oil – HFO*)
Containership			1990-1994 (*HFO*)
General Cargo			1995-1999 (*HFO*)
Ferry (Ro-Ro Cargo, Ro-Pax, Con-Ro Ship)			2000-2004 (*HFO*)
Passenger Ship (Hi-speed Craft, Fast-Ferry)			> 2005 (*HFO*)

Table 1: EX-TREMIS maritime fleet classification system.

The *loading capacity* of the different vessels is an important parameter to transform transported goods/passengers into ship-equivalents. The EUROSTAT New-cronos database Eurostat (2000) provides for each EU country information on the number and gross tonnage (GT) of vessels calling at main ports by type (7 groups) and size of vessel (12 classes). From this collection we derive information on the loading capacity and distribution of cargo and passenger vessels visiting the country by calculating the average gross tonnage for each size class and group of ships. To convert the resulting average gross tonnage parameters in average Deadweight (Dwt), which is a measure of the loading capacity of a vessel, we have calculated a list of differentiated conversion factors based on available visiting vessel inventories for

Italy and Belgium and extractions from the Lloyd's Register Fairplay (LRF) Sea-Web database. By using the same sources we finally convert the 12 cargo-based classes into 3 more appropriate "length" and emission-based classes.

We defined the key parameters for the *engine characteristics* (main engines and auxiliaries) of a vessel. The combustion of fuel in both types of marine engines causes emissions and their operation depends on the stage of navigation. There are three types of main engines in the model: 2-stroke engines, 4-stroke engines and steam turbines. We looked at the characteristics of the vessels visiting Belgium in 2004 and Italy in 2006 . The movements data per ship type and size class were provided by Port Authorities. Data from ship characteristics like the average installed main engine power (per ship type, size class and engine type) and the distribution between 2-stroke and 4-stroke engines, were extracted from the LRF SeaWeb database. Experts were consulted for the average auxiliary power used for air conditioning, ventilation and preheating of heavy fuel oil and the type of fuel used in the engines based on type and age.

The *vessel's year of building* is an important parameter in the methodology for calculating emission and energy consumption figures. The age of the engines is for most vessels the same as the age of the vessel. The UNCTAD secretariat UNCTAD (2007) compiled the age distribution of the world merchant fleet by types of vessels on the basis of data supplied by Lloyd's Register-Fairplay. The percentages of total are expressed in terms of Dwt. We applied the relative age distribution for each year of the time span 1980-2005.

Transport activity module

The *transport activity module* derives national and international (both intra and extra-EU) maritime traffic in terms of number of equivalent ships, ship-miles and hours of navigation stages. The processing is conducted on two main EUROSTAT collections: the total cargo and passenger traffic in all port of the reporting country and the detailed dataset of maritime traffic in main ports of the reporting country by cargo type and partner entity. National and CEMT statistics (CEMT, 1997) were collected in order to cover the whole time span 1980-2005. The *fleet module* and the further EUROSTAT collection of vessel traffic provides relevant parameters for converting cargo tonnes and number of passengers in number of (loaded) equivalent ships operating on each country pair.

One of the main inconvenient of seaborne trade statistics is that we have information about the commodities shipped by sea but not on how they are transported. Detailed maritime statistics on the Newcronos database are instead collected since 1997 according to the cargo type, so that the functional link between the type of cargo and the type of ship engaged in its transportation is direct and clear. In addition, for the main ports of each reporting country, EUROSTAT identifies the part-

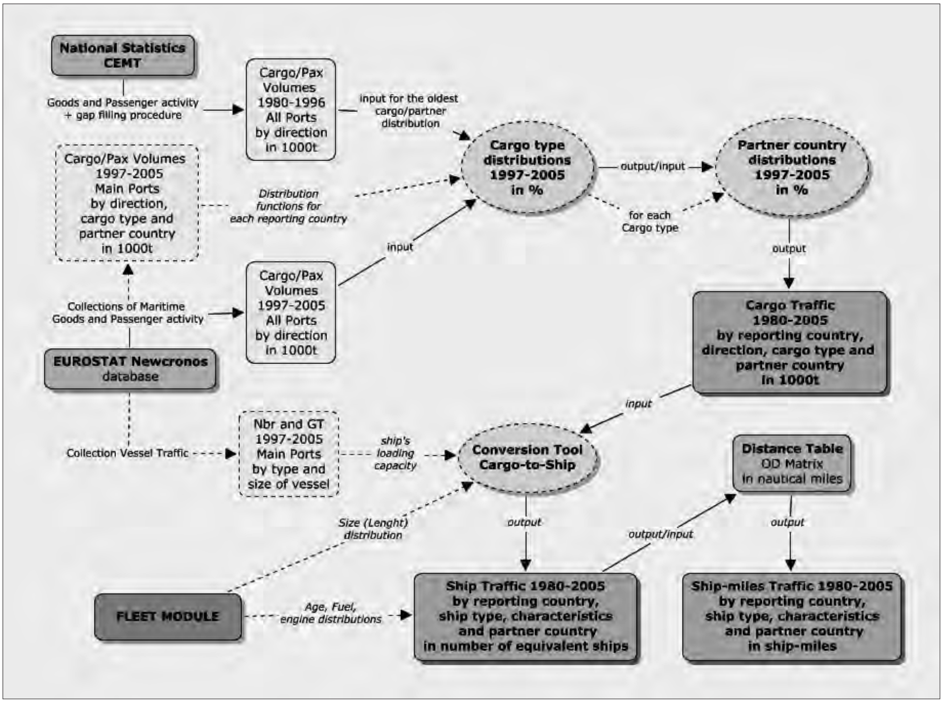

Figure 2: Flow chart of the methodology for the estimation of maritime traffic.

ner country and its relevant Maritime Coastal Areas (e.g. in Spain it identifies the MCA Mediterranean and the MCA Atlantic) plus the direction of the flow.

We have firstly built a comprehensive database of total passenger and cargo tonnage handled in all the ports of each country using both EUROSTAT data and national statistics. Total volumes were afterwards splitted using distributions (by cargo type and partner entity) extracted from the detailed Newcronos collection. The final result of this process is the provision of a complete O/D matrix of cargo type volumes (in tonnes) and number of passengers transported by sea from each reporting country to each partner country/MCA (outwards) and *viceversa* (inwards). Missing years (1980-1996) were added to the process according to the oldest available EUROSTAT cargo type and partner distributions.

In order to derive figures in terms of ship-miles we created a country based O/D table of sailing distances expressed in nautical miles (NM). The distance table is built on a detailed maritime network, which includes bulk shipping, container (liner) routes and ferry links among NUTS2 coastal zones in Europe. For each reporting country or MCA we associated one reference port. The distance table includes all EU country/MCA pairs, all EU-Non EU pairs in the Mediterranean and the Baltic

Sea plus Iceland) and connections with 13 relevant Overseas Zones[1]. In order to calculate the mileage for national maritime traffic (*cabotage* or regular feeder services) we created a table with average sailing national distances. The mileage of Ferries and Passenger ships were calculated using a country specific ferry network which includes as well information on the frequency of services.

The concept of equivalent-ship traffic means that we calculate the number of equivalent (full) vessels loaded to transport by sea the total amount of a given cargo type to a specific partner country, from one sample departure port of the reporting country and without intermediate stops. The same happens for the opposite flow. To derive the number of vessels required to ship the resulting cargo tonnage, we used the country specific distribution of visiting vessels resulting from the *fleet module* (by type, cargo size, length, engine type and age) and considered a *load factor* of 90% to obtain a fairer measure of the real capacity and thus take into account a percentage of the empty trips. The difference between the real traffic and this "country generated" traffic should not be huge, because in practice it represents a redistribution of traffic on a straight line and country-to-country. This method seems more in line with the objective of linking the responsibility of emissions to a specific country and its commercial partners without having to reproduce the real port rotation planned by the shipping companies for a single voyage. In terms of country's emission responsibility, we consider the 50% of the sailing distance. Ships are multiplied by the relative sailing distances to obtain ship-mile values and these values are transformed into ship-hours for cruising and manoeuvring. Hotelling periods are taken from the ENTEC database (2005).

Emission module

The emission module calculates energy consumption figures, fuel related emissions (i.e. CO_2, SO_2) and technology related emissions (i.e. NO_X, PM, CO, HC).

The *specific fuel use* is dependant on the engine type, percentage of maximum continuous rate and the age of the engine. The specific fuel use takes into account the caloric value of the fuel and the efficiency of the engine. The range of specific fuel uses that we integrated into the model are presented for the different engine types in table 2. The assumptions for the main engines were made in close consultation with ship owners, pilots and harbour masters. The specific fuel uses for the auxiliaries were taken from a TNO study (Oonk et al., 2005).

The *energy use* is calculated by multiplying the used power and the duration. The used power is dependant of the maximum installed power and the percentage of maximum continuous rate. The fuel use is the combination of the energy use and the specific fuel consumption.

[1] Black Sea, Arabian Gulf, Red Sea, Indian Sub Continent, Australasia, Far East - China & Japan, South & East Africa, West Africa, US Atlantic & Canada - Great Lakes, Central America – Caribbean, South America – Atlantic, US & Canada – Pacific, South America – Pacific.

	Specific fuel use (g/kWh)
2-stroke engine	157 – 218
4-stroke engine	185 – 235
Steam turbine	290 - 510
Auxiliary	200 - 235

Table 2: Range of specific fuel use for the vessel engines.

The *CO_2 emission factors* are based on IPCC data (IPCC, 1997) and the *SO_2 emission factors* are based on the sulphur content in the fuels used in the past and in legislation (EC, 2002; MARPOL Annex VI convention, 2005/33/EC Directive). Fuel related emissions are calculated by multiplying the fuel use with the corresponding emission factor.

The *technology related emission factors* for HC, CO, NO_X and PM for 2-stroke and 4-stroke engines are those of the project EMS (AVV et al., 2003). They are modeled as a combination of a basic emission factor (g/kWh) and correction factor for the technology (age of the engine and the NO_X regulation) and the percentage of the maximum continuous rate (MCR). The percentage of maximum continuous rate for the main engines depends on the stage of navigation. The figures from ENTEC (2005) are used in the model. The technology related emission factors for HC, CO, NO_X and PM for steam turbines are based on findings from a TNO study by Scheffer and Jonker (1997). Different emission factors for different percentages of maximum continuous rates were put into the model. The *technology related emission factors* for HC, CO, NO_X and PM for *auxiliaries* are those of the project EMS (EC, 2002). They are modeled as a combination of a basic emission factor (kg/ton) and a correction factor for the technology (age of the engine). Technology related emissions are calculated by multiplying the energy use with the corresponding emission factor.

DEVELOPMENT

Database prototype country: Spain

Here we present the results, in terms of estimated total energy consumption, emission factors and emissions from sea-going ships, for a chosen prototype country (Spain).

kton	2000	2001	2002	2003	2004	2005
CO	20,3	28,9	30,5	34,5	38,6	40,2
CO_2	6 222	8 829	9 298	10 931	12 297	12 938
VOC	4,84	6,80	7,10	7,94	8,71	8,99
NO_X	174	250	266	311	349	365
PM	15,4	22,3	23,8	28,3	31,9	33,5
SO_2	105	150	158	187	211	222

Table 3: Emissions for Spain (in kton).

Table 3 presents the total emission figures for Spain calculated by means of the developed methodology. The fuel combustion in the main engines is responsible for more than 90% of the overall emissions.

The cruising phase represents about 99% of the emissions for main engines and about 80% of the emissions for auxiliaries. Manoeuvring emissions are negligible in the total emissions picture, however not negligible when looking to the human impacts of the emissions.

Table 4 presents the total fuel consumption (main engines and auxiliaries) of maritime transport for Spain.

kton	2000	2001	2002	2003	2004	2005
Diesel oil	58	69	66	53	53	47
Heavy fuel oil	1 943	2 770	2 924	3 462	3 901	4 113
Total	**2 001**	**2 839**	**2 990**	**3 515**	**3 954**	**4 160**

Table 4: Fuel consumption for Spain (in kton).

The main engines consume about 95% of the total fuel and more than 99% of the fuel used is heavy fuel oil. This is somewhat different for the auxiliaries. The share of diesel oil is about 45% in the year 2000 and drops down to 22% in 2005 due to the increased share of new vessels. Improvements in technology made it possible for auxiliaries built at the end of the eighties to use heavy fuel oil.

Detailed emission factors are used for the calculation of the emissions. The model can also calculate aggregated emission factors by ship type and size class,

NO_X (g/kWh)	Size	2000	2001	2002	2003	2004	2005
Bulk carrier	< 150 m	15,7	15,7	15,8	15,5	15,4	15,4
Bulk carrier	150 - 250 m	17,3	17,3	17,2	16,9	16,7	16,6
Bulk carrier	> 250 m	17,3	17,3	17,2	16,9	16,7	16,6
Chemical tanker	< 150 m	14,5	14,6	14,5	14,7	14,7	14,7
Chemical tanker	150 - 250 m	16,7	16,7	16,6	16,8	16,6	16,7
Chemical tanker	> 250 m						
Container ship	< 150 m	14,0	14,2	14,3	14,0	14,0	14,1
Container ship	150 - 250 m	16,6	16,5	16,5	16,0	15,8	15,7
Container ship	> 250 m	16,7	16,6	16,6	16,0	15,9	15,8
General Cargo	< 150 m	14,4	14,5	14,5	14,6	14,6	14,7
General Cargo	150 - 250 m	17,6	17,7	17,6	17,6	17,6	17,6
General Cargo	> 250 m						
LG tanker	< 150 m	14,3	14,5	14,4	14,6	14,6	14,6
LG tanker	150 - 250 m	17,4	17,4	17,3	17,4	17,2	17,2
LG tanker	> 250 m						
Oil tanker	< 150 m	14,5	14,5	14,5	14,5	14,4	14,2
Oil tanker	150 - 250 m	17,2	17,1	16,9	16,6	16,3	16,0
Oil tanker	> 250 m	17,1	17,0	16,9	16,6	16,3	16,0
RoRo cargo	< 150 m	14,0	14,2	14,2	14,3	14,4	14,4
RoRo cargo	150 - 250 m	15,1	15,2	15,1	15,3	15,3	15,3
RoRo cargo	> 250 m	15,7	15,7	15,8	15,5	15,4	15,4

Table 5: NO_X emission factors per vessel type and size class for Spain (in g/kWh).

separately for the main engines and auxiliaries. As an example we present in table 5 the aggregated NO_X emission factors for the main engines. These aggregated emission factors are derived from the emission (g) and energy (kWh) calculations in the model by ship type and size class.

The overall methodology and results as the country specific energy consumption and emission factors per ship type and size class can be extracted from the EXTREMIS website (www.ex-tremis.eu) in January 2008.

CONCLUSIONS

A model to calculate emissions of maritime transport was developed. The model is based on a fleet module, a transport activity module and an emissions module. The model can also calculate aggregated emission factors by ship type and size class, separately for the main engines and auxiliaries.

The case-study of Spain shows that the fuel combustion in the main engines is responsible for more than 90% of the overall emissions, the cruising phase represents about 99% of the emissions for main engines and about 80% of the emissions for auxiliaries. Manoeuvring emissions are negligible in the total emissions picture. The main engines consume about 95% of the total fuel and more than 99% of the fuel used is heavy fuel oil. This is somewhat different for the auxiliaries.

A transparent and easy to use model is made available on-line (www.ex-tremis.eu).

REFERENCES

AVV, TNO-MEP, RIZA, MARIN, CE-Delft, Haskoning (2003): *Emissieregistratie en –Monitoring Scheepvaart*. The Netherlands: DGG

EC (2002): *Commission launches strategy to reduce air pollution from ships*. Brussels: EC.

ECMT-CEMT (1997): *Statistical Trends in Transport 1965-1992.* Paris.

ENTEC (2005): *Service Contract on Ship Emissions: Assignment, Abatement and Market-based instruments*. UK: European Commission.

EUROSTAT (2000): *Transport and Environment – Statistics for the transport and environment reporting mechanism (TERM) for the European union*. Luxembourg: Office for Offical Publications of the European Communities.

IPCC (1997): *Greenhouse gas inventory reference manual (IPCC 1996 Revised Guidelines for national greenhouse gas inventories, Volume 3)*. UK: IPCC/OECD/IEA.

Oonk, H., Hulkskotte J., Koch, R., Kuipers, G., Van Ling, J. (2003): *Emissiefactoren voor de binnenscheepvaart*. The Netherlands: TNO.

Scheffer, C.B. and Jonker, W.J. (1997): *Uittreksel van de interne TNO-handleiding voor het vaststellen van verbrandingsemissies*. The Netherlands: TNO.

UNCTAD. *Review of Maritime Transport*: UNCTAD, various years. http://www.unctad.org [accessed 30 August 2007].

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DEMAND-INCOME ELASTICITY OF LEISURE BOATS

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Abstract

Demand-income models for recreational sailing can explain the evolution of the recreational fleet using the evolution of income for a specific country, region and period. These models are useful in that their logarithmic transformations allow the value of the demand-income elasticity to be obtained for recreational crafts in the region considered. Moreover, under the hypothesis of the maintenance of the value of this elasticity, the expected variation in the fleet can be determined from the expected income data.

The aim of this work is to formalise a model for the recreational fleet of a country or region which will allow the evolution of the fleet to be determined with respect to the changes in income taking place in the region, both in absolute and in relative terms. Results are obtained for the demand-income elasticity of recreational crafts for the various recreational fleets of Spain grouped into seven geographic regions.

Keywords: Nautical tourism, recreational fleet, income elasticity.

INTRODUCTION

General Framework

Recreational sailing is one of the fastest-growing areas of nautical tourism in modern societies, particularly over the last three decades (Favro & Glamuzina, 2005; Horak,

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Marusic, & Favro, 2006; Miller & Auyong, 1991). Nautical tourism is a segment of the tourist industry (Xiao & Smith, 2006), made up of a wide variety of activities that take place in the marine environment. These include both sea-based leisure activities such as cruises, angling, scuba diving, sailing, windsurfing, rowing, yachting, boat trips, marine ecotourism, tourist submarines, equipment hire, etc.,(Miller, 1993) and also the development of infrastructures such as recreational ports, marinas, sea-sports installations, sailing clubs, etc. (Kovačić, Gržetić, & Dundović, 2006; Lee, 2001). Nautical tourism is also closely related to other activities that make up coastal tourism (restaurants, hotels, sports installations, second homes, renting of property, etc.). Recent years have seen an increase in the literature on these matters, especially as regards environmental aspects and the sustainable development of the so-called ocean and coastal tourism (C. M. Hall, 2001).

Recreational sailing can be defined as a tourist activity that takes in a wide range of services and infrastructures (Cerit & Içöz, 2006; Luković, 2007), whose main direct consumer is the craft. Thus, while the tourist is the unit of consumption of the various tourist products and services in general tourist activity, it is the crafts that make up the unit of consumption of the various services and infrastructures offered by the tourist activity in recreational sailing. According to the terminology established by the World Tourism Organisation (WTO), recreational sailing corresponds, for any specific country or region, to the category of domestic tourism which, in turn, includes inbound and receptor tourism. In the developed countries, the domestic tourism is clearly greater than receptor tourism while the opposite is true of the under-developed countries.

Leisure activities such as those of recreational sailing are essential in today's society but they are, paradoxically, subject to a permanent contradiction. On the one hand, there is an increasing social demand for such activities (Baine, Howard, Kerr, Edgar, & Toral, 2007; D. Hall, 2000; D. R. Hall, 1998; Hawkins & Roberts, 1994; Kovačić, Bošković, & Favro, 2006; Nijkamp & Verdonkschot, 1995; Pearce, 1988; Smith & Jenner, 1995; Taïeb & Verdiére, 1990; Wong, 1998; Wrangham, 1999), but there is also a lack of social acceptance due to the possible negative effects (Archer, 1985; Baines, 1987; Beekhuis, 1981; Hanna & Wells, 1992; Hawkins & Roberts, 1994; Marchand & Skračić, 2006; Phillips & Jones, 2006). When the problem is not addressed globally, but rather in a self-interested non-objective way, a negative picture is painted which is not founded on any scientific principle (Buckley & Panell, 1992; Charlier, Haulot, & Veryheyden, 1978; Meyer-Arendt, 2002; Milne, 1990; Wong, 1998).

It is a fact, however, that there has been an increase in nautical recreation activity which requires an organised development. Thus, the challenge facing society is not to deprive itself of such an important source of leisure but rather to develop and promote it in a sustainable way from an economic, social and environmental viewpoint.

Aims and Objetives

The present work focuses on the evolution of the fleets of recreational crafts of a country or region with respect to the behaviour of the consumers or demanders of recreational sailing services or infrastructures.

The aim of the present work is twofold: first, to formalise a model for the recreational fleet of a country or region which will allow the evolution of the fleet to be determined with respect to the changes in income taking place in the region, both in absolute and in relative terms; and then to apply this model to the recreational fleet of a specific country or region.

This model will form a tool which may prove useful both to the public and the private sector in a specific spatial domain. Knowledge of the evolution of the fleet in response to the changes in income of a region will provide demand-income elasticity values for recreational crafts in this spatial domain. For a specific elasticity value, the expected magnitude of the fleet could be predicted in response to variations in income, assuming that the rest of the variables remained constant. This would enable the regional government with authority in this sector to plan and organise the sector on the basis of the expected magnitude of the fleet. At the same time, knowledge of the evolution of the magnitude of the fleet would guide operators and companies working in the sector in the development of strategies based on the foreseeable types and volumes of business of the fleet of a specific region.

To this end, the following sections describe the methodology, its application to the Spanish recreational fleet, the results obtained from the estimates made and some discussion and overall conclusions of the research.

METHODOLOGY

The methodology is divided into two clearly distinct stages. In the first stage, a theoretical model is built of the demand for recreational crafts and the concept of demand-income elasticity of recreational crafts is formalised. These are aspects which are used as reference elements in the empirical modelling process.

In the second stage, the econometrics model of the evolution of the recreational crafts fleet is formalised as a function of the regional income, which will be used in the empirical estimation.

Theoretical demand for recreational craft model.

What variables might condition or determine the behaviour of the evolution of the recreational fleet of a country or region? The magnitude or size of the recreational fleet of a country or region i in a period t will be determined by the crafts existing in the period t-1 plus the difference between new additions and withdrawals. The new incorporations will depend on demand variables. The withdrawals will be the result mainly of losses and sales to other countries/regions. In the developed seafaring countries, the withdrawals usually make up a very small percentage with respect to the incorporations, so that the difference is positive and fleets are on the increase.

Thus, the demand for recreational crafts is a vital component in the evolution of the fleet, and the demand model may prove to be a useful theoretical framework with which to address the search for the explicative variables for the evolution of the fleet. In this context, the classic economics model of supply and demand would indicate that the demand for recreational crafts varies according to the tastes and preferences for such goods, on prices and related goods and on levels of income. This model of the theoretical demand for recreational crafts for a country or region i in a period t can thus be expressed as:

$$N_{i,t} = f\left(L_{i,t}, P_{i,t}, Ps_{i,t}, Pc_{i,t}, I_{i,t}\right) \quad (1)$$

where:

- $N_{i,t}$ = is the demand for recreational crafts of a region or country i in a period t.
- $L_{i,t}$ = tastes or preferences of region i for recreational crafts in period t.
- $P_{i,t}$ = prices of recreational crafts in region i in the period t.
- $Ps_{i,t}$ = prices of goods substituting recreational crafts (other crafts) in region i in period t.
- $Pc_{i,t}$ = prices of complementary goods of recreational crafts (fuel, mooring, insurance, etc.) in region i in period t.
- $I_{i,t}$ = regional income of the population region i in the period t.

The decisive demand variables outlined above can be used to guide the selection of the explicative variables of the empirical models of behaviour of the evolution of the recreational fleet. Of all of these variables, the present work focuses its attention on that of income, since data is available for regions or countries drawn up and published by public and private organisms providing solvent statistical series for the elaboration of empirical models.

The behaviour of demand for recreational crafts in response to income variations, when the rest of the variables remain constant, is given by the following equation:

$$\frac{\partial N_{i,t}}{\partial I_{i,t}} > 0 \quad (2)$$

The demand for recreational crafts and the income of a region i in a period t, vary in the same direction. Increases in income raise the demand for recreational crafts and vice-versa.

Demand-income elasticity for recreational crafts

Now that the qualitative relation between the demand for recreational crafts and the income of a region has been established, the next step is to verify the response of the demand for recreational crafts in response to variations in income; that is, the quantitative relation.

In general, when the income increases/decreases, certain goods receive a greater/smaller proportion of the consumers' budget. The demand-income elasticity measures the response of the demand for goods to changes in income, that is, the percentage change in the quantity demanded with respect to the percentage change in income. This measurement of the sensitivity of demand is determined by the following equation.

$$\lambda(Q)_{i,t} = \left(\partial Q_{i,t} / Q_{i,t}\right) / \left(\partial I_{i,t} / I_{i,t}\right) \quad (3)$$

where:

$\lambda(Q)_{i,t}$ = Demand-income elasticity of a goods Q in a region i in a period t.
$\partial Q_{i,t}$ = Variation in the quantity demanded of a goods Q in a region i in a period t.
$Q_{i,t}$ = Quantity demanded of a goods Q in a region or country i in a period t.
$I_{i,t}$ = Income of the population in a region or country i in a period t.
$\partial I_{i,t}$ = Variation in income of the population of a region i in a period t.

The response of the consumers to changes in income differs according to the type of goods considered. Thus, the elasticity values will indicate which type of goods we are dealing with. Table 1 shows the elasticity values of different types of goods and their interpretation.

Table1. Demand-income elasticity of the various goods.

Type of goods	Condition	Interpretation
Basic goods	$\lambda(Q)_{i,t} < 0$	These are goods whose demand falls when income increases. The elasticity of these goods is always negative.
Normal goods with unsatisfied demand	$\lambda(Q)_{i,t} > 0$	These are goods whose demand increases when income increases. The elasticity of these goods is always positive.
Necessary goods	$0 > \lambda(Q)_{i,t} < 1$	These are normal goods whose demanded quantity increases proportionally less than the increases in income. As the income increases, the participation of necessary goods in the consumer's budget decreases.
Luxury goods	$\lambda(Q)_{i,t} > 1$	These are normal goods whose demanded quantity increases proportionally more than the increases in income. As the income increase, the participation of luxury goods in the consumer's budget will also increase.
Normal goods with satisfied demand	$\lambda(Q)_{i,t} = 0$	These are goods whose demand remains unaltered when the income increases. The elasticity of these goods always equals zero.

In accordance with the formalisation established in Table 1, recreational crafts are identified as luxury goods. Thus, the following hypothesis is proposed for use in the estimation of the empirical model.

HYPOTHESIS 1: Recreational crafts are luxury goods whose income elasticity must be greater than the unit.

Empirical econometrics model of the evolution of the recreational crafts fleet.

The aim is to model in both absolute and relative terms the evolution of the recreational fleet of a region using the income data for that region and the linear regression technique. Thus, the number of recreational crafts (N) of a region or country using the income data (I) of that region will respond to a mathematical equation as:

$$N_{i,t} = \alpha_i + \beta_i I_{i,t} \qquad (4)$$

where:

$N_{i,t}$ = number of crafts of the recreational fleet of the zone *i* in period *t*.
α_i = constant of the model of zone *i*.
$I_{i,t}$ = income or added value of zone *i* in period *t*.
β_i = coefficient of the added value variable of zone *i*. Represents for the region *i* –in absolute terms– the increase in the number of crafts when the added value increases by one unit.
t = Period t (year *t*)
i = Geographic zone, region or country

Equation 4 has been denominated 'absolute evolution model' or Type 1, as the regression coefficient represents the increase in the number of crafts when the corresponding explicative variable – the income - increases by one unit.

If neperian logarithms are applied to the N and I variables of equation (4), the new adjustment, which would be a logarithmic transform, will correspond to the following expression:

$$Ln(N_{i,t}) = \theta_i + \lambda_i Ln(I_{i,t}) \qquad (5)$$

where:

$Ln(N_{i,t})$ = neperian logarithm of the number of the number of crafts of the recreational fleet of zone *i* in period *t*
θ_i = constant of the model of zone *i*
λ_i = Coefficient representing income elasticity of zone *i*
$Ln(I_{i,t})$ = Logarithm of income of zone *i* in period *t*
t = Period t (year *t*)
i = Geographic zone

Equation 5 has been denominated 'relative evolution' or Type II model, as the regression coefficient represents the elasticity, that is, the percentage increase in the number of recreational crafts when the corresponding explicative variable, the income, increases by one per cent.

Thus, if equation (5) is derived, we get $\frac{\partial N_{i,t}}{N_{i,t}} = \lambda_i \frac{\partial I_{i,t}}{I_{i,t}}$; from which the following equation is obtained:

$$\lambda_i = \frac{\partial N_{i,t} / N_{i,t}}{\partial I_{i,t} / I_{i,t}} \tag{6}$$

where λ_i is the demand-income elasticity for recreational crafts in zone i, indicating the percentage variation in the number of recreational crafts in zone i in response to the percentage variation in the added value of zone i.

One important aspect that should be noted is the interpretation of the regression coefficients. In the case of the regressions in absolute terms, or Type 1 models, the coefficients represent the increase in the number of recreational crafts in zone i when the corresponding explicative variable increases by one unit. However, if the variable to explicate, and the explicative variable, are expressed in logarithms, the adjusted coefficients represent elasticities, that is, percentage increases in the number of crafts when the explicative variable increases by one per cent. These latter ones are Type II models.

Case Study: Spain

Nautical tourism in Spain, both outbound and domestic, is highly dynamic. There is substantial nautical activity in and among the Spanish coastal regions. According to the Spanish Institute of Tourism (Turespaña), outbound nautical tourism in Spain generates important annual revenues, the average expenditure per nautical holiday trip is higher than that of conventional tourism and the average stay is 11.37 days. Turespaña has signed an agreement with the Autonomous Communities to promote and develop this type of tourism.

Spain disposes of official statistics on its recreational fleets and the income of each of its regions. The recreational fleet is distributed over base ports through 10 coastal Autonomous Communities (Basque Country, Cantabria, Asturias, Galicia, Andalusia, Murcia, Valencia, Catalonia, The Balearic Islands, The Canary Islands) and two Autonomous Cities (Ceuta and Melilla). The recreational craft statistics are drawn up by the regional harbour masters and are sent to the Head Office of the Merchant Navy of the Ministry of Public Works, which is where the new statistics are generated. As for the regional income statistics, the added value data of the Autonomous Communities and of Spain can be obtained from the data bases, "IneBase" and "Tempus" and from the "Regional Accountancy of Spain" of the National Statistics Institute (INE),

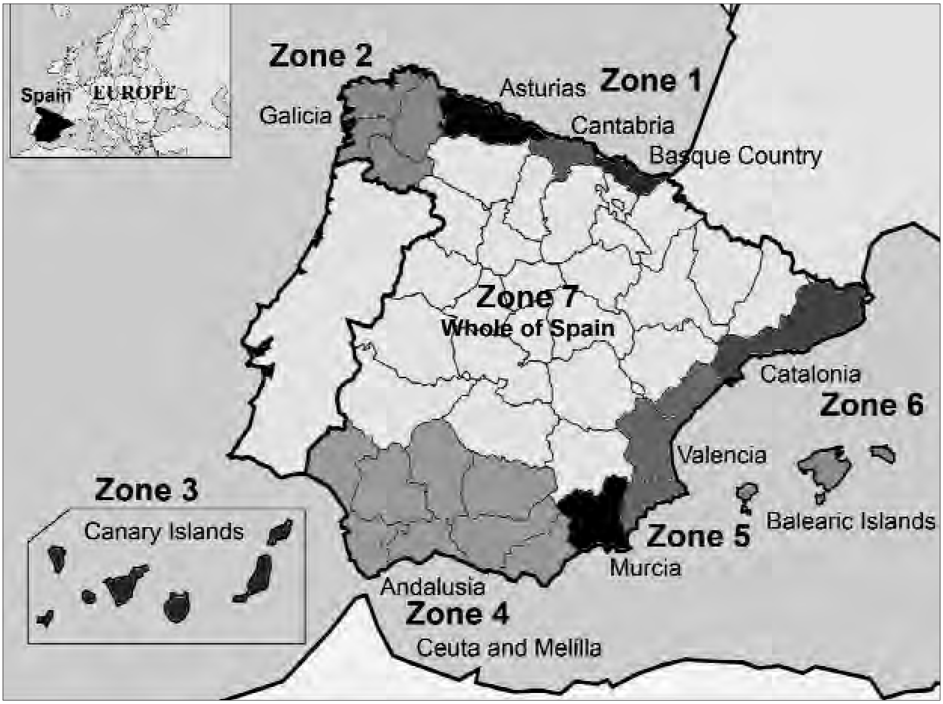


Fig.1. Coastal Regions of Spain. Regions: 1. Basque Country, Cantabria and Asturias; 2. Galicia; 3. Canary Islands; 4. Andalusia, Ceuta and Melilla; 5. Valencia and Murcia; 6. Catalonia and Balearic Islands; 7. Whole of Spain.

and from the Hispadat data base, which is drawn up using information from the Regional Accountancy of Spain by researchers on the Hispalink project.

For the purposes of the empirical estimation of the present work, the regions have been grouped into six zones which correspond to the various sea faces and a seventh representing the whole of Spain, as indicated in the following list (see Figure 1):

— Zone 1. Basque Country, Cantabria and Asturias
— Zone 2. Galicia
— Zone 3. Canary Islands
— Zone 4. Andalusia, Ceuta and Melilla
— Zone 5. Valencia and Murcia
— Zone 6. Catalonia and Balearic Islands
— Zone 7. Whole of Spain

RESULTS

The estimation of all of the Type I and II models for all of the zones mentioned was made by applying the linear regression technique by ordinary least squares for the period 1994-2005, for which there were data available. Thus, 12 observations were made in total. The software used was the E-views programme.

Type 1 Model Estimations

For the estimation of the Type I Model, or absolute evolution model, the number of recreational crafts of the various geographic zones have been used as the endogenous variables and the Gross Added Value of each geographic zone at basic prices in millions of euros based on 1995 as the exogenous variables. The results of the estimation of the coefficients and the individual significance of the variables of the Type I models analysed are shown in Table 2. The statistics for the joint significance of the Type I models are shown in Table 3. Graphs showing the real, estimated and residual series are illustrated in Figure 2.

Table 2. Coefficients and individual significance of the Type I model variables of the number of recreational crafts per geographic zone.

GEOGRAPHIC ZONE	Variable	Coefficient	Std. Error	t-Statistic	Prob.
Zone 1	α_1	-961.2454	2546.95	-0.37741	0.7138
	I_1	0.000522	5.45E-05	9.591873	0.0000
Zone 2	α_2	-7259.263	2835.549	-2.56009	0.0284
	I_2	0.001315	0.00011	11.95186	0.0000
Zone 3	α_3	-8947.89	2704.297	-3.308767	0.0079
	I_3	0.001521	1.48E-04	10.30513	0.0000
Zone 4	α_4	-13223.24	3872.276	-3.414849	0.0066
	I_4	0.000781	0.000058	13.37313	0.0000
Zone 5	α_5	-16198.54	10359.06	-1.563708	0.1490
	I_5	0.001046	1.82E-04	5.751119	0.0002
Zone 6	α_6	-73623.53	11860.08	-6.207677	0.0001
	I_6	0.001746	0.000121	14.40808	0.0000
Zone 7	α_7	-108066	13313.75	-8.116874	0.0000
	I_7	0.000755	2.82E-05	26.7639	0.0000

Table 3. Joint significance statisitcs for the Type I models of the number of recreational crafts per geographic zone.

Statistics	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7
R-squared	0.9019	0.9345	0.9139	0.94704	0.76784	0.95404	0.9862
Adjusted R-squared	0.8921	0.9280	0.9053	0.94175	0.74463	0.94944	0.9848
Durbin-Watson stat	2.3483	2.1621	1.2289	2.28503	0.76805	1.31383	3.0156
Mean dependent var	23338.4	26483	18724.4	38184.0	42951.6	96499.5	246181.1
S.D. dependent var	2771.8	3416.1	3603.0	6695.48	8476.56	17190.7	40441.8
F-statistic	92.004	142.84	106.19	178.84	33.0753	207.592	716.31
Prob(F-statistic)	0.0000	0.0000	0.0000	0.0000	0.00018	0.00000	0.0000

Number of recreational crafts per geographic zone. Real, estimated and residual series of Type I models

Fig. 2. Basque Country, Cantabria and Asturias.

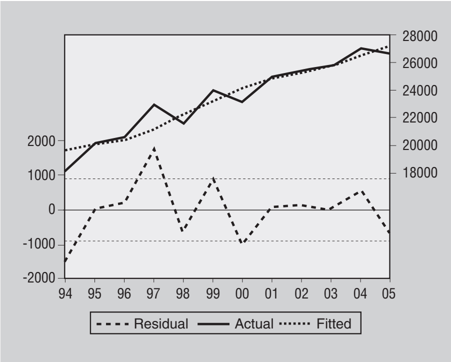


Fig. 3. Galicia.

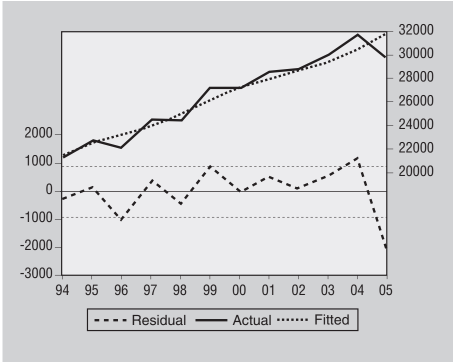


Fig. 4. Canary Islands,

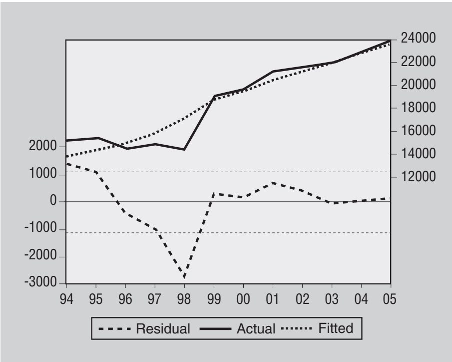


Fig. 5. Andalusia, Ceuta and Melilla.

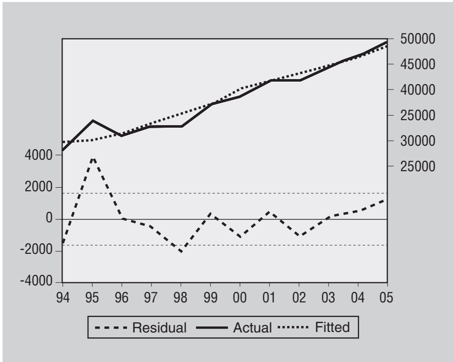


Fig. 6. Valencia and Murcia.

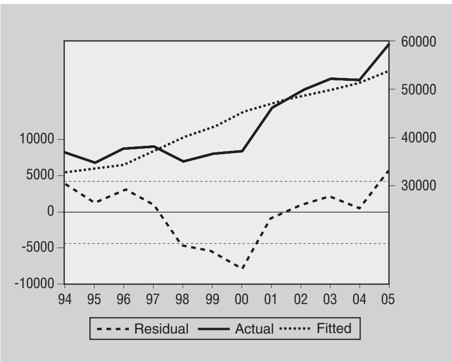


Fig. 7. Catalonia and Balearic Islands.

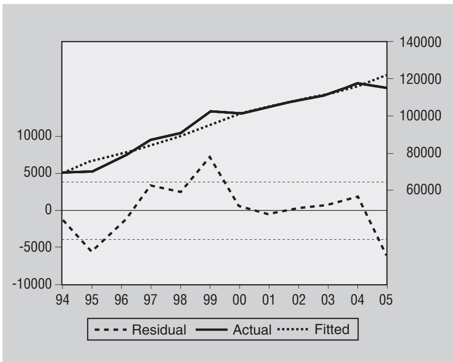
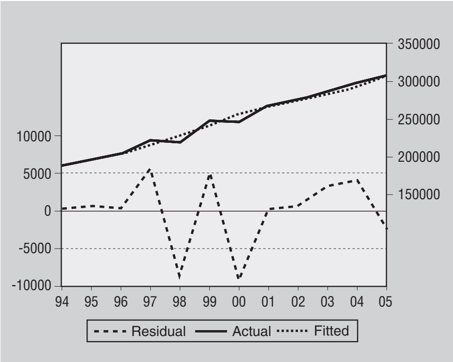


Fig. 8. Whole of Spain.



Type II Models Estimations

In the Type II, or relative evolution, models, the endogenous variable is the neperian logarithm of the number of recreational crafts in the zone and the exogenous variable is the neperian logarithm for the Gross Added Value of the zone at basic prices in constant millions of euros based on 1995. All of the models have been adjusted for the period 1994-2005 with 12 observations. The results for the estimation of the coefficients and the individual significance of the variables for the Type II models analysed are shown in Table 4. The joint significance statistics for the Type II models are shown in Table 5. The graphs showing the real, estimated and residual series are shown in Figure 3.

Table 4. Coefficients and individual significance Type II Model variables of the logarithm of the number of recreational crafts per geographic zone.

GEOGRAPHIC ZONE	Variable	Coefficient	Std. Error	t-Statistic	Prob.
Zone 1	Θ_1	-8.669091	2.04655	-4.235953	0.0017
	$Ln(I_1)$	1.060652	0.115952	9.147357	0.0000
Zone 2	Θ_2	-11.97373	1.721015	-6.957365	0.0000
	$Ln(I_2)$	1.298673	0.100902	12.8706	0.0000
Zone 3	Θ_3	-14.66524	2.743298	-5.345844	0.0003
	$Ln(I_3)$	1.465366	0.164172	8.925777	0.0000
Zone 4	Θ_4	-13.52168	2.023182	-6.683372	0.0001
	$Ln(I_4)$	1.336901	0.112427	11.89127	0.0000
Zone 5	Θ_5	-12.1836	4.23798	-2.87486	0.016
	$Ln(I_5)$	1.279733	0.237506	5.388208	0.0003
Zone 6	Θ_6	-22.46254	2.544734	-8.827071	0.0000
	$Ln(I_6)$	1.844694	0.138373	13.33128	0.0000
Zone 7	Θ_7	-16.47438	1.068589	-15.41695	0.0000
	$Ln(I_7)$	1.446586	0.053533	27.02258	0.0000

Table 5. Statistics on joint significance of Type II models of logarithm of the number of recreational crafts per geographic zone.

Statistics	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7
R-squared	0.89325	0.94307	0.88848	0.93395	0.74381	0.94673	0.98649
Adjusted R-squared	0.88257	0.93738	0.87733	0.92735	0.71819	0.94140	0.98514
Durbin-Watson stat	2.20506	2.21674	1.23986	2.46201	0.77648	1.10420	3.23144
Mean dependent var	10.0511	10.1764	9.82019	10.5359	10.6510	11.4616	12.4012
S.D. dependent var	0.12273	0.13159	0.19595	0.17647	0.18892	0.18901	0.16666
F-statistic	83.6741	165.652	79.6695	141.402	29.0328	177.723	730.220
Prob(F-statistic)	0.00000	0.00000	0.00000	0.00000	0.00031	0.00000	0.00000

Logarithm of number of recreational crafts per geographic zone. Real, estimated and residual series of Type II models.

Fig. 9. Basque Country, Cantabria and Asturias.

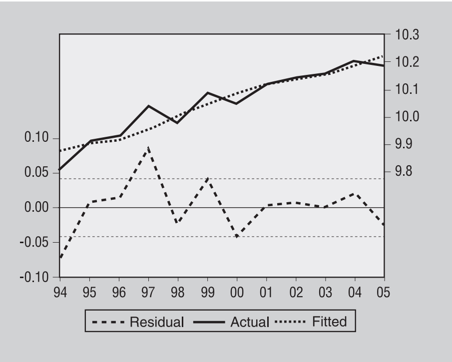


Fig. 10. Galicia.

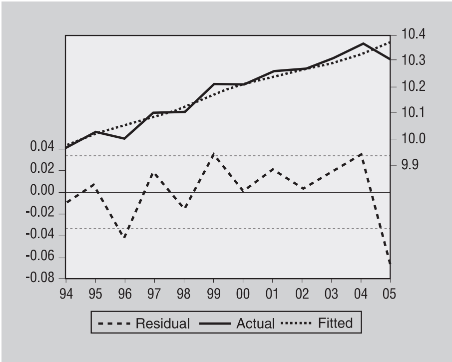


Fig. 11. Canary Islands.

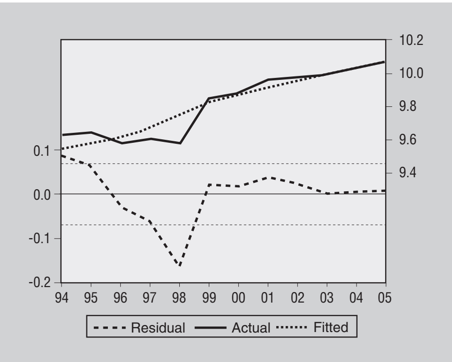


Fig. 12. Andalusia, Ceuta and Melilla.

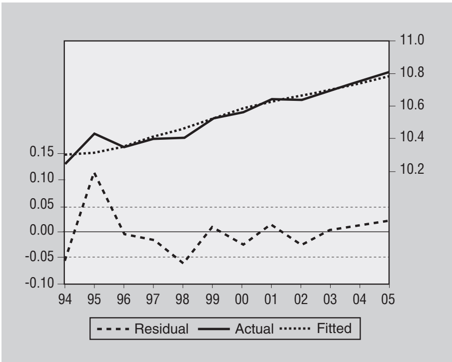


Fig. 13. Valencia and Murcia.

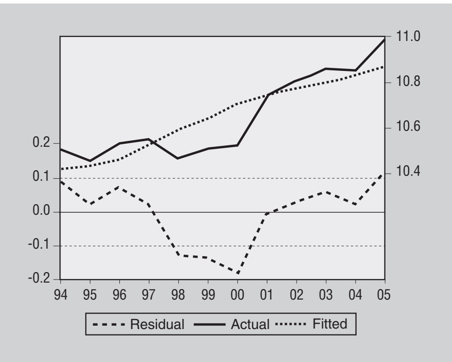


Fig. 14. Catalonia and Balearic Islands.

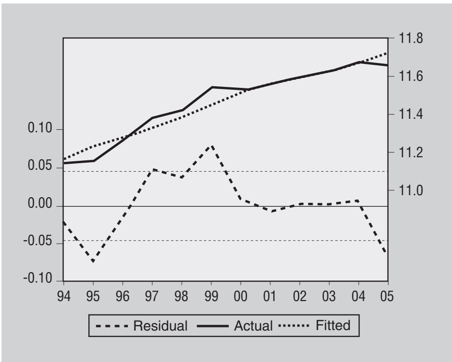
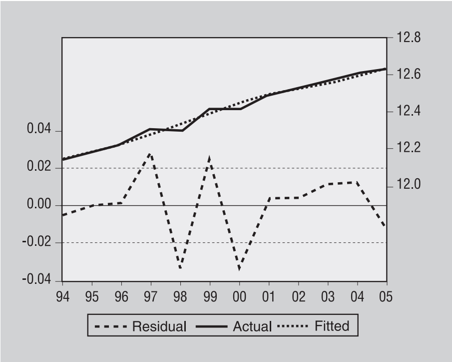


Fig. 15. Whole of Spain.



Analysis of reults of estimations

The results for the individual significance of the variables, both regarding statistic t and Prob, show a high significance of the variables, both in the value and in the logarithm models for all of the zones analysed. The only two exceptions which show a higher significance correspond to parameters α_1 and α_5, which are the constants of the Type I models of zones 1 and 5, respectively.

All of the β_i and λ_i parameters estimated show positive signs. Thus, all of the models indicate that the recreational fleet of a zone for a specific period depends on the evolution of the Added Value of that zone. In all cases, the relation is direct: the higher the added value (profits and salaries) the greater the fleet will be in the future.

The λ_i, coefficients corresponding to the logarithmic model are the elasticities. These values, ordered from high to low, are grouped in Table 6. The elasticities indicate the percentage variation in the fleet of the zone in response to a percentage variation in the added value for this zone. In all of the models, the elasticity is greater than 1, which is consistent with the identification of recreational crafts with the luxury goods category. However, the value of this elasticity shows great differences between some zones and others. As can be observed, the greatest response takes place in Catalonia and The Balearic Islands (1.84) and in the Canary Islands (1.46) which are the ones with elasticities above the Spanish average (1.44). The lowest value is for zone 1, slightly higher than the unit (1.06).

Table 6. Income-Elasticity of the number of recreational crafts per geographic zone.

Geographic Zone	λ_i
Zone 6 Catalonia and Balearic Islands	1.844694
Zone 3 Canary Islands	1.465366
Zone 7 Whole of Spain	**1.446586**
Zone 4 Andalusia, Ceuta and Melilla	1.336901
Zone 2 Galicia	1.298673
Zone 5 Valencia and Murcia	1.279733
Zone 1 Basque Country, Cantabria and Asturias	1.060652

The results for the joint significance of Type I and II models mostly present high determination coefficients, both R-squared and adjusted with two degrees of freedom (Adjusted R-squared), which, together with the high value of the Snedecor

F, makes it possible to confirm that the joint significance is high. The worst results correspond to zone 5, Valencia and Murcia, with an R-squared value of 0.76 and 0.74 for Type I and II models respectively.

Similarly, the values of the Durbin-Watson d statistic make it possible to reject the existence of autocorrelation with a significance of 1% in all cases, except for two which arise in areas of doubt, that of zone 5, Valencia and Murcia and zone 7, Spain.

These models, for zone 5 and especially for zone 7, improve significantly if a mobile average for the period is added, gathering the influence of the pre-existing stock on the fleet size of a certain period (that is, the existing fleet level or initial fleet size). In this case, the doubt related to the autocorrelation disappears and the R-squared value increases substantially up to 0.99 in the case of Spain). It was preferred to keep the same model for all zones for the purposes of coherence when it comes to comparing results and elasticity values, and also because, to a certain extent, the initial fleet level can be registered in the constant term of the equation.

DISCUSSION AND CONCLUSIONS

From the economics point of view, recreational sailing takes in goods termed luxury goods, as these are normal consumer goods with unsatisfied demand of an income elasticity greater than the unit. However, apart from these general economics considerations, two types of country or region can be distinguished, according to the social and taxation treatment applied to these goods.

There are countries or regions that consider recreational sailing as a leisure activity which, at the same time, allows certain values and traditions to be maintained. These offer a committed institutional support, do not consider recreational crafts as luxury goods from the taxation point of view and promote the development of recreational ports. These countries or regions show high elasticity-income values, as small variations in income lead to great variations in the demand for recreational crafts.

In contrast, other countries and regions do not offer institutional support to all of the recreational sailing activities, though they may do so partially. Thus, although they may agree that this is a leisure activity which is socially desirable in part (for example, sailing and rowing), they consider that from the taxation point of view, the crafts must be considered as luxury goods and recreational ports are not to be promoted by the public sector. These countries or regions present elasticity-income values slightly greater than the unit, as great variations in income are required to produce great variations in the demand for recreational crafts.

The income-demand models for recreational sailing can explain the evolution of the recreational fleet from the evolution of the income for a specific country, or region and period. These models have the further advantage that their logarithmic transforms allow the value of the income elasticity of the evolution of recreational crafts in this region to be obtained. Thus, under the hypothesis of the maintenance of the value of this elasticity, the expected variation in the fleet can be determined from the data on the current fleet and that of current and predicted income. There are several public and private organisms that elaborate income predictions in the developed countries. With the above tools and resources, the governments of a country or region can foresee the evolution of their fleets and carry out a planning of their port infrastructures that responds to the real needs.

The results obtained for the income elasticities of the demand for recreational crafts confirm that in Spain, recreational crafts are considered luxury goods. These values place Spain in the group of countries in which nautical activities are given only partial support. The average response of the Spanish recreational fleet to income variations is 144.66%, that is for every increase of 1% in the national income, the demand for recreational crafts will increase by 1.44%. Thus, under the hypothesis of invariability of this elasticity, and taking into account an annual growth in the national income of 3%, the recreational crafts will increase by 4.32%. This, in compliance with the census figures for Spain (see Section 3), means a rhythm of growth of around 13,261 crafts per year. However, not all regions respond with the same elasticity. The Mediterranean regions of Catalonia and The Balearic Islands (zone 6) present the highest values with a response of 18446%, so that for income increases of 3%, the crafts will increase by 5.52%, that is, 6386 crafts/year. In contrast, the northern regions of the Basque Country, Cantabria y Asturias (zone 1), show demand-income elasticity values for recreational crafts of 106.06% almost at the threshold of the values of luxury goods. For predicted income increases of 3%, similar variations are expected for the fleet, around 3.18%.

In normal situations, port planning responds to increases in recreational craft fleets. Otherwise, their development usually springs from speculative movements. Thus, the ordered development of nautical tourism requires an appropriate development of these infrastructures to allow the existing excess of demand to be satisfied. Hence, apart from any other considerations, the regional authorities should promote the development of recreational ports and infrastructures in order to position the crafts and avoid a disordered expansion of the sector.

Moreover, the possibility of having these predictions available allows the various business agents working in the nautical sector of each region to plan their activities on the basis of the predicted volume of business. Thus, the companies who carry out their activity in the field of recreational sailing will have more information available to devise their policies of production, employment, investment and renovation of equipment.

REFERENCES

Archer, E. (1985): Emerging environmental problems in a tourist zone: The case of barbados. *Caribbean Geography, 2* (1), 45-55.

Baine, M., Howard, M., Kerr, S., Edgar, G., & Toral, V. (2007): Coastal and marine resource management in the galapagos islands and the archipelago of san andres: Issues, problems and opportunities. *Ocean & Coastal Management, 50* (3-4), 148-173.

Baines, G. B. K. (1987): Manipulation of islands and men: Sand-cay tourism in the south pacific. *Ambiguous Alternative: Tourism in Small Developing Countries,* , 16-24.

Beekhuis, J. V. (1981): Tourism in the caribbean: Impacts on the economic, social and natural environments. *Ambio, 10*(6), 325-331.

Buckley, R., & Panell, J. (1992). Environmental impacts of tourism and recreation in national parks and conservation reserves. *Ecotourism: Incorporating the Global Classroom,* , 89-93.

Cerit, A. G., & Içöz, O. (2006: Tourism in marine environments: Introduction. *Tourism in Marine Environments, 3* (1), 1.

Charlier, R., Haulot, A., & Veryheyden, L. R. A. (1978): COASTAL ENVIRONMENT DILEMMA - ECONOMIC DEVELOPMENT VS. TOURISM., 73-77.

Favro, S., & Glamuzina, N. (2005): Contemporary problems of nautical tourism development in croatia. *Promet - Traffic - Traffico, 17* (2), 107-112.

Hall, C. M. (2001): Trends in ocean and coastal tourism: The end of the last frontier? *Ocean & Coastal Management, 44* (9-10), 601-618.

Hall, D. (2000): Sustainable tourism development and transformation in central and eastern europe. *Journal of Sustainable Tourism, 8* (6), 441-457.

Hall, D. R. (1998): Rural diversification in albania. *GeoJournal, 46* (3), 283-287.

Hanna, N., & Wells, S. (1992): Sea sickness. *Focus (Tourism Concern), 5*, 4-6.

Hawkins, J. P., & Roberts, C. M. (1994): The growth of coastal tourism in the red sea: Present and future effects on coral reefs. *Ambio, 23*(8), 503-508.

Horak, S., Marusic, Z., & Favro, S. (2006): Competitiveness of croatian nautical tourism. *Tourism in Marine Environments, 3* (2), 145-161.

Kovačić, M., Bošković, D., & Favro, S. (2006): Possibilities and limitations of spatial technical and technological development of a port of nautical tourism. [Mogućnosti i organičenja prostornoga i tehničko-tehnološkog razvoja luka nautičkoga turizma] *Nase More, 53*(1-2), 54-62.

Kovačić, M., Gržetić, Z., & Dundović, C. (2006): Planning and selection of location for the nautical tourism port for sustainable development. [Planiranje i izbor lokacije za luku nautičkoga turizma u funkciji održivoga razvoja] *Nase More, 53*(3-4), 118-124.

Lee, H. -. (2001): Determinants of recreational boater expenditures on trips. *Tourism Management, 22*(6), 659-667.

Luković, T. (2007): Nautical tourism - definitions and dilemmas. [Nautički turizam - Definicije i dileme] *Nase More, 54* (1-2), 22-31.

Marchand, H., & Skračić, V. (2006): The island and marine national park of kornati (croatia): A space in reprieve. [Le parc national insulaire et marin des Kornati (Croatie): Un espace en sursis] *Geographie, 178* (1521), 38-62.

Meyer-Arendt, K. J. (2002): *BIBLIOGRAPHY for commentary: Recreation, tourism and sport geography...*

Miller, M. L. (1993): The rise of coastal and marine tourism. *Ocean & Coastal Management, 20* (3), 181-199.

Miller, M. L., & Auyong, J. (1991): Coastal zone tourism: A potent force affecting environment and society. *Marine Policy, 15*(2), 75-99.

Milne, S. (1990): The impact of tourism development in small pacific island states: An overview. *New Zealand Journal of Geography, 89*, 16-21.

Nijkamp, P., & Verdonkschot, S. (1995): Sustainable tourism development: A case study of lesbos. *Sustainable Tourism Development,* , 127-158.

Pearce, D. G. (1988): The spatial structure of coastal tourism: A behavioural approach. *Tourism Recreation Research, 13*(2), 11-14.

Phillips, M. R., & Jones, A. L. (2006): Erosion and tourism infrastructure in the coastal zone: Problems, consequences and management. *Tourism Management, 27*(3), 517-524.

Smith, C., & Jenner, P. (1995): Marinas in europe. *Travel Tourism Analyst, 6*, 56-72.

Taïeb, G., & Verdiére, V. (1990): L'émergence touristique. *Espaces, 104*, 43-48.

Wong, P. P. (1998): Coastal tourism development in southeast asia: Relevance and lessons for coastal zone management. *Ocean & Coastal Management, 38*(2), 89-109.

Wrangham, R. (1999): Management or domination? planning tourism in the banda islands, eastern indonesia. *International Journal of Contemporary Hospitality Management, 11*(2-3), 111-115.

Xiao, H., & Smith, S. L. J. (2006): Case studies in tourism research: A state-of-the-art analysis. *Tourism Management, 27*(5), 738-749.

ELASTICIDAD RENTA DE LA DEMANDA DE EMBARCACIONES DE RECREO

Los modelos de demanda-renta de la náutica de recreo pueden explicar la evolución de la flota de recreo a partir de la evolución de la renta, para un país o región y período determinados. Dichos modelos tienen la utilidad de que sus transformaciones logarítmicas permiten obtener el valor de la elasticidad renta de la demanda de embarcaciones de recreo en dicha región. Además bajo la hipótesis de mantenimiento del valor de dicha elasticidad, se puede determinar la variación esperada de la flota en base a datos previstos de la renta.

El objetivo del presente trabajo es doble. Por un lado formalizar un modelo de la flota de recreo de un país o región que permitan determinar la evolución de la flota con respecto a los cambios de renta originados en la región, tanto en términos absolutos como relativos. Se obtienen resultados de elasticidades-renta de la demanda de embarcaciones de recreo para las diferentes flotas de recreo de España agrupadas en 7 zonas geográficas.

OBJETIVOS

El presente trabajo centra su atención en la evolución de las flotas de embarcaciones de recreo de un país o región, en relación con el comportamiento de los consumidores o demandantes de servicios e infraestructuras de la náutica de recreo.

El objetivo del presente trabajo es doble. Por un lado formalizar un modelo de la flota de recreo de un país o región que permitan determinar la evolución de la flota con respecto a los cambios de renta originados en la región, tanto en términos absolutos como relativos. Por otro, aplicar dicho modelo a la flota de recreo de un país o región concreta.

Se pretende disponer de una herramienta que pueda ser útil tanto al sector público como al privado, en un ámbito espacial determinado. En tal sentido, el conocimiento de la evolución de la flota en respuesta a los cambios de la renta de una región supondría disponer de valores de la elasticidad renta de la demanda de embarcaciones de recreo en dicho ámbito espacial. Para un valor determinado de la elasticidad se podría conocer la magnitud esperada de la flota ante variaciones de la renta suponiendo el resto de variables constantes. Ello permitiría, por un lado, a la administración regional con competencias en dicho sector planificar y ordenar el sector en base a una magnitud esperada de la flota. Por otro, orientaría a los operadores y empresas del sector sobre las estrategias a desarrollar en base a los tipos y volúmenes de negocio esperados en torno a la flota de una región determinada.

METODOLOGÍA

La metodología se desarrolla en dos fases claramente diferenciadas. En la primera se construye un modelo teórico de demanda de embarcaciones de recreo y se formaliza el concepto de elasticidad renta de la demanda de embarcaciones de recreo: Se trata de aspectos que son utilizados como elementos de referencia en el proceso de modelización empírico. En la segunda fase se formaliza el modelo econométrico, de la evolución de la flota de embarcaciones de recreo en función de la renta regional, que se utilizará en la estimación empírica.

HIPÓTESIS

Las embarcaciones de recreo son bienes de lujo por lo que su elasticidad renta debe ser mayor que la unidad.

Análisis de los resultados de las estimaciones

Los resultados de la significación individual de las variables, tanto atendiendo al estadístico t como al Prob, muestran una alta significación de las variables, tanto en los modelos en valor como para los logarítmicos, de todas las zonas analizadas. Las dos únicas excepciones, que presentan menor significación, corresponden a los parámetros α_1 y α_5, que son las constantes de los modelos tipo I de las zonas 1 y 5 respectivamente.

Todos los parámetros β_i y λ_i estimados presentan signos positivos. Por tanto, todos los modelos nos indican que la flota de recreo de una zona en un período concreto depende de la evolución del Valor añadido de la zona. En todos los casos la relación es directa, cuanto mayor sea el valor añadido (beneficios y salarios) mayor será la flota en el futuro.

Los coeficientes λ_i, correspondientes a los modelos logarítmicos, son las elasticidades. Estos valores, ordenados de mayor a menor, se agrupan en la tabla 5. Las elasticidades indican la variación porcentual de la flota de la zona en respuesta a una variación porcentual del valor añadido de dicha zona. En todos los modelos la elasticidad es mayor que 1 lo que es consistente con la identificación de las embarcaciones de recreo con la categoría de bienes de lujo. Sin embargo, el valor de dicha elasticidad presenta diferencias acusadas de unas zonas a otras. Como puede apreciarse la mayor respuesta se produce en Cataluña y Baleares (1.84) y en Canarias (1,46) que son las que presentan elasticidades superiores a la media española (1.44). El menor valor lo presenta la zona 1, ligeramente superior a la unidad (1,06).

Los resultados de la significación conjunta de los modelo tipos I y II, en su mayoría presentan altos coeficientes de determinación, tanto R-squared como el ajustado con los grados de libertad (Adjusted R-squared), lo que junto con el valor elevado de la F de Snedecor permite afirmar que la significación conjunta es alta. Los peores resultados corresponden a la zona 5 Valencia y Murcia, con R-squared de 0.76 y 0.74 para los modelos tipo I y II respectivamente.

Asimismo los valores del estadístico d de Durbin-Watson permiten rechazar la existencia de autocorrelación con una significación del 1% en todos los casos, excepto en dos que cae en zona de duda, los correspondientes a la zona 5 Valencia y Murcia y a la zona 7 España.

Estos modelos, para la zona 5 y especialmente para la 7, mejoran sensiblemente si se añade en la ecuación del modelo una media móvil de un período, que recoge la influencia que sobre el nivel de flota en un período tiene el stock preexistente. Es decir el nivel de flota existente o el tamaño de la flota de partida. En este caso desaparece la duda relativa a la autocorrelación e incrementa sensiblemente el R-squared (hasta 0.99 en el caso de España). Se ha preferido mantener para todas las zonas el mismo modelo por coherencia a la hora de comprar resultados y valores de elasticidad. Y porque en cierta medida, el nivel de flota de partida puede recogerse en el término constante de la ecuación.

DISCUSIÓN Y CONCLUSIONES

Desde el punto de vista económico la náutica de recreo aglutina bienes económicos denominados de lujo, ya que se trata de bienes de consumo normales de demanda insatisfecha de elasticidad renta superior a la unidad. Sin embargo, al margen de tal consideración económica de carácter genérico, se pueden distinguir dos tipos de países o regiones dependiendo del tratamiento social y fiscal dado a dichos bienes.

Hay países o regiones que consideran la náutica de recreo como una actividad de ocio que al mismo tiempo permite mantener valores y tradiciones. Por ello, apoyan institucionalmente la actividad de forma decidida, no consideran desde el punto de vista fiscal a las embarcaciones bienes de lujo y fomentan el desarrollo de puertos de recreo. Dichos países o regiones presentarían valores altos de la elasticidad renta debido a que pequeñas variaciones de la renta originan grandes variaciones de la demanda de embarcaciones de recreo.

En cambio otros países o regiones no apoyan institucionalmente toda la actividad de la náutica de recreo, aunque lo hagan parcialmente. Por ello, aunque pueden estar de acuerdo en que se trata de una actividad de ocio socialmente deseable en parte (por ejemplo la práctica de la vela y el remo), consideran que desde el punto de vista fiscal las embarcaciones deben ser consideradas bienes de lujo y los puertos de recreo no deben ser fomentados desde el sector público. Dichos países o regiones presentarían valores de la elasticidad-renta algo superiores a la unidad, debido a que se necesitan grandes variaciones de la renta para que se originen grandes variaciones de la demanda de embarcaciones de recreo.

Los modelos de demanda-renta de la náutica de recreo pueden explicar la evolución de la flota de recreo a partir de la evolución de la renta, para un país o región y período determinados. Dichos modelos tiene la utilidad de que sus transformaciones logarítmicas permiten obtener el valor de la elasticidad renta de la evolución de las embarcaciones de recreo en dicha región. Bajo la hipótesis de mantenimiento del valor de dicha elasticidad, se puede determinar la variación de la flota esperada en base a datos de la flota actual y datos de la renta actuales y previstos. En tal sentido, existen diversos organismos públicos y privados que elaboran previsiones sobre renta en los países desarrollados. Con las herramientas y recursos indicados las Administraciones de un país o región pueden prever la evolución de sus flotas y realizar una planificación de infraestructuras portuarias de acuerdo con las necesidades reales.

Los resultados obtenidos –de las elasticidades renta de la demanda de embarcaciones de recreo- permiten afirmar que en España las embarcaciones de recreo son consideradas bienes de lujo. Dichos valores sitúan a España en el grupo de países en los que las actividades de la náutica de recreo son apoyadas sólo parcialmente. La respuesta media de la flota de recreo española ante variaciones de la renta es del 144,66%, es decir, por cada un 1% de incremento de la renta nacional la demanda de embarcaciones de recreo se incrementará un 1,44%. En tal sentido, bajo la hipótesis de invariabilidad de dicha elasticidad, teniendo en cuenta un crecimiento anual de la renta nacional del 3%, las embarcaciones de recreo crecerían al 4,32%. Ello supone, de acuerdo con las cifras del censo de España (ver sección 3) un ritmo de crecimiento en torno a 13261 embarcaciones al año. Sin embargo no todas las regiones responden con la misma elasticidad. Las regiones mediterráneas de Cataluña y Baleares (zona 6) presentan los valores más altos con una respuesta del 184,46%, por lo que para incrementos esperados de la renta del 3% las embarcaciones crecerían un 5,52%, es decir, 6386 embarcaciones/año. En cambio las regiones del norte del País Vasco, Cantabria y Asturias (zona 1), presentan valores de la elasticidad renta de la demanda de embarcaciones de recreo del 106,06% casi en el límite de los valores propios de los bienes de lujo. Para incrementos esperados de la renta del 3% se esperan variaciones similares de la flota en torno al 3,18%.

En situaciones normales, la planificación de los puertos responde al crecimiento de las flotas de embarcaciones de recreo. En caso contrario su desarrollo suele originarse por movimientos especulativos. En tal sentido, el desarrollo ordenado del turismo náutico precisaría de un desarrollo suficiente de tales infraestructuras que permitiese satisfacer el exceso de demanda existente. Por ello, al margen de otras consideraciones de diversa índole las autoridades regionales deberían potenciar el desarrollo de puertos e infraestructuras de recreo con el fin de ubicar las embarcaciones y evitar una expansión desordenada del sector.

Además la posibilidad de disponer de tales previsiones permite a los diferentes agentes empresariales del sector náutico de cada región planificar su actividad en base al volumen de negocio previsto. En tal sentido, las empresas que desarrollan su actividad en el ámbito de la náutica de recreo podrían disponer de mayor información para establecer con menor riesgo sus políticas de producción, empleo, inversión y renovación de equipos.

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RULE- AND ROLE-RETREAT: AN EMPIRICAL STUDY OF PROCEDURES AND RESILIENCE

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Abstract:

To manage complex and dynamic socio-technical systems places demands on teams to deal with a range of more and less foreseeable situations. Three groups of participants with different maritime experiences were studied using the same simulation of a ship to better understand the role of generic competencies (e.g. information management, communication and coordination, decision making, and effect control) play in such high-demand situations. Groups with moderate maritime experience were able to balance contextual knowledge with use of generic competencies to successfully manage unexpected and escalating situations. Novices, lacking contextual knowledge, performed less well. Groups with the most maritime expertise remained committed to presumed procedures and roles and did not perform as well as the other two groups. The results suggest that training to operate complex socio-technical systems safely and effectively should go beyond procedures and include development of generic competencies. This could provide operators with better tools to enhance organizational resilience in unexpected and escalating situations.

Keywords: resilience, procedures, emergency management, training, simulation.

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INTRODUCTION

Procedures & resilience

Teams managing complex and dynamic systems have to be able to deal with a range of more and less foreseeable situations. In unexpected and escalating situations demands on such abilities can increase rapidly, for example when an operational problem of unknown origin becomes more serious or more intense. A fire aboard a ship could be a relevant example, such as the blaze on the *Scandinavian Star*, a passenger ferry on the route between Oslo and Copenhagen, on 7 April 1990, in which 158 people died when fire broke out and could not be contained until the next day (NOU, 1991). Unexpected and escalating situations create a range of cognitive and coordinative demands. As the tempo of operations rises and becomes more (if not entirely) event-driven, there is more to consider, communicate and coordinate, i.e. more information to process, distribute and act upon (e.g. Woods, Patterson & Roth, 2002). Goals can multiply, diversify and compete more steeply, and risk can increase dramatically.

A common regime in many operational worlds for absorbing those increased demands is proceduralization - the matching of situational symptoms with prepared scripts of coordinated action. Proceduralization is meant not only to help teams accomplish the sorts of actions necessary to further diagnose the situation, reduce uncertainty in it, and deal with its effects. It also supports the prioritization of certain work in the face of time pressure and resource constraints. Proceduralization can also be indivisibly connected with role assignments that govern who does what in dealing with the problem, and who double-checks or follows up the accomplishment or effect of specified actions. Proceduralization has provided operators in complex socio-technical systems with solutions on how to resolve normal and emergency situations and thus increased the reliability of operational activities. In the aviation industry in particular, proceduralization has been regarded as the most important system component to achieve increased operational safety and this has inspired maritime, nuclear and chemical industry as well as recently medicine. Shipping has relatively unthinkingly adopted this practice without reflection on the consequences, often perceived by seafarers as “counteracting the use of common sense, experience, and professional knowledge epitomized in the concept of seamanship” (Knudsen, 2009). Over time proceduralization has become more than an answer of how to increase safety in modern socio-technical systems, it may have become *the* answer.

Scientific management gave the original impetus to the development of procedures as ways of specifying action (see Taylor, 1947). It assumed that order and stability in operational systems can be achieved rationally, mechanistically, and that control is implemented vertically. These strategies persist. For instance, shortly after a fatal shootdown of two US Black Hawk helicopters over Northern Iraq by US fighter jets "higher headquarters in Europe dispatched a sweeping set of rules in documents several inches thick to 'absolutely guarantee' that whatever caused this tragedy would never happen again" (Snook, 2000, p.201). In the maritime regulatory domain, one sees the direct influence of singular accidents in new rules, often to the point where a ship can be identified by name. In many operational worlds, the strong influence of information-processing models on human factors has reinforced the idea of procedures as IF-THEN rule following, where procedural prompts serve as input signals to the human information processor (Wright & McCarthy, 2003). Procedures, however, are inevitably incomplete specifications of action. They contain abstract descriptions of objects and actions that relate only loosely to particular objects and actions that are encountered in the actual situation, and a procedure often requires a whole set of cognitive and coordinative tasks to be executed that the procedure itself cannot specify or call for (Suchman, 1987). Therefore it will remain difficult to construct global and prescriptive rules intended to guarantee certain outcomes of human behavior in complex socio-technical systems. Consequently, an over-reliance on procedures for safe operation may add additional layers of complexity rather than guide action and become part of the problem rather than the solution on to how to resolve a situation. One example is the fatal accident of Swissair 111 that crashed into the Atlantic ocean after that the presence of smoke in the cockpit was responded to promptly by the crew by adhering to the relevant checklist (Transportation Safety Board of Canada, 2003). However, while following established procedures for this situation (aiming at finding the source of the smoke rather than extinguishing any fire or putting the aircraft on safe ground), the fire engulfed the aircraft. In this case following the procedures turned out to be the problem rather than the solution (see Burian & Barshi, 2003).

The literature has recognized the limits and costs of a procedural approach to management of high-demand situations (e.g. Vicente, 1999, ; Snook, 2000, ; Burian & Barshi, 2003, ; Dismukes, Berman & Loukopoulos, 2007), but it has remained relatively mute on the mechanisms that translate that cost into real performance losses. Whereas the literature has shed light on the difficulty of processes of sensemaking in demanding situations that lie beyond procedural reach (Weick, 1993) it has not developed a detailed understanding of those aspects of performance that enhance or debilitate a team's adaptive capacity; its ability to migrate into a different regime for handling high demands. These are situations where novel behaviors can emerge, new and different resources are brought to bear, a regime where the stretched capacities of its constituent members actually open up opportunities for novel initiatives, interactions or role adoptions.

The ability to adapt is one of the key aspects of making a team work as a resilient organization, where resilience is defined as the ability to recognize, absorb and adapt to disruptions that fall outside a system's design base (Woods, 2006). The design base incorporates soft and hard aspects that went into putting the system together (e.g., equipment, people, training, and indeed procedures). The question is whether we can expect this kind of resilience from operators, experts as they may be, who are trained to follow the rules, adhere to checklists, and who have perhaps been professionally indoctrinated to believe that there is a procedure for every occasion.

In this paper we report on a series of empirical studies in which we explored the basis for the kind of adaptive capacity that could enhance organizational resilience in high-demand situations. Previous micro-world experiments (see Dörner, 1996) have illuminated the importance of generic competencies in handling dynamically escalating situations. Based on previous research on team decision making and human behavior, when handling unexpected and escalating events, as well as case studies from various domains, Bergström, Dahlström and Petersen (2008) suggested a theoretical framework to describe such generic competencies. The framework contains the four categories information management, communication and coordination, decision making, and finally effect control.

Here we ask the question whether a gap in such generic competencies can lead to over-proceduralization, over- reliance in role behavior and real operational losses. Without generic competencies to lean on, an increase in demands could actually accelerate rule- and role-retreat: a fall-back into, and an increasing rigidity of, rehearsed roles and rules (procedures). Possession, articulation and rehearsal of generic competencies, in contrast, could enhance a team's resilience in the face of accumulating demands.

The M/S Antwerpen simulation

The M/S Antwerpen simulation is part of a two-day emergency management training course developed at the University of Bamberg in Germany (Strohschneider & Gerdes, 2004). The course consists of first one simulator session, followed by instructions, extensive debriefings and theoretical training on emergency management, and concludes the following day with a second simulation session. However, apart from its training purposes, the simulation can be used as a research tool for providing data on group action and interaction in escalating events.

The simulation is designed for a group of five to seven participants who act as the ship's officers. Each participant takes on a specified role, namely: captain, chief officer, chief and main engineer, chief steward, ship's doctor and navigation officer. Initially each participant is provided with general information which describes the features of the ship as well role specific information. The information emphasizes the conditions for the simulation with extreme clarity, e.g. stresses not to make assumptions about the ship or its status but rather use the information that is available. It is the participants' task to safely navigate the ship through a stormy night in the North Atlantic. Due to the adverse conditions, and because the ship has been poorly maintained, the crew is forced to deal with a number of passenger-related problems and technical failures that towards the end of the simulation result in a state of emergency.

To sail the ship and handle these events, the participants have a wide variety of options and actions available to them. They have control over the technical facilities of the ship, including maintenance and repairs. Furthermore, they are presented with an abundance of information regarding the ship provide by regular printer outputs. By filling out order sheets they direct the crew and give various orders relating to the passengers (including, e.g. sending misbehaving passengers to their cabins, closing or evacuating sections of the ship, and using life boats and rafts to abandon the ship). Participants are not provided with a prescribed list of possible responses. Instead they have to plan and execute actions as a team and deal with the possible consequences and side-effects of their actions. The participants, therefore, find themselves in a dynamically developing situation, one that has a high level of uncertainty. Moreover, they have to deal with all this under the threat of all the conceivable emergencies that come with navigating a poorly maintained ship in bad weather.

The effect of different levels of procedural-experience

In this study, three different types of groups participated in the M/S Antwerpen training program. Each type of group differed in their familiarity with maritime operations. We were interested in the effects of the different levels of knowledge, experience and availability of procedures on concepts regarding team interaction and management of unexpected and escalating situations. Each type of group was represented by three groups of participants which were observed during the M/S Antwerpen training program.

The first type of participants was made up of novices in maritime settings, namely civil aviation student pilots. This type of group had minimal knowledge of maritime concepts, operations, and procedures. The second type of group consisted of maritime students with limited experience of maritime operations. These participants had some professional experience, however, being students, they did not have years of practical firsthand experience with the procedures and practices on large ships. The third group consisted of experienced seafarers, who had multiple years of experience on large ships. This type of group possessed practical expertise in regards to maritime concepts as well as with normal and emergency procedures onboard such ships.

Our main point of interest was whether the availability of procedures would enhance or impair the groups' use of generic competencies and therefore their ability to be resilient. When observing the three groups in order to assess their generic competencies, we categorised statements made and strategies chosen into the four categories information management, communication and coordination, decision making, and effect control (see Bergström, Dahlström & Petersen, 2008).

Regarding the teams' information management-strategies we specifically recorded whether or not the participants: openly stated their personal and group's goals, whether or not these goals were discussed, and whether or not decisions were based upon them. The simulation ensures that the groups are required to find a way to manage the continuous printer outputs. Therefore strategies for receiving and distributing incoming information to the group or its individual members were examined. We were also interested in how the groups would establish strategies, like prioritize incoming information based on the team goals, to cope with the data overload problem.

Secondly we focused our attention on the category communication and coordination; mainly how team members dealt with workload and role definition. We were interested to see to what extent participants shared their tasks and workload (flexible structure), or whether they rigidly remained within the work constraints of their prearranged roles (robust structure). How the groups dealt with the idle time during the simulation was a further area of interest. Idle time refers to the periods during the simulation in which there is hardly any work to do for the group. Idle time, intentionally produced by the simulation, provided the groups with the opportunity to think ahead, reflecting upon team processes, and construct team strategies accordingly, instead of just waiting for the next crisis to come along.

Thirdly we observed and recorded the decision making process, specifically at where the decision making process took place (distributed, hierarchical, etc.). We were interested in observing whether or not group goals were used to build up shared mental models and shared expectations of the problems at hand, and also in how team members shared information about decisions made.

Finally we examined the groups' overall capabilities to step back and on a meta-level analyze, discuss, and adjust their approach and team functioning during the simulation.

It seems that the different levels of (procedural) experience described above give rise to different ways of managing emergencies, in particular unexpected and escalating situations. In analyzing the performance of the groups, we distinguished between the two perspectives of "process" and "outcome". Outcome relates to the quantitative results of the simulation; primarily numbers of injuries and casualties, and damage to the ship. As a performance measure, however, the outcome of the simulation is dependent on the interaction between the participants and the facilitators of the simulation and therefore renders it a less reliable measure of performance. "Process" refers to qualitative aspects of how the group managed situations encountered in the simulator sessions, e.g. the generic competencies outlined above, in relation to accepted and recommended practices for emergency management. Reporting of results are mainly focused on "process".

RESULTS: DESCRIPTIONS OF THE THREE TYPES OF GROUPS' PERFORMANCES DURING THE M/S ANTWERPEN SIMULATION

Group type 1: Civil aviation student pilots

The first type of group, in general, performed poorly in the first simulator session in regards to both process and outcome. Most of these groups lost the ship and barely saved any passengers on their first trips. This began directly with the group getting immersed in the simulation, literally just starting and going wherever events would take them, without any clearly communicated goal or strategy, thus becoming locked in the dynamics of events almost immediately. This was manifested in the group's performance; they soon became overwhelmed by the amount of information they received. At no time did they discuss whether their initial approach of handling the information (printouts that soon formed piles and stacks of paper) was successful or even functional. Actions were almost exclusively reactive, i.e. in response to emerging problems, and normally based on urgency, not priority. Tasks were not shared in the group outside their original role descriptions, which led to a very high workload for some participants while others had few tasks to perform. The group did not monitor, discuss or change the group processes in any way, even when the workload was recognized within the group as becoming impossible to manage.

In the second session this type of groups did better regarding the outcome of the simulation: all groups still lost the ship, however this time they managed to save the majority of the passengers and crew. On a process level, the improvements were even more evident. The group showed great improvements in competencies. Although this improvement is somehow expected due to the participants' experience from the first trip and the subsequent theoretical training on emergency management, it was surprising how these groups were able to successfully transfer this to improved behavior in the second session. Tasks were explicitly distributed and redistributed to manage workload within the group. A role with low workload took the role of moderator, who then was in charge of monitoring the group's processes and dynamics. This meant that the captain was able to maintain an overview of the current situation and focus on issues of priority (rather than of urgency). Measures to ensure effective information sharing were taken, such as attempts at establishing routines for regular briefings and other forms of presenting the current situation of the ship, personnel, and problems to establish a shared mental model of the situation (use of blueprints, whiteboard, log notes etc.). They also followed up on more orders to ensure that they were carried out as intended (i.e. "effect control") and were much more cautious when making assumptions about a situation when there were gaps in their knowledge. The groups took more precautions in regards to various threats and were more proactive during this trip, for example by checking that rescue equipment was operative. The differences between the two sessions, in terms of team processes and generic competencies, are outlined in table 1.

	Session one	Session two
Information handling	■ No explicit goals ■ No prioritizing of incoming information ■ Information overload	■ Clearer formulation of goals ■ Captain able to prioritize tasks
Communication and coordination	■ No assignment of tasks outside role descriptions ■ Robust rather than flexible environment	■ Distribution and redistribution of some tasks ■ Not overruling the predefined roles ■ Moderator responsible for monitoring group processes and dynamics
Decision-making	■ No sharing of goals ■ No sharing of expectations ■ Little sharing about decisions made	■ Regular briefings to share information about the latest decisions made ■ Using blueprints, whiteboards to share information ■ Clearer orders
Effect control	■ No following-up on decisions made ■ No reflections about, or updates of, the tasks assigned to each role	■ Redistribution of tasks based on the situation ■ Follow-ups on decisions made and orders given

Table 1. Summary of the established processes to manage the simulation in the groups of type one.

Overall these groups, being student pilots, were hampered by a lack of understanding of maritime concepts which made it challenging for them to extrapolate from available knowledge in order to invent creative solutions for solving the problems they faced. Nevertheless, clever alternatives were devised for a number of problems, e.g. as the general alarm was defective an effective notification was devised for passengers to tell them that they should go to the life boats.

Group type 2: Maritime students

During the first trip, the second type of group performed, in regards to final outcome, moderately better then the first group, however, most groups still lost the ship and the majority of the passengers and the crew. These groups devised creative solutions which were difficult for the first type of group to come up with, since a basic understanding of ships is required to be able to devise such solutions. An example of this was when a group of this second type used a stream anchor to maneuver the ship after a breakdown of the steering engine. However, despite their creative problem solving capabilities, in comparison with the first type of group this type of group only performed marginally better in regards to aspects of process. Similarly to the previous groups, almost all of the second groups' actions were reactive; discussions and action were prompted exclusively by the information that came out of the printer. There was hardly any analysis of the occurred events, revision of current situation and strategies, or discussions on which potential tasks and risks may be ahead of them. There were also no structural solutions to deal with the information overflow.

After reflecting on the first trip and receiving the theoretical training, these groups performed very well in the second trip; saving the ship and its passengers. They were still applying their creative problem solving skills, but proactive thinking was added to that. They questioned their initial approaches to problems, and what became apparent during their second trips was their anticipation of potential problems. Examples of improved effect control were evident in the groups' continuous verification of the results of all their actions. There were numerous examples of proactive actions and planning in regards to potential threats to the safety of the ship. During a large fire all these groups sent people to higher decks, anticipating the spread of the fire. Their ability to foresee contingencies and consequences lead them to react quickly and forcefully. They prioritized effectively and responded in this way to every event that threatened safety. They were able to rank actions, given the situation, and defer the least important of them until a normal status of operation was regained. They were also reluctant to make any sort of assumptions which could not be sustained by facts. They were also able to dynamically adjust their strategies, given the conditions encountered. An example of this was their discovery, prior to any emergency situation, that the instructions did not include specific references to muster stations and the resulting creation of an alternative approach to evacuation. The differences between the two sessions, in terms of team processes and generic competencies, are outlined in table 2.

	Session one	Session two
Information handling	■ Everyone's responsibility to handle incoming information ■ No explicit goal formulations	■ Clear goals ■ Prioritizing and ranking potential threats
Communication and coordination	■ No assignment of tasks outside role descriptions ■ Robust rather than flexible environment	■ Resisting confirmation bias ■ Clear roles, but flexible distribution of tasks
Decision-making	■ Creative solutions to maritime-related problems ■ No discussions about potential tasks and risks	■ Creative solutions to maritime-related problems ■ Formulation of potential problems guided a distributed decision making processes ■ Quick reactions to contingencies
Effect control	■ Hardly any analysis of occurred events ■ No revision of current situations or strategies	■ Continuous verification of the results of actions ■ Dynamically adjusting strategies

Table 2. Summary of the established processes to manage the simulation in the groups of type two.

These groups performed better than the first type of groups mainly because they had contextual knowledge that supported a more effective use of generic competencies. They devised creative solutions based on extrapolations of their nautical knowledge, e.g. reducing roll angle by course change and using auxiliary engines proactively.

Group type 3: Experienced seafarers

This type of group consisted of participants with first hand practical experience in direct relation to their roles in the simulation (the captain, chief officer and chief engineer all had experience in these respective professional roles). In the first trip a steep hierarchy of command was quickly established among the participants. This hierarchy seemed comparable to that of real vessels, with the captain being clearly in charge of everything. This hierarchical role division and task distribution worked effectively during this session as it provided structure to both normal tasks and unclear situations. All group members reported to the captain, which resulted in the captain being in control of all goals and problems, and he gave orders accordingly. He then relied on his crew to execute the given orders. The captain and the rest of the group relied heavily on many types of procedures that they would also apply in real-life situations, and these proved useful on most occasions. These procedures, drawn from practical experience, led to the participants checking a number of parameters. This also proved useful as it supported a structured plan for management of emergencies. However, the group did not fully integrate and act on information given to them even though this issue was heavily emphasized in the instructions they had received. This was manifested on many occasions, including a fire where a captain ordered the crew to go to their muster stations and only then it was discovered that these were not specified in the simulation. The participants were however unable to solve this problem by inventing an alternative to the concept of muster stations; instead there were repeated questions about them in the group as well as complaints to the facilitators about the lack of them. Overall the procedures, often unspoken and simply assumed, did not always work as anticipated, because the scenario of the simulation did not match entirely with their expectations based on their previous experiences. As a result the group was not able to advance much beyond their silent consensus on how things "should be". There were also expectations on the behavior of the crew in the simulation which did not prove valid. The amount of expectations and inability to break out of them resulted in unanticipated failures and losses. The hierarchical team structure worked smoothly initially. It did however start to erode as soon as the workload increased; the captain became buried in information and tasks. For example, during a large fire the captain was in charge of both the fire fighting and evacuation of passengers. In practice, this meant that only one of these two tasks could be adequately managed. The final outcome was moderately successful because, based on his experience, the captain decided at an early stage of the emergency that they were not going to be able to fight the fire effectively and therefore he decided to evacuate.

Surprisingly, after the relatively good first trip (keeping in mind the flaws of relying solely on procedures mentioned above) and subsequent training, this group showed only marginal improvement in the second session after receiving the training that the other types of groups received. The group preserved their reliance on roles and procedures that proved less than ideal during the first trip. In many aspects the mistakes during the second session were identical to those committed during the first session. The serial approach to problems used in the first session, which was ineffective at times when the captain was preoccupied, again in the second session lead to standstills until the captain was free to approach the next problem. With the exception of maintenance of machinery, practically no action was executed in parallel. An example of this was seen as the group was attempting to investigate potential water penetration at a time when a bomb threat was received, resulting in a switch of full focus to the bomb threat and a return to the potential water penetration only when the bomb threat had been investigated. By not approaching these two problems in parallel, for which there were more than enough resources available, the lower decks could have been flooded before both problems had been addressed. The group members stayed precisely within the boundaries of their roles and task descriptions (relying on other "roles" to do "their own" tasks). In one case it took a "hero", one of the most experienced group members, a chief engineer, to break out of

	Session one	Session two
Information handling	■ All group members reporting to the captain ■ The captain in control of possible goals	■ All group members reporting to the captain ■ The captain in control of possible goals
Communication and coordination	■ Steep hierarchy ■ Robust rather than flexible environment	■ Steep hierarchy ■ Robust rather than flexible environment
Decision-making	■ Decisions made by the captain ■ Reliance on perceived procedures ■ Not acting on the information given ■ No information sharing except for reporting to the captain ■ Tasks not performed in parallel	■ Decisions made by the captain ■ The Captain overloaded with tasks ■ Reliance on perceived procedures ■ No information sharing except for reporting to the captain ■ Tasks not performed in parallel
Effect control	■ Unable to revise the belief in perceived roles and procedures ■ No revision of roles and tasks ■ Few follow-ups on orders given	■ Unable to revise the belief in perceived roles and procedures ■ Few revisions of roles and tasks ■ Few follow-ups on orders given

Table 3. Summary of the established processes to manage the simulation in the groups of type three.

this structure. During an emergency he stepped out of the hierarchy to suggest to the captain that he should take charge of the evacuation as long as the captain was preoccupied with fire fighting. Due to this initiative, the evacuation was taken care of effectively and again the outcome was relatively successful (although not nearly as successful regarding process as session two for the type 2 groups). The differences between the two sessions, in terms of team processes and generic competencies, are outlined in table 3.

DISCUSSION

Group type 1 & 2 vs. type 3: The limiting effect of procedural experience

Overall, the third type of group did relatively well in terms of group process and outcome. Despite that they did not perform optimally under increasing stress they did have a clear solution to the information flow problem and a clear distribution of tasks, as well as a systematic approach to most of the situations encountered. However, as soon as events developed beyond the "design base" of their procedures, the work structure started to disintegrate rapidly. This did not occur in the other two types of groups – ones that were not as reliant on presupposed procedures. These two groups used the generic competencies and the knowledge they gained from their experiences in the simulation as well as from the training in-between the two scenarios. Furthermore, in contrast to the other two types of groups, the third type of group very rigidly held onto their original hierarchical group structure, even when this proved ineffective. The other groups were able to manage a more dynamic group structure in order to deal with unexpected situations and the different phases of escalation.

Although procedures may prove effective to some degree, as shown by the relative success of the third group during their first trip, as soon as the specific conditions for a procedure did not precisely apply, control was lost and competence degraded. As not all scenarios or situations can be foreseen, relying on procedural knowledge or procedures may not always be enough. However, trained crews tend to react to emergency events with the use of pre-prescribed procedures even when these do not match the problem. In other words, for someone equipped with a hammer all problems will look like nails, and this is where the danger lies. In particular in emergency situations individuals and groups need to be able to review their situation and assess whether their "standard" approach is appropriate (exemplified by the fatal accident of Swissair 111, outlined above).

Relying on procedural knowledge can limit alternatives and may prevent potentially powerful non-presupposed solutions from being considered. This may mean that not even reviewing or reframing of a situation may occur. In short, relying on procedural knowledge can severely limit crews' options to be resilient.

Moreover, armed with the knowledge that they have a procedure for every scenario, the experienced participants (group type 3) felt more secure than the inexperienced groups (group type 1 and 2). This sense of security seemed to cause overconfidence. In the simulation this was manifested by the following: giving non-specific orders, not following up on orders and making unfounded assumptions in many situations. This may be a functional approach in extremely stable and reliable conditions. However, this was not the case in the simulation and is rarely the case in the transportation industry, where crew composition and operational conditions may change frequently and equipment often is used at or close to the limits prescribed by the manufacturer.

Despite long periods of operation during which nothing dangerous ever happens, it is important that operators go to work and are prepared to expect the unexpected (Dekker, 2006). In the simulation sessions, in particular during the second trip, group types 1 and 2 showed caution regarding their situation; institutionalizing effect control, proactively checking the status of equipment (e.g. technical and rescue equipment) and simply contemplating what might go wrong next. Multiple groups of type 1, for example, checked whether all the life-boats were in good condition, whereas the experienced seafarers assumed that they were, based on the claim that such matters are regularly tested (even though they admitted that there has been a number of accidents at sea where rescue equipment has been defective). This summarizes exactly the issues that the experienced crews faced (group type 3); they assumed that things were as they should have been, that situations would proceed as expected or as ordered, and all of this would occur in accordance with procedures. Experience makes people expect certain things regarding quality of equipment, action sequences performed by crews, crew reactions in emergencies, passenger reactions and behavior etc. Procedures create reliability, i.e. expected events. Procedures are in place to fight foreseeable problems, whereas caution, forethought and inspection can give rise to resilience, to the ability to adapt to unexpected and escalating events (see McDonald, 2006).

A point of criticism may be that the experienced crew did not do as well as the other type of groups during the simulation because the simulation did not exactly mirror real world conditions. This is however to some degree the main point that the participants of the simulation were meant to take home; in an emergency situation not everything will go according to plan, e.g. not everybody will report back and not all orders will be carried out (Dahlström, van Winsen, Dekker, & Nyce, 2008). But under those circumstances groups need to find and mobilize resources and competences that will enable them to remain functioning. When procedures limit options they need to be able to find alternative ways to solve problems.

Group 1 vs. group 2: Difference between generic competencies, domain knowledge and procedural knowledge

If relying entirely on procedures is not appropriate, we can argue that having only generic competencies without having any domain specific knowledge (group type 1) may have the same effect. Maritime knowledge should facilitate the generation of solutions to the problems encountered in the simulation. The student pilots (group type 1) were not likely to come up with alternative solutions for navigation at sea. The second group type did have knowledge of maritime concepts in addition to the general competencies learned during the training phase of the program; even when the steering engine broke down they explored actions in order to make the bow of the ship turn into the wind, thereby reducing the dangerous roll angle of the ship. However they were not limited to following established procedures, even when there were explicit procedures available. To argue that even in a simulation appropriate contextual and domain competence "counts" seems self-evident. But this is not the point we wish to make here. What we believe this simulations suggests is that the role generic competencies can play for safety needs to be reconsidered for unexpected and escalating situations.

On a process level, it proved easier for groups with a certain level of domain knowledge (group type 2), as compared to groups with only generic competencies (group type 1), to cooperate. The reason for this lies in the more appropriate match between their common knowledge and the situation. The type 1 groups improved their generic competencies between the two trips and therefore performed more effectively during the second trip. Despite this improvement, it proved harder for these groups to apply their skills in an unfamiliar setting. Moreover, for participants without previous domain-specific knowledge, it proved impossible to step out of their roles, in order to assist or even overrule other roles. The reason for this lays in the role-specific information being the only information on which to base their behavior. With no alternative knowledge to use in these unfamiliar settings they remain "too loyal" to these roles.

There is a fine line that distinguishes the second group's (theoretical) domain knowledge, which enabled them to come up with more creative solutions, from the first group who lacked maritime concepts, and the third group's procedural experience which seemed to limit them to following procedures. The student pilots had no tools with which to deal with a maritime emergency, they had to rely solely on generic knowledge and competencies. The experienced crews relied on tools and procedures they normally used. The maritime students on the other hand were able to look into the toolbox and select an appropriate (but not necessarily prescribed) tool for the situation.

CONCLUSIONS

If operators are to be able to resolve normal and emergency situations, they do need to be trained in established procedures. Many industries, including the maritime, have tended to equate training and education with the acquisition of procedural knowledge. This has led to a regime of control, a discourse, in which every conceivable variation away from normal operation can be "anticipated" or controlled additively by the creation of new or more procedures and rules—a trend that may be larger than the safety-critical situations studied for this paper (see Foucault, 1977). However, the intractability of human action and design compromises inherent in any complex socio-technical system can lead to operational situations which require action and response that extends beyond any set of established procedures no matter how elaborate or detailed. Observations of emergencies in these ship simulations suggest that procedural knowledge or guidance can lead operators in unexpected and escalating situations to act in ways that are irrelevant or detrimental given the situation at hand. The issue here is not whether procedural knowledge be part of any operator's training. It is to suggest that operator training should not be limited to this. Apart from being reliable in the sense of following predetermined procedures, an organization also has to be able to "recognize and adapt to handle unanticipated perturbations that call into question the model of competence, and demand a shift of processes, strategies and coordination" (Woods, 2006, p.22). McDonald (2006) suggests that being able to successfully resolve this apparent contradiction is a characteristic of a resilient organization. While unanticipated, it is industry's strong commitment to and investment in safety and procedure that has left operators less able to respond to unexpected and escalating situations. Next to the training of procedures, operator training needs to stress as well the development of generic competencies that add up to resilience in the face of unexpected and escalating situations. This would provide operators with the tools they need to manage situations that go beyond what can be anticipated. Only then can the kinds of counterproductive rule- and role-retreat behavior observed in these shipboard simulations (and often reported in accident reports) be avoided.

REFERENCES

Bergström, J., Dahlström, N. and Petersen, K. (2008): Securing Organizational Resilience in Escalating Situations: Development of skills for crisis and disaster management, *Proceedings of the third Resilience Engineering Symposium,* 28-30 October, Antibes-Juans Les Pins, France, pp.11-17 .

Burian, B. and Barshi, I. (2003): *Emergency and Abnormal Situations: A Review of ASRS Reports*. the 12th International Symposium on Aviation Psychology, Dayton, OH, Wright State University Press.

Dekker, S. (2006): *The field guide to understanding human error*. Aldershot: Ashgate Publishing Company.

Dismukes, R. K., Berman, B. A. and Loukopoulos, L. D. (2007): *The limits of expertise: Rethinking pilot error and the causes of airline accidents*. Aldershot: Ashgate Publishing Company.

Dörner, D. (1996): *The Logic of Faliure*. New York: Metropolitan Books.

Foucault, M. (1977): *Discipline and punish: The birth of the prison (A. Sheridan, Trans.)*. New York: Vintage (Original work published 1975).

Knudsen, F. (2009): Paperwork at the service of safety? Workers' reluctance against written procedures exemplified by the concept of 'seamanship'. *Safety Science*, *47*, 295-303.

McDonald, N. (2006): Organisational Resilience and Industrial Risk. In E. Hollnagel, D. Woods and N. Leveson (Ed) *Resilience Engineering, Concepts and Precepts,* pp. 155-180. Aldershot, Ashgate Publishing Company.

NOU (1991): *1A Scandinavian Star: Ulykken 7 april 1990 Hovedrapport*, Oslo

Snook, S. A. (2000): *Friendly Fire, The accidental shootdown of U.S. Black Hawks over northern Iraq*. Princeton: Princeton University Press.

Strohschneider, S. and Gerdes, J. (2004): MS: ANTWERPEN: Emergency management training for low-risk environments. *SIMULATION & GAMING* 35 (3), 394-413.

Suchman, L. A. (1987): *Plans and situated actions: The problem of human-machine communication*. Cambridge, UK: Cambridge University Press.

Taylor, F. W. (1947): *Scientific Management*. New York: Harper & Brothers Publishers.

Transportation Safety Board of Canada (2003): *Aviation Investigation Report: In-flight fire leading to collision with water, Swissair Transport Limited, McDonnell Douglas MD-11 HB-IWF, Peggy's Cove, Nova Scotia 5 nm SW, 2 September 1998, (Report number A98H0003)*, Catinau, QC

Weick, K. (1993): The Collapse of Sensemaking in Organizations: The Mann Gulch Disaster. *Administrative Science Quarterly*, *38*(4), 628-652.

Vicente, K. (1999): *Cognitive work analysis: Toward safe, productive, and healthy computer-based work*. Mahwah, NJ: Lawrence Erlbaum Associates.

Woods, D. D. (2006): Essential Characteristics of Resilience. In E. Hollnagel, D. D. Woods and N. Leveson (Ed) *Resilience Engineering - Concepts and Precepts,* pp. 21-34. Aldershot, Ashgate Publishing Company.

Woods, D. D., Patterson, E. S. and Roth, E. M. (2002): Can we ever escape from data overload? A cognitive systems diagnosis. *Cognition, Technology & Work* 14, 22-36.

Wright, P. C. and McCarthy, J. (2003): Analysis of procedure following as concerned work. In E. Hollnagel (Ed) *Handbook of cognitive task design,* pp. 679-700. Mahwah, NJ, Lawrence Erlbaum Associates.

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Journal articles

Srivastava, S. K. and Ganapathy, C. (1997) Experimental investigations on loop-manoeuvre of underwater towed cable-array system. *Ocean Engineering* 25 (1), 85-102.

Conference papers and communications

Kroneberg, A. (1999) Preparing for the future by the use of scenarios: innovation shortsea shipping, *Proceedings of the 1st International Congress on Maritime Technological Innovations and Research,* 21-23 April, Barcelona, Spain, pp. 745-754.

Technical Reports

American Trucking Association (2000) *Motor Carrier Annual Report.* Alexandria, VA.

Doctoral theses

Aguter, A. (1995) *The linguistic significance of current British slang.* Thesis (PhD).Edinburgh University.

Patents

Philip Morris Inc., (1981). *Optical perforating apparatus and system.* European patent application 0021165 A1. 1981-01-07.

Web pages and electronic books

Holland, M. (2003). *Guide to citing Internet sources* [online]. Poole,
Bournemouth University. Available from:
http://www.bournemouth.ac.uk/library/using/guide_to_citing_internet_sourc.html
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