STRATEGIC RESEARCH AGENDA

IMPLEMENTATION

Waterborne Transport & Operations
Key for Europe’s Development and Future

Route Map Issue 2 - May 2011
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IMPLEMENTATING WATERBORNE STRATEGIC RESEARCH AGENDA (WSRA)

1. Introduction ................................................................. 2
2. Towards the Vision 2020 .................................................. 3
3. Approach to Implement the WATERBORNE Strategic Research Agenda (WSRA) ........ 4
4. Implementation Route Map. ............................................. 7
   4.1 WATERBORNE Pillars Research Topics ......................... 7
   4.2 Exploitation Outcomes ............................................. 8
   4.3 Large Project Initiatives .......................................... 10
5. Financing the WSRA Implementation ................................ 11
   5.1 What is needed to finance the WSRA? ......................... 11
   5.2 Who finances the implementation of the WSRA? ............ 11
Annex 1 - Route Maps ..................................................... 12
Annex 2 - Research Topics .............................................. 27
Annex 3 - Large Project Initiatives ................................. 80
I. Introduction

The Waterborne Community is composed of representatives from Industry (Manufacturers, Users & Service Providers), Society (Regulatory, Research & Education Organisations, Unions) and Public Authorities (Commission & Members States). Waterborne has formulated its ambitions to meet the future and its challenges in the form of a Vision 2020 document leading to a WATERBORNE TP Strategic Research Agenda (WSRA). To achieve its objectives WATERBORNE™ has, most noticeably with its industrial support, developed an Implementation Route Map for the WSRA. This report is the first update of the original 2008 document and incorporates developments in the WSRA, in particular in the fields of energy efficiency and green technologies.

This Executive Summary of the Strategic Research Agenda Implementation outlines the results of a process aimed at giving the stakeholders’ insight to the interrelation of the relevant Research, Development and Innovation (RDI) topics of the Strategic Agenda and the Vision 2020 targets. It identifies priorities and provides an idea of the scope in time and the necessary resources, as well as the possibilities of clustering in the form of Large Project Initiatives. It is a tool aiming at maximising the practical outcome of RDI resources available in the EU (Commission funding, National funding as well as Private funding). It forms a guidance document for consistent long term RDI programmes and demonstrates to politicians of both the Member States as well as the European Commission the innovative nature of the Waterborne Community.

Irrespective of how it was developed, the strength of this document is that it is a reference to be used for planning RDI investments across the whole sector. It provides a justification for public funding where it triggers private investments in new technology and processes, which are necessary to maintain and foster the Industries global position and to adapt its products and services to global challenges (including climate change). It makes opportunities visible to the research community, demonstrates the need for relevant education and shows the areas of potential cooperation with other related clusters.

To use a maritime analogy: the resulting “Route Map” is a high level tool to be used as the starting point of an evolutionary planning process. Like any plan, particularly in the RDI field, it will need continued updating to respond to the realities of our ever changing world. Further detailed work is necessary to provide more data as to time, money and the necessary actors involved. This is a challenge in a sector that comprises thousands of companies and other stakeholders.

Finally, this Executive Report introduces a number of RDI outcomes, which, as per today, are considered necessary for the Vision 2020 to materialise. The resulting complete document is the WSRA Implementation Route Map that has recently been disseminated for comment among the Waterborne Community. Further consultation with the waterborne stakeholders is envisaged for the coming period, with the aim of producing the first edition of the Implementation Process document by the end of this year. As part of the responsibilities of the WATERBORNE™ a monitoring system of the results in terms of research outcomes - whether initiated at National, European or private levels - has to be developed as well as a methodology to fuse these future results with the Implementation Route Map. One essential role of WATERBORNE™ is to identify the RDI needs and to contribute with its Route Map to a coordinated effort for an efficient use of available resources.
In almost every sector of the Waterborne Community today, European companies are world leaders in innovative technologies, market share or turnover. A continuous and high-level RDI expenditure is necessary for the European companies to maintain their strong position in the medium and long term. The European waterborne industries spend therefore an important share of their turnover on RDI. A strong partnership between innovation leading firms, SMEs and the maritime research community forms the basis for an effective cluster. The waterborne stakeholders formed the WATERBORNE TP in the conviction that only a combined and focussed approach would generate the required RDI results. Their vision for the medium term was developed and presented to the Commission in February 2006 as the WATERBORNE TP Vision 2020 document.

The Vision 2020 targets were characterised under the WATERBORNE TP pillars of Sustainability, Competitiveness and Growth:

1. Safe, Sustainable and Efficient Waterborne Transport;
2. A competitive European Waterborne Industry;
3. Managing and facilitating the growth in transport volumes and the changes in trade patterns.

This Vision categorises qualitative measures of the waterborne sectors’ success by the year 2020, with the ambitious targets to be met and the related innovation challenges. These targets are not rigid and are subject to the feasibility of technological and economic development; they therefore represent the drivers and challenges for innovation towards 2020, not absolutes or deadlines.

The WATERBORNE Strategic Research Agenda (WSRA) Overview was produced and presented to the Commission in May 2006 to address the Vision 2020 targets and challenges. It contains a comprehensive list of WSRA priorities necessary to achieve the Vision targets.

The last part in this three-step approach is the implementation of the WSRA in the form of an “Implementation Route Map” for the period up to 2020 and prepared by a consolidation of a ‘bottom up’ development from the VISION targets and WSRA priorities, and a ‘top down’ assessment of product, service and infrastructure needs by industry.
3. Approach to the implementation of the WATERBORNE Strategic Research Agenda (WSRA)

The scope and the scale of the WSRA means that there is seldom a direct “one on one relation” between a WSRA Chapter and a particular Vision Target. The research priorities in the WSRA chapters cover a large number of activities or Research Topics.

Development Milestones are the major results that the Research Topics will deliver over a 5 to 15 year time scale and together create substantial new world leading product capability.

Exploitation Outcomes (EO), enabled by Development Milestones, show how the Waterborne WSRA programme results in concrete benefits in terms of the more abstract VISION 2020 targets.

The Exploitation Outcomes are defined as “Products, Services or Capabilities that can actually be delivered by the European Waterborne Industries that clearly enable and demonstrate achievement of the VISION 2020 targets”. They are the achievements of the coordinated investments in the WSRA Implementation by all the waterborne stakeholders.

Figure A shows the logic of this “Route Map” process, starting from the research priorities of the WSRA, and leading to the Exploitation Outcomes.
Figure B presents an overview of the logical structure and topology of the resulting Implementation Route Map (for the detailed Route Maps see Annex 1).
In this process, a number of considerations have played an important role:

**The Character of Systems Innovation:**
Innovation does not work to a rigid plan or necessarily proceed as a uniform linear process, but it must be managed given the level of investment in both knowledge and resources. WATERBORNE TP plans to cope with this by being open minded from the start and on the other hand treating the Implementation Route Map as a living document.

**The Different Types of RDI Activities:**
The WSRA encompasses all research issues relevant to the set of European waterborne targets. Thus it covers all types of RDI activities: Pre-Competitive / largely publicly funded with emphasis on (Fundamental/high risk) research, partly publicly funded (medium risk) or Competitive / mainly privately funded (close to market). Stakeholders participating in different types of activities may have different motivations and requirements, e.g. regarding the confidentiality of results. The implementation process must take all of this into account. It must estimate the magnitude and impact of the results, the technical challenge, the added value, the required development time and the required funding.

**The Need for Flexibility:**
In the build-up to a particular Exploitation Outcome many players address different parts of the Research topics. This will generate a world of results that will often not seamlessly match but nevertheless foster knowledge and innovation potential. Further external influences such as changing rules, new interpretations of the challenges and the development of new key technologies call for a flexible, creative research environment where continuous new thinking, re-focusing, adjustment of milestones and timescales are essential.

**The Route Map Consensus:**
There is consensus in the WATERBORNE TP discussions that the responsibility for the implementation of the WSRA lies with the members e.g. the individual companies and institutes as well as the public stakeholders at EU and Member State levels, and not with the management of the WATERBORNE TP. Furthermore, it is a matter of principle that Large Project Initiatives can only exist with the full support and participation of the main industrial players in a particular sector. This gives on the one hand evidence for the relevance of the project and on the other hand stimulates the participation of SME's.

*The Implementation Route Map results from consensus among the Waterborne Community.*
4. Implementation Route Map

The Implementation Route Map shows the main directions of the future RDI needs.

The Implementation Route Map intends to show the main directions of the future RDI needs, established by consensus among the WATERBORNE TP stakeholders in order to achieve the Vision 2020 targets.

As a first step in a “bottom up process”, the Research Topics needed to achieve the WSRA priorities were established.

As a second step, a “Top down” process led to a list of possible Large Project Initiatives.

Workshops were then held with the aim of identifying the corresponding Exploitation Outcomes and establishing the Implementation Route Map as described in Figures A & B.

See in Annex 1 for resulting Route Maps (overall and by Exploitation Outcome).

4.1 WATERBORNE Pillars Research Topics

The Research Topics, developed by the waterborne stakeholders to address the WSRA priorities and industry research needs, are arranged in the hierarchy under the Vision Pillars and the Research Priorities, using the following format:

<table>
<thead>
<tr>
<th>Vision Pillar</th>
<th>Strategic Research Agenda Priority</th>
<th>Expected Research Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research Topic</td>
<td>RESEARCH OBJECTIVES</td>
<td>TECHNOLOGY, TOOLS &amp; PROCESSES</td>
</tr>
<tr>
<td>Pre-requisites</td>
<td>RESEARCH PROGRAMME</td>
<td></td>
</tr>
<tr>
<td>Research Timescales</td>
<td>Budget requirements</td>
<td></td>
</tr>
</tbody>
</table>

The Research Topics details are presented individually in detail in Annex 2.
### 4.2 Exploitation Outcomes

Exploitation Outcomes are defined as “Products, Services or Capabilities that have been delivered by the European Waterborne Industry that clearly enable and demonstrate achievement of the Vision 2020 targets.”

The table below presents the Exploitation Outcomes that would achieve the Vision Targets.

<table>
<thead>
<tr>
<th>The Exploitation Outcomes:</th>
<th>Description of the expected exploitation outcomes</th>
<th>Pillar 1 Sustainability</th>
<th>Pillar 2 Competitiveness</th>
<th>Pillar 3 Growth</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. The Low Risk Ship</strong></td>
<td>An in depth understanding of the design and operation of ships from a risk based perspective allows for development and approval of low risk ships. Better risk control options for example, new structural solutions/designs providing improved collision and grounding resistance and damage stability control are available. The standardised approval processes for ships developed using risk based design and operation has reduced costs and improved risk management. A modernised regulatory framework has been approved at the IMO based on the safety-level approach together with appropriate acceptance criteria.</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td><strong>2. The Low Energy, Low Emissions Ship</strong></td>
<td>New efficient propulsion technology is integrated into innovative hull forms to dramatically reduce power requirements. Diverse power supplies are derived from ultra low emissions prime movers, fuel cells and renewable sources. Hybrid drives and intelligent power networks maximise the efficient use of energy.</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td><strong>3. The Autonomous Ship</strong></td>
<td>Next generation modular control systems and communications technology will enable wireless monitoring and control functions both on and off board. These will include advanced decision support systems to provide a capability to operate ships remotely under semi or fully autonomous control.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>4. The Sustainable Recreational Craft</strong></td>
<td>By 2020, recreational craft will offer better performance and be safer than current vessels, with lower through life costs and less total environmental impact. They will be more comfortable and easier to operate in crowded and difficult waters, all of which will ensure a greater market share for EU builders.</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td><strong>5. The Future Ship Designs For Short Sea Operations</strong></td>
<td>Dedicated Short Sea Ships will be essential links in environmentally friendly, integrated transport chains in and around Europe. Fast, highly automated ship/shore interfaces enable the most effective use of transport routes and port infrastructures. Sophisticated links to shore-based and inland waterway transport modes will provide the most efficient and cost effective transport system to meet the challenges of growth.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>The Exploitation Outcomes:</td>
<td>Description of the expected exploitation outcomes</td>
<td>Pillar 1 Sustainability</td>
<td>Pillar 2 Competitiveness</td>
<td>Pillar 3 Growth</td>
</tr>
<tr>
<td>---------------------------</td>
<td>--------------------------------------------------</td>
<td>------------------------</td>
<td>-------------------------</td>
<td>----------------</td>
</tr>
<tr>
<td>⑥ The European Cruise Ship</td>
<td>The Cruise Ship built in European Yards will maintain its world leading position by providing the best passenger recreation facilities, matched with the highest safety and security standards, while achieving the lowest per passenger emissions.</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>⑦ Seven Day Ship Design</td>
<td>By 2020 European yards will have developed a design environment enabling them to provide detailed designs in world leading minimum times, enabling the combination of ultimately tailor-made designs with minimal technical and commercial risk.</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>⑧ Leading Shipbuilding</td>
<td>By 2020 European shipyards will have perfected the flexible production process and the capability for full process control over distributed production locations. Retooling for new designs will be minimised, as will be time to market. European shipbuilders will be world leaders in energy efficient shipbuilding.</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>⑨ Energy Transport in Extreme Conditions</td>
<td>New highly specialised floating structures and vessel types will be produced by the European shipbuilding and offshore industries to meet the challenge of extreme conditions. The economic transport of energy to Europe from harsh climates and “hitherto un-navigable” waters will be possible.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>⑩ Intelligent Integrated Transport Network</td>
<td>A secure Web-based system of vessel and cargo tracking will be accessible to all operators and users, with unified rules for the transport of goods within the EU-27. Integrated ICT (Information and Communication Technologies) and ITS (Intelligent Transport Solutions) will enable efficient planning, booking, simulation, routing and control of cargo across different transport modes.</td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>⑪ Intermodal Waterways</td>
<td>The shipbuilding industry will provide collision proof ship designs with optimal hydrodynamic properties for maximum size transport units, with reduced risk and increased efficiency for new fleets of inland waterway vessels. New designs for integrated logistic concepts for Containers, Tankers, RoRo, Bulk and General Cargo enable cost effective transhipment between transport modes. Increased transport of goods on the inland waterways relieves congestion on road and rail, fostering incentives for international industrial investment.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>⑫ Accelerated Sustainable Port Development</td>
<td>A streamlined open planning process enabling efficient and timely infrastructure development. The impacts of natural causes and events, as well as by human intervention – construction, operations, etc – have been benchmarked for judgment and comparison.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
4.3 Large Project Initiatives

A number of the individual research programmes in the Implementation Route Map can be combined into larger scale programmes concentrated around a certain theme and spanning over several years. Such themes can be a guideline for a combination of EU, National and private sub-programmes, each with their own funding. To date fourteen potential combinations have been identified. They cover subjects such as: low emission ships, new propulsion systems and innovative transport modalities. Each of the combinations is detailed in Annex 3, including the expected results, the required time and the necessary funds. Like in the most recent consultation process, it is the intention of WATERBORNE™ to introduce these “Large Project Initiatives” as input for the coming FP7 and national research work programmes.
5. Financing the WSRA Implementation

5.1 What needs to be financed?

Since available information is neither exhaustive nor complete, an approximation based on the empirical relation of turnover and RDI expenditure is one way forward. Recent work by the European shipbuilding industry points to Research, Development & Innovation expenditures in the range of 9-11 percent of the turnover. An estimated 1 to 2 percent is spent on the “R” (basic and industrial research), involving the maritime universities and research institutes as well. In the offshore industry this part is likely to be higher, as well as in major parts of the marine equipment sector and the naval sector. Other sectors may have lower percentages of “R” expenditure. The turnover of the European maritime industry, largely represented in WATERBORNE™, is well over €200 bn. Only the (major) part of this turnover that is spent on hardware investment, as opposed to consumables and operational costs, is relevant in terms of the implementation of the WSRA. Furthermore the turnover figures have to be corrected for double accounting between the various actors. Taking this into account one can reasonably assume that given an average of 1.5 percent of the relevant turnover of the maritime cluster, yearly €0.5 bn is spent on Research (R). Companies will have to at least maintain this level of expenditure in the future to keep world leadership. In order to create the European maritime future as outlined in the WATERBORNE™ Vision 2020 document and in the WSRA, waterborne stakeholders expect that an extra effort will have to be made on specific complex and high risk issues. Given that the cyclical nature of any downturn leads to increased competition. This can only be countered by increased research now, leading to innovative European products and processes when they are needed. A conservative effort would be an increase with 10 to 15 percent, leading to an estimated €.65 bn to €.75 bn spent for research per annum.

5.2 Who finances the implementation?

It should not be forgotten that the funding for RDI activities, including research, comes in the vast majority from private sources. National maritime research programmes, regional and EU programmes (EU 7th Framework Programme (FP7) | Transport | Waterborne) offer important incentives through co-financing. In the FP7 covering the years from 2007 to 2013, the Transport theme amounts to €2.2 bn for all transport-modes. Assuming a funding of €3 bn to €4 bn for surface transport and an equal allocation of these funds over the modes, this provides around €0.450 bn for waterborne transport over the entire period i.e. around €70 M per annum. From different reports (including ERA.Net MARTEC) and sources, it appears that the EU27 members’ national funding of maritime research could amount up to €60 M per annum. Assuming that €.7 bn needs to be financed every year for the implementation of the ambitious WSRA, the graph presents the respective shares of the funding sources. European funds are predominantly used to support Pre-Competitive, Fundamental and Scientific Research, while Applied Research “close to market” is largely financed by private equity. To level the burden and to stimulate cross-border multi-party Research, an increase in National funding should be advocated.

*1.7 bn needs to be financed every year.*
Annex I: The Strategic Research Agenda Route Map

1. WSRA IMPLEMENTATION PROCESS

1.1 Route Map Objectives
1.2 Evolution of an Implementation Route Map
1.3 Update of the Implementation Document
1.4 WSRA Individual Route Maps
1. WSRA Implementation Process

1.1 Route Map Objectives

WATERBORNE™ is an initiative of all the stakeholders of the maritime community (associations, national authorities and the Commission) with the aim of stimulating coordinated maritime research at the European level. The WSRA is the consensus on the content of the necessary research to deliver the Vision 2020 targets. An important feature of the WSRA is that via the Route Map it brings STRUCTURE.

The Route Map will disseminate the research ideas and opportunities to the whole waterborne community for constructive analysis, debate and prioritisation, leading to the formulation of a robust Implementation Plan to deliver the Vision 2020 targets. The Route Map is essentially a snapshot in time of the progress of the Implementation Plan. It gives an overview of all the ideas and aspirations formulated by waterborne stakeholders and shows their relation to the achievement of the Vision Targets. In the real world the implementation plans will change as will the Vision targets, and the Route Map is a tool designed to disseminate information and keep track of progress in this changing environment.

1.2 Evolution of an Implementation Route Map

To use the WSRA Implementation Route Map to its full potential, it is of the essence that the key actors in European research engage in the development of the Route Map into a robust WSRA Implementation Plan. This will generate a clear understanding of which research projects are undertaken in Europe with relevance to the Vision targets and what results these research projects yielded in the actual achievement of these targets.

These research projects are to a large extent private sector financed and partly co-financed by either EU or national or regional programmes. To ensure the awareness of these projects it is essential that the parties (financially) supporting these projects like the Commission, national authorities or associations and most of all the industrial parties are willing to share this information, with a level of detail sufficient to make the impact on the overall Implementation understood.

The WATERBORNE™ agenda calls for the development of a management structure to promote this information exchange (projects and results) and to evaluate and map the extent of its impact on the implementation process. This could include participation of WATERBORNE™ in the review of EU, national or regional co-funded projects (the latter via the National Associations).
1.3 Update of the Implementation Document

The WSRA Implementation Route Map is a living document to be used as a tool to stimulate constructive debate in the European maritime community on the long term direction and research priorities of its stakeholders. It will be updated at regular intervals, not only with the actual research undertaken and the impact of the results on the implementation process, but developments in the world around us need to be addressed in the WSRA Implementation Plan. A formal review and re-issue of the WSRA Implementation Plan and the Route Map should be made annually leading to a three yearly review of the Vision targets.
1.4 Individual WSRA Route Maps

Route Map for EO 1 Low Risk Ship

TODAY

ONGOING PROGRAMMES

DEVELOPMENT MILESTONES

RESEARCH TOPICS

2020

EXPLOITATION OUTCOMES

VISION TARGETS

- Serious ship accidents in EU waters and by European vessels globally will be extremely remote.
- Ships designed and built in Europe will be crashworthy and will be able to operate and survive under the most severe conditions (e.g. freak waves, ice etc.).
- A risk-based regulatory framework will be operating, enabling the maritime industry to develop innovative and safe transport solutions.
- In 2020 the cost for sustainable, safe and secure waterborne transport will continue to be clearly lower than other transport modes.
**Route Map EO 2 Low Energy, Low Emissions Ship**

**TODAY**

**ONGOING PROGRAMMES**

**DEVELOPMENT MILESTONES**

**RESEARCH TOPICS**

**EXPLOITATION OUTCOMES**

**VISION TARGETS**

- Waterborne operations will have a clear perspective of the feasible and most economic systems for the propulsion of large ships as the supply of fuel oil reduces.
- In 2020 the environmental impacts of air and water emissions will be reduced drastically. Efficient and economic techniques will be available for onboard treatment of liquids and solid waste. The pollution impact of maritime accidents will be reduced to a minimum.
- Ships designed and built in Europe will be capable of disposal and recycling in a safe and environmentally friendly manner.

**PILLAR 1**

- Vessels produced in Europe will be the world's most advanced, have the lowest energy cost, life cycle cost and the highest customer focus.
- The European shipbuilding industry will continue to be the leader in the world market for high tech vessels (new and refurbished ships).
- Waterborne operations will have a clear perspective of the feasible and most economic systems for the propulsion of large ships as the supply of fuel oil reduces.
Route Map EO 3 Autonomous Ship

**PILLAR 1**
- Serious ship accidents in EU waters and by European vessels globally will be extremely remote.
- Ships designed and built in Europe will be crash-worthy and will be able to operate and survive under the most severe conditions (e.g. freak waves, ice etc.).
- Ships built in Europe will be equipped with on board systems for performance monitoring which are supporting safe operation and life cycle maintenance.
- In 2020 seamless monitoring, identification, communication and vessel traffic management systems will be operational around Europe to improve the coordination and efficiency of operations.
- In 2020 the cost for sustainable, safe and secure waterborne transport will continue to be clearly lower than other transport modes.
- In 2020 European deep-sea shipping will still be leader in maritime transport. European Short Sea Shipping and inland waterway transport will be the favourite choice and the backbone of many existing and new logistic transport chains.
- In 2020 Europe’s ship and boat builders as well as the marine equipment manufacturers will work at the world’s highest productivity level and will command the shortest lead and delivery times to defend their global competitiveness.

**PILLAR 2**
- In 2020 European deep-sea shipping will still be leader in maritime transport. European Short Sea Shipping and inland waterway transport will be the favourite choice and the backbone of many existing and new logistic transport chains.
- In 2020 Europe's ship and boat builders as well as the marine equipment manufacturers will work at the world's highest productivity level and will command the shortest lead and delivery times to defend their global competitiveness.
- Increased use of unitised cargo will offer enhanced streamlined transport operations, enabling Short Sea Shipping and inland waterways to cater for 50% of regional trade and feeder traffic between main and smaller ports.
- The larger numbers of recreational craft will be able to participate safely in waterborne traffic.
- Ships designed and built in Europe will be capable of disposal and recycling in a safe and environmentally friendly manner.
- In 2020 Europe’s ship and boat builders as well as the marine equipment manufacturers will work at the world’s highest productivity level and will command the shortest lead and delivery times to defend their global competitiveness.
- Vessels produced in Europe will be the world’s most advanced, have the lowest energy cost, life cycle cost and the highest customer focus.
- The European shipbuilding industry will offer interesting, motivating and desired professional careers for highly qualified people, without risk for health, safety and environment (HSE).
- In 2020 the European recreational craft industry will have strengthened its position as a global market leader in the production of sailing boats, powerboats and super yachts.
**PILLAR 1**

- In 2020 seamless monitoring, identification, communication and vessel traffic management systems will be operational around Europe to improve the coordination and efficiency of operations.
- Short Sea Shipping is fully acting as an alternative transport mode in the supply chain.

**PILLAR 2**

- In 2020 European deep-sea shipping will still be leader in maritime transport. European Short Sea Shipping and inland waterway transport will be the favourite choice and the backbone of many existing and new logistic transport chains.
- The European shipbuilding industry will offer interesting, motivating and desired professional careers for highly qualified people, without risk for health, safety and environment (HSE).
- In 2020 European ports are on the leading edge in the use of innovative cargo handling systems and overall efficiency.

**PILLAR 3**

- Increased use of unitised cargo will offer enhanced streamlined transport operations, enabling Short Sea Shipping and inland waterways to cater for 50% of regional trade and feeder traffic between main and smaller ports.
- Advanced logistic chain management systems and operational tools will be available, facilitating very fast sea/land interchange.
The Cruise Ship

- Serious ship accidents in EU waters and by European vessels globally will be extremely remote.
- Ships built in Europe will be equipped with onboard systems for performance monitoring, which are supporting safe operation and life cycle maintenance.
- A risk-based regulatory framework will be operating, enabling the maritime industry to develop innovative and safe transport solutions.
- Waterborne operations will have a clear perspective of the feasible and most economic systems for the propulsion of large ships as the supply of fuel oil reduces.
- In 2020 the environmental impacts of air and water emissions will be reduced drastically. Efficient and economic techniques will be available for onboard treatment of liquids and solid waste. The pollution impact of maritime accidents will be reduced to a minimum.
- In 2020 Europe’s ship and boat builders as well as the marine equipment manufacturers will work at the world’s highest productivity level and will command the shortest lead and delivery times to defend their global competitiveness.
- Vessels produced in Europe will be the world’s most advanced, have the lowest energy cost, life cycle cost and the highest customer focus.
- The European shipbuilding industry will continue to be the leader in the world market for high tech vessels (new and refurbished ships).
- The European shipbuilding industry will offer interesting, motivating and desired professional careers for highly qualified people, without risk for health, safety and environment (HSE).
In 2020 Europe's ship and boat builders as well as the marine equipment manufacturers will work at the world's highest productivity level and will command the shortest lead and delivery times to defend their global competitiveness.

- The European shipbuilding industry will continue to be the leader in the world market for high tech vessels (new and refurbished ships).
- The European shipbuilding industry will offer interesting, motivating and desired professional careers for highly qualified people, without risk for health, safety and environment (HSE).
- The EU maritime equipment industry will still be the favourite supplier of world shipbuilding and offshore operations. The export share will have increased further.
**PILLAR 1**
- Ships designed and built in Europe will be capable of disposal and recycling in a safe and environmentally friendly manner.
- In 2020 the cost for sustainable, safe and secure waterborne transport will continue to be clearly lower than other transport modes.
- In 2020 Europe’s ship and boat builders as well as the marine equipment manufacturers will work at the world’s highest productivity level and will command the shortest lead and delivery times to defend their global competitiveness.
- The European shipbuilding industry will continue to be the leader in the world market for high tech vessels (new and refurbished ships).
- The European shipbuilding industry will offer interesting, motivating and desired professional careers for highly qualified people, without risk for health, safety and environment (HSE).
- The EU maritime equipment industry will still be the favourite supplier of world shipbuilding and offshore operations. The export share will have increased further.

**PILLAR 2**
- Ships designed and built in Europe will be crash-worthy and will be able to operate and survive under the most severe conditions (e.g. freak waves, ice etc.).
- Safe offshore terminals and re-gasification plants will be available to satisfy increasing demand for LNG delivery to EU customers.
- The European shipbuilding industry will offer interesting, motivating and desired professional careers for highly qualified people, without risk for health, safety and environment (HSE).
- The EU maritime equipment industry will still be the favourite supplier of world shipbuilding and offshore operations. The export share will have increased further.
- In 2020 platforms and technologies to access marine resources in water depths exceeding 2000m and in extreme regions of the Arctic will be ready to use.
- EU operators will be the world leaders in commissioning offshore renewable energy installations.
- EU companies are the world leaders in design and construction of elements of the natural gas transport chain.
In 2020 the cost for sustainable, safe and secure waterborne transport will continue to be clearly lower than other transport modes.

Short Sea Shipping is fully acting as an alternative transport mode in the supply chain.

In 2020 European deep-sea shipping will still be leader in maritime transport. European Short Sea Shipping and inland waterway transport will be the favourite choice and the backbone of many existing and new logistic transport chains (HSE).

The European shipbuilding industry will offer interesting, motivating and desired professional careers for highly qualified people, without risk for health, safety and environment (HSE).

Inland waterway transport will be regarded as an efficient, modern, high tech transport mode.

In 2020 European ports are on the leading edge in the use of innovative cargo handling systems and overall efficiency.

Increased use of unitised cargo will offer enhanced streamlined transport operations, enabling Short Sea Shipping and inland waterways to cater for 50% of regional trade and feeder traffic between main and smaller ports.

Advanced logistic chain management systems and operational tools will be available, facilitating very fast sea/land interchange.
TABLE OF CONTENTS

1. Strategic Research Agenda

1.1 On-going Programmes

1.2 Development Milestones

1.3 Research Topics

1.4 Exploitation Outcomes

1.5 Vision Targets

2. Today

2.1 Risk Based Ship & Ship System Design

2.1.1 Accident & Incident Database

2.1.2 Risk Based Ship & Ship System Design

2.1.3 Environmental & Economical Maritime Security

2.1.4 Modular Control Systems

2.1.5 Automated Operations & Life Cycle Cost Reduction

2.1.6 New Generation Inland Navigation

2.1.7 Ship/Shore Systems Integration

2.1.8 Planning Tools for Logistics Chains & Hinterland Connections

2.1.9 Ports Network & Data Exchange

2.1.10 Cargo Logistic Management

2.1.11 Refinement of Environmental Regulation for Consistency

2.1.12 Effects of Climate Change on Waterborne Transport

2.1.13 Determination of Baseline to Measure Effects of Infrastructure Development

2.1.14 Understanding Potential Impact of Development

2.1.15 Non Invasive Measurement

2.1.16 Advanced Field Measurement Techniques

2.2 Goal Based/ Risk Based Frameworks

2.2.1 Implementing Goal Based/ Risk Based Frameworks

2.2.2 The Zero Accidents Target

2.2.3 The Crashworthy Vessel

2.2.4 Effective Waterborne Operations

2.2.5 Technologies for New Marine Operations

2.3 Interoperability between Modes

2.3.1 Interoperability between Modes

2.3.2 Advanced Field Measurement Techniques

2.3.3 New Generation Inland Navigation

2.3.4 Automated Operations & Life Cycle Cost Reduction

2.3.5 Planning Tools for Logistics Chains & Hinterland Connections

2.3.6 Cargo Logistic Management

2.3.7 Refinement of Environmental Regulation for Consistency

2.3.8 Effects of Climate Change on Waterborne Transport

2.3.9 Understanding Potential Impact of Development

2.3.10 Non Invasive Measurement

2.3.11 Advanced Field Measurement Techniques

2.4 Traffic Management Strategies

2.4.1 Traffic Management Strategies

2.4.2 Automated Operations & Life Cycle Cost Reduction

2.4.3 Planning Tools for Logistics Chains & Hinterland Connections

2.4.4 Cargo Logistic Management

2.4.5 Refinement of Environmental Regulation for Consistency

2.4.6 Effects of Climate Change on Waterborne Transport

2.4.7 Understanding Potential Impact of Development

2.4.8 Non Invasive Measurement

2.4.9 Advanced Field Measurement Techniques

2.5 Accelerated Development of New Port & Infrastructure Facilities

2.5.1 Accelerated Development of New Port & Infrastructure Facilities

2.5.2 Automated Operations & Life Cycle Cost Reduction

2.5.3 Planning Tools for Logistics Chains & Hinterland Connections

2.5.4 Cargo Logistic Management

2.5.5 Refinement of Environmental Regulation for Consistency

2.5.6 Effects of Climate Change on Waterborne Transport

2.5.7 Understanding Potential Impact of Development

2.5.8 Non Invasive Measurement

2.5.9 Advanced Field Measurement Techniques

2.6 More Effective Ports & Infrastructures

2.6.1 More Effective Ports & Infrastructures

2.6.2 Automated Operations & Life Cycle Cost Reduction

2.6.3 Planning Tools for Logistics Chains & Hinterland Connections

2.6.4 Cargo Logistic Management

2.6.5 Refinement of Environmental Regulation for Consistency

2.6.6 Effects of Climate Change on Waterborne Transport

2.6.7 Understanding Potential Impact of Development

2.6.8 Non Invasive Measurement

2.6.9 Advanced Field Measurement Techniques

3.2020

3.2 In 2020 the cost for sustainable, safe and secure waterborne transport will continue to be clearly lower than other transport modes.

3.3 Short Sea Shipping is fully acting as an alternative transport mode in the supply chain.

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3.9 Advanced logistic chain management systems and operational tools will be available, facilitating very fast sea/land interchange.
2.1.5.1 Environmental & Economical Maritime Security
- New environmentally friendly techniques are implemented for dredging of polluted sediments.
- In 2020 seamless monitoring, identification, communication and vessel traffic management systems will be operational around Europe to improve the coordination and efficiency of operations.
- In 2020 the cost for sustainable, safe and secure waterborne transport will continue to be clearly lower than other transport modes.
- The European dredging industry will remain the world’s leading technology provider and operator, offering the most advanced and environment friendly dredging methods.
- EU companies are world leaders in advanced rapid and low cost site investigation methods.
- In 2020 advanced scenario planning techniques for world trade growth and trade patterns estimations will be in common use to support public and private planning and investments.
Annex 2: Research Topics

1 INTRODUCTION ................................................................. 28

2 DETAILED RESEARCH TOPIC DESCRIPTIONS .............................. 29

2.1 Research Topics for Safe, Sustainable and Efficient Waterborne Operations ................................................. 29
  2.1.1 Implementing Goal/Risk Based Frameworks for Cost Efficient Safety ................................................. 29
  2.1.2 Towards the Zero Accident Target ........................................ 31
  2.1.3 The Crashworthy Vessel, Offshore Traffic Safety and Cargo Containment ......................................... 35
  2.1.4 Low Emissions Vessels and Waterborne Activities .................................................. 37
  2.1.5 Enhanced Waterborne Security .............................................. 42

2.2 Research Topics for a Competitive European Waterborne Industry .................................................. 43
  2.2.1 Innovative Vessels and Floating Structures ........................................ 43
  2.2.2 Innovative Marine Equipment and Systems ........................................ 47
  2.2.3 Tools for Accelerated Innovation .............................................. 50
  2.2.4 Next Generation Production Processes ........................................ 52
  2.2.5 Effective Waterborne Operations .............................................. 58
  2.2.6 Technologies for New & Extended Marine Operations ........................................ 61

2.3 Research Topics to Manage and Facilitate the Growth and Changing Trade Patterns ........................................ 65
  2.3.1 Accelerated Development of New Port & Infrastructure Facilities ........................................ 65
  2.3.2 Interoperability between Modes .............................................. 69
  2.3.3 More Effective Ports & Infrastructure ........................................ 70
  2.3.4 Intelligent Transportation Technologies and Integrated ICT Solutions ........................................ 73
  2.3.5 Understanding the Environmental Impact of Infrastructure Building and Dredging ........................................ 75

3 RESEARCH TOPICS SPONSORS .............................................. 79
The Implementation Route Map shows the main directions of the future RDI needs, established by consensus among the WATERBORNE TP stakeholders in order to achieve the Vision 2020 targets. As a first step in a “bottom up process”, the Research Topics needed to achieve the WSRA priorities were established. As a second step, a “top down” process led to a list of possible Large Project Initiatives as Research Topics.

Descriptions of the Research Topics developed by the WATERBORNE TP stakeholders to address the WSRA priorities and industry research needs are presented individually in this appendix. Not all of the Research Topics are fully developed proposals and there are inevitable overlaps as well as gaps in the coverage of the WSRA priorities. The Research Topics represent the ideas and aspirations for future research of the WATERBORNE TP stakeholders and as such constitute a valuable reference database as the starting point for the evolutionary Route Map planning process. This process will disseminate the research ideas and opportunities to the whole WATERBORNE TP sector for constructive analysis, debate and prioritisation to formulate a robust Implementation Plan to deliver the Vision 2020 targets. The Research Topics are presented using the following format:

<table>
<thead>
<tr>
<th>Vision Pillar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategic Research Agenda Priority</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Research Topic</th>
<th>RESEARCH OBJECTIVES</th>
<th>TECHNOLOGY, TOOLS &amp; PROCESSES</th>
<th>EXPECTED RESEARCH OUTCOMES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-requisites</td>
<td>Research Timescales</td>
<td>Budget requirements</td>
<td></td>
</tr>
</tbody>
</table>

The WATERBORNE TP stakeholders who have sponsored a particular Research Topic are given in section 3 as a reference to lead the development and integration of the activities into the Implementation Plan.

**Note:**

The Expected Research Milestones & Outcomes are the expected outcomes of a specific topic. They do not appear explicitly in the Route Map and are enablers of the Route Map Development Milestones singly, or in combination with the results of other Research Topics.

In turn, the Route Map Development Milestones are singly or in combination with the enablers of the Route Map Exploitation Outcomes.
2. Detailed Research Topics Description

2.1 Research Topics for Safe, Sustainable & Efficient Waterborne Operations

2.1.1 Implementing Goal/Risk Based Frameworks for Cost Efficient Safety

2.1.1.1 Goal Based Regulations and Approval

RESEARCH OBJECTIVES

The following main objectives need to become addressed before goal-based / risk-based regulations and approval are implemented:

• A modernized regulatory framework needs to be established at the IMO. This will be under the headline of the safety-level approach to goal-based standards, and it includes the debate on acceptable risk levels and public risk perception.
• Approval for risk-based designed ships and ship systems needs to be standardised following the first version developed by the running project SAFEDOR.
• Operation of risk-based ships needs to be addressed taking into account existing codes and practices.
• Smooth classification and port-state-control for risk-based ships needs to be enabled.

RESEARCH PROGRAMME

• Pre-requisites: Successful development of the SAFEDOR FP6 Research project and of those aspects of INTERSHIP and FLAGSHIP that are directly relevant to risk-based ship design
• Research Timescales: 2008-2020
• Budget requirements: to be determined

TECHNOLOGY, TOOLS & PROCESSES

• The current level of safety or risk for ship types
• Risk acceptance criteria related for human life and the environment
• Risk evaluation models for ship types and main ship systems including the necessary data
• Hull and ship operation monitoring system and data treatment for risk based maintenance regime
• A risk-based maintenance and inspection regime.
• Pilot applications to identify the effects of introducing risk-based goals into the regulatory framework for maritime transport
• Qualification scheme for review and approval personnel and training for PSC officers
• A risk-based ISM-code for application on a risk-based designed ship

EXPECTED RESEARCH OUTCOMES

2015 High level standards for development and approval of risk based rules / regulations for standard ships
A standardized approval for risk-based designed ships to reduce costs and improve quality
A modernized regulatory framework at IMO based on the safety-level approach together with appropriate acceptance criteria

2020 Standards for documenting the risk-based elements of ships; Industrial application of remote real-time monitoring, support and maintenance.
2.1.1.2  Risk-based Ship and Ship System Design

RESEARCH OBJECTIVES

• Risk-based ship and ship system design implementation entails substituting compliance with a set of safety rules/regulations with a set of safety objectives that necessitate functional requirements and design criteria to be verified by available knowledge
• Acceptable risk levels together with design scenarios with calculable probabilities and consequences to facilitate design
• Top-level functions and systems for each ship type and design criteria to satisfy relevant safety objectives
• Enhancing and benchmarking first-principles tools needed for verification of design criteria and functional requirements
• Derivation of knowledge-rich formula for use in early concept design
• System integration and standardisation of design scenarios

RESEARCH PROGRAMME

Ongoing Projects: GOALDS, FIREPROOF, SAFEICE, EXTREME SEAS
Research Timescales: 2008-2020
Budget requirements: to be determined

TECHNOLOGY, TOOLS & PROCESSES

• Verified and validated first-principles risk analysis tools
• Design parameter uncertainties distribution models
• Probabilistic corrosion predictive models
• Parametric models linking performance (in addition to hazards and functionality) to ship design and risk control options related parameters
• Integrated design environment based on specification from on going projects to facilitate fast and all-encompassing risk balance and design optimisation
• Automated multi-criteria, multi-objective optimisation schemes using genetic algorithms, aiming to balance safety, performance and functionality

EXPECTED RESEARCH OUTCOMES

2010  Probabilistic corrosion predictive modelling
2015  Complete pilot applications on knowledge-intensive and safety-critical ships
2.1.2 Towards the Zero Accident Target

2.1.2.1 Accident and Incident Data Reporting and Analysis

RESEARCH OBJECTIVES

• In order to demonstrate the benefit of ship’s systems redundancy and cost efficiency of the fail-safe manoeuvring and propulsion systems, a systematic experience feedback analysis is necessary.

• To complete feedback from operation, and to support risk analyses in the broadest sense, efforts are needed to the creation of databases for recording of waterborne accidents and incidents. However, existing schemes do not work nor deliver as expected and before starting new initiatives reasons for non-performance have to be identified.

• European solutions alone are not sufficient in this case and a worldwide approach should be envisaged with strong European leadership. Therefore, the second step involves developing and proposing a new common international injury reporting system (occupational health and safety), a new accident and near-accident reporting system to the IMO, and initial implementation by a voluntary pilot scheme, taking as an example the meteorological observation reporting organisation.

RESEARCH PROGRAMME

Pre-requisites: none
Research Timescales: 2008-2020
Budget requirements: to be determined

TECHNOLOGY, TOOLS & PROCESSES

• A new process to collect accident and incident data for vessels with European flag
• A novel data model for archiving accident and incident data
• A standard for reporting personal accidents, include injuries and ill health issues relating to working on ships
• A promotion for voluntary pilot scheme

EXPECTED RESEARCH OUTCOMES

2010
A data base structure able to contain those accidents and incidents structured by relevant scenarios and detailing causes, probabilities and consequences
A reporting and analysis demonstration

2015
A voluntary pilot scheme, analysis reports and an international information network
2.1.2.2 Systems Integration for Safety and Security

**RESEARCH OBJECTIVES**

Safety systems management can be enhanced through improving sensor technologies and alert algorithms used in monitoring systems. This will result in earlier and more dependable warnings. Where possible the alert systems should be married to automatic counter measures such as fire suppression. Hull and ship behaviour in waves can be monitored to provide information for optimised master operational decisions. New technologies such as smart valves should be developed to create self-healing systems. New materials and their innovative use will increase safety and decrease commercial risk by e.g. guaranteeing intrinsic fire survivability.

Next generation navigation systems on-board of commercial vessels need to be substantially improved in terms of track keeping accuracy. The objective is fully automatic control over the whole passage and docking. The track is prepared by local Vessel Traffic Services (VTS) & River Information Services (RIS) centres with detailed knowledge of the traffic situation. For track keeping in congested waterways a more precise and reliable positioning system than GPS is required. Galileo is the choice. Navigation and safety systems on-board recreational vessels need to be more user friendly with improved decision support systems.

**RESEARCH PROGRAMME**

**Pre-requisites:** Wide availability of Galileo, successful development of EC-DOCK and EFFORTS. National authority support for regulatory requirements.

**Research Timescales:** 2008-2020

**Budget requirements:** to be determined

**TECHNOLOGY, TOOLS & PROCESSES**

- Modelling of complex safety systems
- Standardised, maritime Intel communication and database technologies
- Global tracking and reporting of vessels & slot management based upon safety assessments of actual traffic situation and using VTS and RIS systems
- Coastal surveillance with high-definition radar sensors
- Autonomous underwater vehicles for survey operations
- Mobile CNRN sensors for cargo inspection at sea
- Ship assist systems including safeguarding shore approaches
- Offshore and on-board training of seafarers concerning port approaches
- Hull monitoring (overload, fatigue, corrosion) and ship behaviour at sea
- Simulation tools to model the interaction of relatively slow moving recreational craft with higher speed commercial traffic for application in regulated waters

**EXPECTED RESEARCH OUTCOMES**

- Better and faster operator decision making enabled in an increasing crowded and fast moving marine environment
- Demonstration of more reliable tools and systems providing industrial application of remote real-time monitoring, support and maintenance
- Better predictions and forecasts
- Recommendations to IMO
2.1.2.3 Survivability of Smaller Vessels in Extreme Weather Conditions

RESEARCH OBJECTIVES

Although safety at sea is regulated, the existing safety criteria, standards and regulations work quite well for large ocean-going ships, but in the case of small vessels, the existing stability regulations are not sufficient. The safety level is definitely unsatisfactory in the smaller ships category. This is proven by accident statistics, which indicate that annual casualties involving smaller vessels exceed several times those on large ships. Particularly alarming is the safety of fishing vessels, which constitutes the most acute and urgent problem.

The overall objective is to increase safety of small ship operations through development of criteria and standards preventing capsizing and foundering in extreme waves through:

- Theoretical analyses of physical phenomena
- Development of mathematical models and computer software
- Model tests
- Systematic numerical simulations
- Statistical analyses of real accidents versus "safe" ships
- Development of rational criteria preventing capsize
- Development of safety standards and regulations

RESEARCH PROGRAMME

Pre-requisites: none
Research Timescales: 2008-2020
Budget requirements: to be determined

TECHNOLOGY, TOOLS & PROCESSES

- Development of methods and practical tools for verification of ship form characteristics and examination of actual safety level
- Development and implementation of new standards. Application of new standards to existing ships and new designs
- Development of design methods and procedures for designers to ensure that the new designs satisfy the new safety standards
- Development of operational guidance on how to reduce the risk of capsizing in extreme waves for various types of smaller vessels
- Development of operational criteria
- Development of training methodology for fishermen

EXPECTED RESEARCH OUTCOMES

2010 Improved small vessel design, with robust intact stability and reduced risk of capsizing
Operational guidelines for individual types of ships, to enhance and supplement the inherent stability of the ships
Training instructions and crew training courses to educate the crews about basics of stability, safety and how to avoid critical mistakes

2015 On-board capsizing expert systems and other decision support systems
2.1.2.4 Operation in Ice Infested Waters

RESEARCH OBJECTIVES

Important oil, gas and mineral reserves have been proven in Arctic areas, and Arctic shipping routes look economically interesting for the future, for example the North-West passage and Barents Sea.

To develop EU traffic within these areas, the many difficulties for shipping in ice cover have to be solved. The ships must have much higher performance levels (propulsion power, manoeuvrability) than ships navigating only in open water and higher strength to withstand the high ice loads that act on the ship’s hull and machinery. It must also allow the operation of the deck equipment and adequate crew protection.

The Arctic environment is more sensitive than other regions. Ship design must prevent any rupture of the ship’s hull leading to environmental damage or at worst a total loss, in particular due to possible extensive icing in a combination with high wind speeds and low temperatures.

The following challenges will be addressed:

• Inexperienced crew in ice
• Improved self reliance of ships operating in difficult ice conditions such as compressive ice
• Better understanding of the power requirements encountered in ice conditions
• Improved fairway management in restricted waters such as harbours

RESEARCH PROGRAMME

Pre-requisites: None
Research Timescales: 2008-2020
Budget requirements: to be determined

TECHNOLOGY, TOOLS & PROCESSES

The following critical capability should be developed:

• Systematic risk analysis of ice navigation both in the Baltic Sea area and northern Russian Arctic. This should include analysis of the modelling methods of ice induced loads and their long term statistical characteristics together with evaluation of reliable methods for strength analysis, icebreaking loads and collision with floating growlers.
• Analysis of the development of a compressive ice situation. The occurrence probability of compressive ice situation should be systematically studied.
• Theoretical simulation models of ship movements in ice with proper verification by e.g. model scale testing ice tanks
• Effect of winterization on the crew and equipment onboard. Systematic analysis of human behaviour in cold climate and effects of icing on the equipments
• Systematic analysis of human behaviour in cold climate and effects of icing on the equipment
• Development of the simulation tools of ice navigation for training purposes of inexperienced crews to decrease the risks of winter navigation
• Design of rescue/evacuation systems/equipment for vessels in Arctic trade

EXPECTED RESEARCH OUTCOMES

2010 Requirements to navigate in convoys behind an icebreaker with short distance between the ships
Risk models to classify the risks along various routes

2015 Commercial large icebreaker ships design,
Recommendations and criteria for different routes
Specific rescue/evacuation systems for Arctic trade

2020 Training tools for crews involved in arctic ice infested waters. Ship accident risk management system to prevent pollution
2.1.3 The Crashworthy Vessel, Offshore Traffic Safety and Cargo Containment

2.1.3.1 Research with Respect to Collision and Grounding

RESEARCH OBJECTIVES

To improve the safety of navigating in the coastal waters and the inland waterways of the EU-25 and for ships under EU flags in all waters.

With intensified traffic, larger unit sizes and increased dangerous goods’ movements, there is an increased need for improved traffic safety and accident management. By ensuring the acceptability of larger transport units, the European companies and consumers will benefit from reduced transport costs.

The research objectives are to gain more insight into the following aspects:
• Collision and Grounding Scenario Research
• Consequences versus the transported cargo and accident area
• Emergency measures to prevent or minimize accident consequences

In this respect the focus of the project is to analyse the ship collision and grounding scenarios and typical leakages versus ship types.

RESEARCH PROGRAMME

Pre-requisites: none
Research Timescales: 2008-2020
Budget requirements: to be determined

TECHNOLOGY, TOOLS & PROCESSES

• Technology to support (accurate and compulsory) reporting of accidents
• Development of databases for realistic accident scenarios and probabilities
• Development of mathematical models for accidents and consequences
• Research into typical failure of vessel systems
• Development of mathematical models for cargo spills (including arctic conditions)
• Development of scripts/scenarios for emergencies ensuring minimum impact to environment
• Pollution control solutions for sea-lanes, coastlines, estuaries and inland waterways
• European database and shipping safety modelling

EXPECTED RESEARCH OUTCOMES

2010 Availability of databases containing scenarios and probabilities of collision and grounding events for the use of regulators and designers

2015 Availability of cargo spill models and EU emergency action recommendation to minimize human and environmental consequences
2.1.3.2 Failure Mechanism Research and Modelling

RESEARCH OBJECTIVES

The risks of environmental pollution or loss of life as a consequence of collision and/or grounding events could be mitigated by improving the crashworthiness of ship structures. The objective would be to reduce significantly the extent of damage for a specific incident scenario and reduce the consequential risks of:

• Flooding leading to sinking
• Flooding leading to loss of stability and capsize
• Outflow of oil and other harmful substances
• Break up of the hull into several parts

In this respect the focus of the project is to analyse the integrity of the ship hull with respect to the containment of the cargo after crash. For low energy collisions and groundings the ship structure should be designed to absorb damage without loss of integrity.

The research objectives are to gain more insight into the following aspects:

• Failure Mechanisms Research and Modelling
• Residual strength of damaged liquefied gas carriers, chemical carriers and tankers

RESEARCH PROGRAMME

Pre-requisites: none
Research Timescales: 2008-2020
Budget requirements: to be determined

TECHNOLOGY, TOOLS & PROCESSES

• Technology to support (accurate and compulsory) reporting of ship hull accidents
• Theoretical tools which have been calibrated against model or full scale experimental data to provide confidence
• Development of crashworthy designs tailored to cope with realistic accident scenarios
• Research into failure mechanisms of vessel systems
• Simulation tools to model the collision/grounding ship hull behaviour
• Probabilistic methods where appropriate
• Design load and criteria to ensure collision/grounding ship hull resistance

EXPECTED RESEARCH OUTCOMES

2010 Structural solutions/designs providing improved collision and grounding resistance
Analysis tools which have been tested and calibrated which are recognized as being best practice
EU recommendations for collision / grounding-resistant ship hulls
2.1.4 Low Emissions Vessels and Waterborne Activities

2.1.4.1 Marine Fuel Cell - Fuel Operation Test Facility

**RESEARCH OBJECTIVES**

Fuel cells with efficiencies up to 70% are being developed for land-based applications running on natural gas. Marinisation of this technology will significantly reduce marine power system emissions and provide clean, efficient power sources for niche marine applications. Widespread application of fuel cells in power propulsion requires the development of a cost effective diesel oil re-formation technology.

The marinisation, fuel reformation and power systems integration of high power (>250 kW) marine fuel cells needs to be developed in shore based test facilities. These will simulate ships’ power system and operation to optimise the design and operation of fuel cells for harbour power generation and auxiliary power supplies. The prototype fuel cell system will then be demonstrated in an operating vessel. The practical application of the fuel cell as a prime mover on an inland vessel is one possibility as well as for auxiliary power units on local ferries and luxury yachts. 250 kW is a realistic starting point for such applications.

**RESEARCH PROGRAMME**

**Ongoing projects:** MC-WAP, FELICITAS

**Research timescales:** 2008 - 2020

**Budget estimates:** to be determined

**TECHNOLOGY, TOOLS & PROCESSES**

- Critical technologies include
- Fuel processing and storage system design
- Fuel reformation pilot plant development and operation
- Integration of fuel cells into ships power system
- Transient load and part load performance optimisation of fuel cell systems
- Whole system energy efficiency measurement and analysis
- Prototype marine application specification and design

**EXPECTED RESEARCH OUTCOMES**

**2010** Pilot fuel processing/reformation plant operation
Development fuel cell power system operation

**2015** Prototype marine fuel cell APU sea trials
2.1.4.2 Fuel Supply and Fuel Systems

RESEARCH OBJECTIVES

The maritime industry has relied on the use of fuel oil as a source of energy for decades because of its low cost. The amount of resources required for high viscosity (heavy) fuel oil treatment, with its deteriorating quality, is of concern from the viewpoint of environmental impact, manpower and engine lifetime. At present expensive measures are used to improve fuel handling, combustion characteristics and emissions that negate the low cost of heavy fuel oil.

Fuel processing and alternative fuels should be considered for the purpose of cost reduction and environmental benefits for shipping, including coastal and inshore and inland shipping. The use of alternative fuels such as RME, LNG, Methanol, and LPG needs research regarding their application and technical standards. Technology transfer from automotive and clean land based local power generating systems should be investigated. Research is required into the reformation of diesel fuel and removal of sulphur and other contaminants for future marine fuel cell applications.

RESEARCH PROGRAMME

Ongoing projects: Successful development of the HERCULES and HERCULES B

Research Timescales: 2008-2020

Budget requirements: to be determined

TECHNOLOGY, TOOLS & PROCESSES

• Fuel treatment
• Fuel supply infrastructure analysis for deep sea, coastal and inland shipping
• Alternative fuels; Methanol, LPG, Biofuels e.g. Rapeseed Methyl Ester (RME)
• Environmental analysis
• On board fuel storage technology
  • Compressed Natural Gas (CNG)
  • Liquefied Natural Gas (LNG)
  • Hydrogen
• Diesel reformation
• Life Cycle Cost (LCC) modelling including a variation of the fuel cost in medium and long term
• Classification and safety work
• Improved treatment of fuel by the fuel supply chain

EXPECTED RESEARCH OUTCOMES

2015 Prime movers operate on low sulphur fuels
Prime movers able to operate on synthetic oils and fuels
Diesel oil reformation technology commercially available
2.1.4.3 Eco-Ship Systems

**RESEARCH OBJECTIVES**

To minimise the impact on eco-systems by ships by minimising waste and water residuals and discharges into water and by developing technology and designs for the next generation of efficient and environmentally friendly vessels, particularly cruise and Ropax, whilst aiming at reduced operational and maintenance costs.

For the expanding fleet of smaller recreational vessels, developing technology and designs for efficient and environmentally friendly vessels are also necessary.

A holistic approach to energy, waste reduction and waste management needs to be developed. We must explore how one systems’ waste can be used as an input to the other. Flue gas cleaning systems need to recover waste heat, and waste water can be used in diesel engine injection systems in order to reduce NOx. New approaches are required for the management of ballast water. We need to develop new materials and treatments to improve ease of recycling and reduce anti fouling contamination. Additionally the use of renewable materials and re-cycling needs to be investigated.

**RESEARCH PROGRAMME**

**Pre-requisites:** Successful completion of the BAWAPLA FP6 ballast treatment research project

**Research Timescales:** 2008-2020

**Budget estimates:** to be determined

**TECHNOLOGY, TOOLS & PROCESSES**

- Research, develop and validate innovative vessel designs with low environmental impact and reduced or no dependency on ballast
- Address in a holistic approach all waste sources (e.g. black water, sewage, grey water, shower, sink and galley water, hazardous waste, solid waste, oily bilge water) as well as ballast water treatment
- Explore the synergies of energy recovery and emissions reductions.
- Develop and validate economic, efficient and robust anti-pollution processes, technologies and systems

**EXPECTED RESEARCH OUTCOMES**

**2010** Verifiable reduced impact on eco-systems as compared to existing vessel types
- Validated marketable designs of ballast-reduced or ballast-free vessels
- Solutions for bio-pollution and anti-fouling contamination of water
- Innovative designs and logistic chain developments leading to reduced dependency on ballast
- The recovery of energy from organic waste and flue gas to operate the on-board waste treatment systems
2.1.4.4 Minimising Wash, Noise and Vibration

**RESEARCH OBJECTIVES**

Further advances, especially but not exclusively, in the recreational craft sector, are required to reduce wash, internal and external noise and vibration and the overall environmental impact of the vessel.

Research is required into sources of noise and vibration (including analysis of the complete drive train, exhaust system and behaviour of the hull), internal and external propagation mechanisms (including propagation over long distances, the land water interface and underwater), mitigation strategies and design rules to minimise the need for post construction compliance testing.

Research is required in hull and propulsion system to reduce wash and the resulting environmental impact to sensitive eco systems.

**RESEARCH PROGRAMME**

- **Pre-requisites:** None
- **Research Timescales:** 2008-2020
- **Budget estimates:** to be determined

**TECHNOLOGY, TOOLS & PROCESSES**

- Research, develop and validate intelligent vibration and shock control methods, new cost effective design methods for the minimisation and prediction of on board noise and vibration and new methods for the design and analysis of wet exhaust systems.
- Research innovative vessel design with a minimal noise and vibration to be achieved by means of an improved understanding of the sources of marine noise vibration and propagation mechanisms, an improved understanding of the nature of nuisance noise in terms of character and level and the development of strategies and technologies for the minimisation of noise.
- Improved hull and propulsion system design resulting in reduced wash and environmental impact

**EXPECTED RESEARCH OUTCOMES**

- **2010** Design rules for the accurate prediction of noise emissions obviating the need for post construction compliance testing 50% reduction of noise impact on the environment Wash height reduced by 10% for specified Froude numbers
- **2015** Further contributions to the development of recreational craft noise and vibration standards On board noise and vibration levels approaching automotive standards
2.1.4.5 The Future Sustainable Recreational Craft

RESEARCH OBJECTIVES
The recreational craft industry needs to produce vessels that have minimum environmental impact whilst sustaining or improving upon current levels of functionality, accessibility and customer appeal. Producing the sustainable recreational craft of the future requires the use of more efficient power and propulsion systems (including regenerative hybrid diesel/electric drives), and innovative sail design, reduced overall power consumption, minimal emissions to both air and water, together with low noise, vibration and wash. The long-term environmental impact of recreational craft manufacturing processes and constructional materials will be reduced and their ultimate disposal or recovery optimised. New design and analysis tools will support the integration of these individual elements into the final product and will optimise life cycle costs. Improved instrumentation and decision support systems will be developed to improve safety in crowded waters.

Technology transfer from other sectors will be an important part of all the research programmes with the intention of using collaboration to reduce risk, accelerate the innovation process and reduce the time to market for the research outcomes. To demonstrate the practicality and viability of the outcome it is intended that results of the various research elements will be demonstrated in a new vessel design.

RESEARCH PROGRAMME
Pre-requisites: None
Research Timescales: 2008-2020
Budget estimates: 10 MEuro

TECHNOLOGY, TOOLS & PROCESSES
• More efficient power and propulsion systems
• Improved structural analysis, materials selection and manufacturing processes
• Improved safety and accessibility
• Tools for life cycle analysis including integrated waste management, end of life disposal and materials recovery
• Design and construction of a demonstration vessel integrating the research outcomes

EXPECTED RESEARCH OUTCOMES
2010
- Analytical tools – 20% reduction in overall vessel weight; 50% reduction in noise; automotive levels of internal noise and vibration.
- Tools for life cycle analysis – 100% of materials to be recycled on disposal
- Sustainable materials and manufacturing processes – 30% reduction in energy and carbon tariffs, and through life costs.
- Integrated waste management systems – emissions to air reduced ahead of legislative demand, to water by 80%.
- Alternative propulsion and power systems – Overall fuel consumption reduced by 25%, whilst meeting noise, vibration and weight targets.

2015
- Improved instrumentation, navigation, decision support and safety systems – zero collision between recreational and commercial craft; 50% improvement in accessibility for the elderly and disabled.
- A demonstration craft illustrating the opportunities and improvements created by the research programme.
2.1.5 Enhanced Waterborne Security

2.1.5.1 Environmental and Economic Maritime Security

RESEARCH OBJECTIVES

Definition of functional requirements for a pan-European solution:
Dozens of actors rule maritime security. Each country has set up a system covered by more than five, and up to eleven different agencies.

Development of practical solutions for long range maritime security:
The European maritime area is larger than the terrestrial zone (roughly 5 million m² compared to 4 million m²). 90% of this enormous zone is not permanently monitored.

Development of practical solution to integrate existing systems and sensors

Preservation of existing national operational culture:
Member States have developed throughout centuries their own way to survey and act. These national systems have roots in national and even regional culture. The project shall come up with solutions able to preserve every national culture to secure the seas.

Development of a “Think global, act local” process:
The Waterborne Platform is a unique attempt to gather all the European maritime actors. The project shall pursue this integrative process, and ensure that all social, environmental and economic aspects of maritime security will be taken into account.

RESEARCH PROGRAMME

Pre-requisites: On-going specifications definition carried out by EU agencies (EMSA and FRONTEX)
The gaps identified by the Preparatory Action in the Field of Security Research (PASR), Industry and RTOs

Research Timescales: 2008-2020

Budget requirements: to be determined

TECHNOLOGY, TOOLS & PROCESSES

Monitoring and Data Logging
• Inter-agency communication networks
• Information, crisis prediction & recovery engines
• Automatic tracking of goods
• Cargo inspecting strategies

Simulation models identifying critical points in the waterborne network and crisis management strategies
• Monitoring of incidents
• Improved decision support systems

Development of Efficient and Economically Viable Security Strategies Equipment and Specialised Vessels
• New vessel stabilization systems (SWATH)
• Modular missions packages (for customs, police, coast guards, )
• Unmanned vehicles (UUV, USV)
• Integration on platforms
• Payload (set of sensors)

EXPECTED RESEARCH OUTCOMES

2010 Improvement of environment protection: To detect and react whatever the weather looks like.
To provide instantaneously a common operational picture to all actors as well as a “control tower” tool, avoiding any other “Erika” way of dealing with massive pollution.

2015 Improvement of fishing monitoring: Real-time localization map of fishing vessels, able to monitor 100% of all the fishing activity in Europe’s seas.

2020 Improvement of security harmonization: A room for interoperability, joint formation and common equipment.
2.2 Research Topics for a Competitive European Waterborne Industry

2.2.1 Innovative Vessels and Floating Structures

2.2.1.1 Future Ship Designs for Short Sea

RESEARCH OBJECTIVES

The next European Short Sea Fleet generation must provide improved ships for enhanced European logistic chains, meeting the challenges of a growing and increasingly competitive transport market, and of societal demands for safety, security and environmental sustainability. New ship concepts and new concepts in collaborative ship design and production will be needed to secure industry’s competitiveness and its role as leading builder and maintainer of the European Short Sea Fleet of about 10,000 ships. Maintaining an efficient European Short Sea Fleet therefore needs to be addressed at the European level by the European shipbuilding industry.

The aim is to obtain a breakthrough in Short Sea Ships design, production and operation for at least 60% of the Short Sea Fleet that will enable ship owners to obtain efficient ships at competitive prices & delivery times. New Short Sea Ship concepts in future logistic chains will compete with road transport, without jeopardizing safety and the environment.

RESEARCH PROGRAMME

Pre-requisites: none
Research Timescales: 2008-2020
Budget requirements: to be determined

TECHNOLOGY, TOOLS & PROCESSES

New Short Sea Ship concepts:
• Lifetime maximum energy efficiency, low emissions, low maintenance
• New cargo handling and ship/shore interface systems
• Safety of containers on deck, roro cargoes,
• Development of voyage planning systems to fit the transport chain

Requirements for intensive traffic in limited waters and for new northern routes:
• Innovative hull forms with optimal hydrodynamic performance
• Safe, reliable and energy efficient propulsion trains and manoeuvring systems
• Navigation and automation including E-navigation principles,
• Innovative ship structures: optimal weight/cost performance & crashworthiness

Reduction of lead-time/costs through standardisation and modularisation:
• Design variants for each ship type
• Innovation in design, manufacturing, assembly and outfitting processes
• New concepts for collaborative shipbuilding and supporting tools for efficient shipbuilding process execution and control.

EXPECTED RESEARCH OUTCOMES

• Improved environmental and economic performance Short Sea fleet
• Consolidate Short Sea Shipbuilding collaborative practices in Europe based on effective supply chains with reduced lead time and costs
• Shortened response time to changing market and societal requirements
• European leadership as primary provider of Short Sea Ships
2.2.1.2 BESST: Breakthrough in European Shipping & Shipbuilding Technology for Cruise & RoPax

**RESEARCH OBJECTIVES**

The research objectives are to develop next generation cruise and RoPax ships with significantly reduced environmental impacts and operational costs, less energy consumption, waste and crew onboard in order to defend and improve their world leadership in this important market segment. European shipbuilders need to offer their customers continuously improved products, in terms of “value for money”. During the last ten years the trend has been to develop larger ships. This scale effect provides potential for change in the technologies to be used onboard of the next generation ships. To take full advantage of this European shipbuilders must take the lead in the development of goal-based regulations.

The producers must also improve their design and production techniques in order to offer their products at competitive prices. Competitiveness for the customer depends on the specific market, economic and environmental boundary conditions and on the strategies of specific customers and markets. Hence it is not possible to develop one specific “competitive cruise ship or ferry”. The Research Objectives are therefore to develop a set of high-tech solutions for specific ship systems, for integration into optimum overall products with regard to ship sizes or types.

**RESEARCH PROGRAMME**

Pre-requisites: none
Research Timescales: 2008-2020
Budget requirements: to be determined

**TECHNOLOGY, TOOLS & PROCESSES**

The following sub-goals (and technologies) are envisaged for a competitive ship:

- Reduced environmental impact (low emissions, no waste, recycling)
- Increased energy efficiency (hull form, propulsion chain, auxiliary engines)
- Increased safety and security (hull structures, manoeuvring, emergency handling, decision support, monitoring systems.)
- Modelling of flooding and related emergency responses
- Optimum system redundancy through goal/risk based design
- Increased passenger welfare (comfort, onboard logistics)
- Reduced crew size (ship management systems/automation)
- Increased payload and space (hull structures and compartmentation)

**EXPECTED RESEARCH OUTCOMES**

- Safety and security in the operation of cruise and ferry ships will be further improved
- Environmental impact of cruise and ferry ships will be reduced
- Technological leadership of the European Waterborne stakeholders in design, engineering and manufacturing of advanced innovative product solutions will be maintained.
- Closer interaction between shipyards, system suppliers and technology providers will be realised

Implementation of the Waterborne Strategic Research Agenda - Route Map 2011 - Annex II
2.2.1.3 Future Advanced Hull Structures

**RESEARCH OBJECTIVES**

New and harsh environments, call for new structural solutions. Larger units on (shallow) inland waterways call for higher integrity and collision and grounding resistance. New thermally or chemically aggressive cargos will challenge present design solutions and call for new materials and coatings. Their introduction into the shipbuilding industry calls for systematic investigation and testing. Fast recreational vessels require the development of analytical tools for hull load prediction to optimise structure, materials use and scantlings.

In this respect the research objectives are:

- To address the issue of goal based regulations in order to enable an optimal approach to design for new materials and new load environments
- To develop the tools and models for the description and analysis of loads and structural response fit for the needs of goal based regulations
- To further develop, explore and introduce new materials and new structural configurations (sandwiches)

To address current and upcoming problems in surfaces and structures by developing new materials, new joining and new production methods to increase the competitiveness of European maritime transport.

The consequences of using new material concepts in the production shall be taken into account. Key performance indicators are structural performance as well as building costs.

**RESEARCH PROGRAMME**

**Ongoing projects:** MARSTRUCT

**Research Timescales:** 2008-2020

**Budget requirements:** to be determined

**TECHNOLOGY, TOOLS & PROCESSES**

The description of loads and structural response merits further development and verification.

- Eulerian and Lagrangian codes such as FEM, SPH, VOF
- Statistical approach to lifecycle load exposure
- Failure mechanisms in fatigue, collision, mechanical or thermal shock
- Through-life monitoring of structural performance

New materials need new technologies:

- New standards for duplex material and composites
- Verification of corrosion resistance and mechanical properties
- Improvements in LNG insulation are required
- Improvements in the speed of panel line welding and deformation control by innovative hybrid laser welding

**EXPECTED RESEARCH OUTCOMES**

- Goal based approach in Class and authority rules
- Innovative solutions in composites and matrices
- New light metals for shipbuilding with durable use qualities
- Intrinsic fire survivability in as-built composite structures
- Efficient manufacturing methods for new polymers and composites
- Integrated intelligent systems to monitor the health of structures during their service life
- Smart self-monitoring and self-repairing materials
2.2.1.4 Life Cycle Philosophy

RESEARCH OBJECTIVES

Research in the environmental and economic impact of vessels throughout their life cycle with the aim of delivering maximum value and minimal environmental impact from production to eventual disposal. Life cycle tools and strategies need to be developed which are compatible with the way the maritime industry is operating.

Further research is required into the logistics of disposal, initial materials selection to optimise the opportunities for recovery, reuse and reduce the energy costs of recycling.

RESEARCH PROGRAMME

Ongoing projects: Through Life
Research Timescales: 2008-2020
Budget estimates: to be determined

TECHNOLOGY, TOOLS & PROCESSES

New tools to allow the analysis of the environmental and economic impact of vessels to be assessed from production through operation to end of life disposal, and the integration of such analysis into industrial application.

New tools, methods and technologies for the integrated management and deconstruction of out of service vessels, including the modelling and evaluation of materials flows and recycling methods and the development of business models and strategies for cost effective implementation.

EXPECTED RESEARCH OUTCOMES

Integrate life cycle research into real life industry applications to increase competitiveness of the maritime industry.
2.2.2 Innovative Marine Equipment and Systems

2.2.2.1 More Efficient Propulsion

RESEARCH OBJECTIVES

The primary requirement for merchant ships is very high efficiency combined with low levels of propeller cavitation, noise and vibrations. Integrated hull and propulsor design is required to optimise these simple configurations under all conditions, including during manoeuvring. Significant increases in efficiency will require more complex propulsor configurations or radical new concepts such as biomechanical designs. New propulsion system designs are needed for mechanical and electric drive. New hull forms such as trimaran, pentamaran and swath will require optimum propulsion system designs specifically developed for those applications.

RESEARCH PROGRAMME

Ongoing projects: STREAMLINE, POSEIDON, HYMAR

Research timescales: 2008 - 2020

Budget requirements: to be determined

TECHNOLOGY, TOOLS & PROCESSES

- Large area propulsors integrated into new optimised hull designs with efficient robust actuator technology
- Distributed propulsion concepts
- New high efficiency propulsor applications using, for example drives with integrated rudder systems.
- Prediction methods for operation in off-design conditions
- Integration of the prediction methods for ship propulsion, manoeuvring, and propulsor cavitation characteristics
- Higher-efficiency waterjets for HSC ships
- Pods for new trimaran and pentamaran ship concepts
- Robust propulsor designs to operate in ice

New designs need to be integrated with other technologies and features to enhance the concept applications.

- Modular design of pods for in service replacement
- Rim driven propulsors and thrusters
- Low vibration and light weight water jet designs for HSC ships
- New non-metallic propulsor materials
- High efficiency propulsion systems for inland vessels, optimised for operation under shallow water conditions

EXPECTED RESEARCH OUTCOMES

2012 Large scale bio-mechanical propulsors demonstrate big efficiency gains
2012 Propulsor design integrated with hull design models
2015 Large area propulsors integrated into new SSS designs
2.2.2.2 Prime Mover Development

RESEARCH OBJECTIVES

Further advances in prime mover efficiency are still possible over the high efficiencies achieved today, through the development of more capable materials allowing higher operating temperatures and pressures. Typical applications would include turbochargers and injection systems. Engines must be designed for multi-fuel capability to enable efficient operation on new cleaner fuels. Future engines will have intelligent adaptive control systems optimising their operating parameters for fuel type and emissions, ambient conditions and load.

RESEARCH PROGRAMME

Ongoing projects: HERCULES, HERCULES B, CLEANENGINE
Research timescales: 2008 - 2020
Budget estimates: to be determined

TECHNOLOGY, TOOLS & PROCESSES

The following topics are major technology areas to be addressed.

• Medium speed 2 stroke engines
• Injection systems and intelligent engine management
• New high temperature materials
• Combined cycle systems
• Recuperator and heat exchanger design for long life in the marine environment

EXPECTED RESEARCH OUTCOMES

5 Years
• New high temperature engine materials

10 Years
• Prime movers able to operate on synthetic oils and fuels
• Adaptive engine management systems
2.2.2.3 Next Generation Power and Propulsion Concepts

**RESEARCH OBJECTIVES**

Energy efficient power management and propulsion system designs are required for hybrid multiple engine/drive installations. System modelling tools are required to analyse the performance of a range of propulsion options for different vessel designs, operating characteristics and whole product cycle environmental impact and cost, in order to optimise the design at system level. Case studies of propulsion system life cycle costs (LCC) will provide operating databases and model validation. The range of vessel types and their applications is constantly expanding. Operators require machinery systems with higher power density, efficiency and greater flexibility in design and operation, all at lower cost. Whilst improvements to existing technologies will meet some of these requirements, radical changes in the powering and propulsion plants will be necessary to meet the current and future environmental legislation. Expansion of electric propulsion options with increased efficiency and environmental benefit could be achieved by the adoption of high power fuel cells. Alternative energy sources can be developed through photovoltaic and wind/wave energy conversion technology for propulsion, for hybrid electricity generation systems and energy storage through hydrogen production.

**RESEARCH PROGRAMME**

Ongoing projects: POSEIDON, HYMAR, SUPERPROP, BESST, KITES, HELIOS

Research Timescales: 2008-2020

Budget requirements: to be determined

**TECHNOLOGY, TOOLS & PROCESSES**

Power management for multiple engine/drive installations.

- Engine load/efficiency optimisation
- Intelligent electrical power management systems
- Fuel cell system applications
- Propulsion system option Cost Benefit Analysis models
- Hybrid electric/mechanical drives
- Full electric propulsion
- Availability, Reliability and Maintainability models
- Risk analysis and redundancy optimisation
- Life Cycle Cost (LCC) modelling
- Alternative energy sources & energy storage
- Photovoltaic conversion
- Sail design
- Wind/wave energy conversion
- Hydrogen production and storage
- Case studies of propulsion system LCC to provide operating databases and model validation
- Options for extension and optimisation of operating life
- The whole product cycle environmental impact

**EXPECTED RESEARCH OUTCOMES**

Validated optimum propulsion system design models

New propulsion system configurations with minimum LCC

Opportunities for insertion of alternative energy sources
2.2.3 Tools for Accelerated Innovation

2.2.3.1 State of the Art Design and Analysis Tools

RESEARCH OBJECTIVES

Tools for Accelerated Innovation are a cross industry topic, addressing virtually all stakeholders in the Waterborne platform. Unified development will be a major asset in facilitating communication between parties in the industry. The tools required are:

• Advanced design tools
• Knowledge management
• Simulation software for process acceleration and minimising risk.

Research is needed to:

• Acquire ability for fast identification and evaluation of new knowledge and inventions regarding their possible use to improve or totally renew products and processes
• Shorten the time required to implement new knowledge or inventions into the design of improved or new products and processes
• Benchmark improved or new products and processes against existing relevant rules & regulations, propose modified/new if necessary
• Create conditions for shortening the time needed to implement these designs in terms of human skills, production facilities etc.

RESEARCH PROGRAMME

Ongoing projects: Through Life, CORFAT
Research Timescales: 2008-2020
Budget requirements: to be determined

TECHNOLOGY, TOOLS & PROCESSES

• Tools and software for design, analysis and modelling of composites, advanced structures and engineering systems (FEM, SPH, VOF, etc.)
• Prediction methods for failure, aging and durability
• Knowledge management networks for shipyards
• Life long learning programmes for European shipyards
• Simulation tools for modelling the transport chain
• Development of systems for simulation and modelling of ship operational life cycle costs
• Development of simulation tools for module design and production processes
• Simulation tools for functional performance

EXPECTED RESEARCH OUTCOMES

• Accepted analysis tools as an option to execute approval on basis of goal based regulation
• Software and know-how for management of design and production risk
• E-learning data bases driven by a multi-language shipbuilding dictionary
• Tools for analysing and ensuring lifelong integrity
• Communication protocols and software for co-design and engineering by customer, contractor and subcontractor
2.2.3.2 Technology Base

RESEARCH OBJECTIVES

Pre-requisite for the Tools for Accelerated Innovation is a technology infrastructure with adequate understanding of the critical technologies for water-borne structures. This infrastructure, in the form of technology institutes and academia will supply the stakeholder industry in the Waterborne platform.

The application of the technology can differ widely over the topics presented in the three pillars of this Implementation plan for the Waterborne Strategic Research Agenda. The present research topic “Technology Base” will cover the critical technologies and the challenges to be met in order to enable the Waterborne TP industrial objectives.

The critical technologies specifically for the Waterborne industry that need specialized attention from specialised organisations are:

- Hydrodynamics, Hydromechanics and Oceanography
- Structural Mechanics, Materials and Joining Technology

RESEARCH PROGRAMME

Ongoing projects: STREAMLINE, TARGETS, BESST, SILENV
Research Timescales: 2008-2020
Budget requirements: to be determined

TECHNOLOGY TOOLS AND PROCESSES

Hydrodynamics, Hydromechanics and Oceanography
- Shallow water hydrodynamics
- Multi-body hydrodynamic interaction
- In-stationary flow force solvers
- Multi-phase flow force solvers
- Measurement technology for multi-phase flows
- Hydrodynamic impact force calculation techniques
- Extreme wave modelling
- Improved statistical environmental modelling of oceans, shallow water basins and arctic basins

Structural Mechanics, Materials and Joining Technology
- Light construction technology and new materials for shipbuilding and propulsor manufacturing
- Fatigue and ULS modelling of new materials
- Joining technology (bonding and welding)
- Coating technology

EXPECTED RESEARCH OUTCOMES

- Accepted technology enabling the development of design and engineering/analysis tools
- Software and know-how for new construction methods and maintenance support tools
- Calculation protocols and software algorithms for advanced flow calculation and material modelling
2.2.4  Next Generation Production Processes

2.2.4.1  Leading Edge Integrated Shipbuilding Production

RESEARCH OBJECTIVES

The integration of the latest developments in ICT, logistics, and technology into the local as well as the distributed shipbuilding process, in order to achieve leading edge productivity and efficiency world-wide. Solutions to develop and establish efficient co-operation (e.g. distributed design and manufacturing, transport logistics) in shipbuilding result in the following research objectives:

• Process Optimisation & Control: Systematic investigations of shipbuilding processes by means of simulation (the virtual enterprise) in order to reduce time-to-market and building cost while improving value to the customer.
• Shipbuilding Logistics Control: Systematic investigations into techniques to rationalise inventory management and process logistics by means of ICT.
• Knowledge mobilisation in the shipbuilding production environment: Systematic investigations into technology and learning schemes for IT-supported training and production assistance in the workshops.
• Knowledge management in design & engineering: Research & development into a distributed internet-supported framework for harnessing knowledge of specialist service providers.
• Virtual prototyping to allow craft design to be optimised without recourse to prototype manufacture.

TECHNOLOGY, TOOLS AND PROCESSES

For rapid identification and evaluation of innovation:
• Simulation tools for modelling the transport chain.
• Development of systems for simulation and modelling of ship operational life cycle costs.

For fast development of new products and processes:
• Methods and supporting tools for simulation of functional performance.
• Development of a standard product model.
• Tools and software for design, analysis and modelling of composites, advanced structures and engineering systems (FEM, SPH, VOF, etc.).

Prediction methods for aging and durability:
• Failure mechanisms.
• Simulation methods and supporting tools for module design and production processes.

For fast implementation of innovations:
• Knowledge management networks for shipyards.
• Life long learning programmes for European shipyards.
• E-learning databases driven by a multi-language shipbuilding dictionary.

RESEARCH PROGRAMME

Ongoing projects: Through Life, BESST, NEXT MUSE, CLEANMOULD, SHIPMATES.
Budget requirements: to be determined.

EXPECTED RESEARCH OUTCOMES

Reduction of lead times in production by 50%.
Reduction of downtime costs by 80%.
Controlled distributed design and engineering processes.
2.2.4.2 Human Factors in the Shipbuilding Process

RESEARCH OBJECTIVES

The practice of outsourcing and offshoring on an Inter-European as well as a worldwide scale is growing. Workers from other EU Member States are more frequently seeking and finding employment throughout Europe. The multicultural workplace poses a challenge that has implications in health, safety and environmental issues.

The image of Europe’s manufacturing industry is not sufficiently attractive for young men and women. Besides a relatively low influx of young talent, the gender balance in the industry reflects this problem. Common solutions to promote the image of manufacturing in Europe are the research objective.

A research project is required in European shipyards, aimed at finding the best managerial and cooperative solutions to improve the production process and productivity and address the above issues.

RESEARCH PROGRAMME

Ongoing projects: POSEIDON
Research Timescales: 2008-2020
Budget requirements: to be determined

TECHNOLOGY, TOOLS & PROCESSES

- Social aspects of shipyard work
- Multicultural processes, and communication
- Working conditions, health and safety in the workplace and job satisfaction
- Image of shipbuilding industry among younger generations
- Quality and productivity of the production process
- Developing methods in cooperative improvement of the production process
- Interaction in multi-cultural working places and production chains

EXPECTED RESEARCH OUTCOMES

- Reduction of industrial accidents in the shipbuilding industry and diminished risks in the workplace
- More applicants for vocational training in shipbuilding or metal industry
- New or at least better cooperative developing models in improving the production process
- Better job satisfaction in shipbuilding industry
- Better quality and higher productivity
- Better interaction between general contractor and suppliers on all levels of the production process
- Better possibilities to career development on all levels of the production process.
2.2.4.3 Electric Power & Propulsion Component Design

RESEARCH OBJECTIVES

- Research, develop and validate advanced concepts and technologies towards an all-electric ship.
- Enhance significantly the overall efficiency and cost effectiveness of electric power and propulsion systems, in order to enlarge the economically viable range of vessel applications by developing system designs and components for a range of generation/drive applications taking advantage of the latest technology, alternative energy sources and power management capability to increase efficiency and facilitate reductions of emissions.

RESEARCH PROGRAMME

Ongoing projects: POSEIDON

Research Timescales: 2008-2020

Budget requirements: to be determined

TECHNOLOGY, TOOLS & PROCESSES

- New power generation, control and drive machinery, components and systems with higher power and torque density, efficiency and flexibility in design and operation, all at lower cost, size and weight.
- New concepts to enable the maximum benefits of electric propulsion, control, manoeuvrability and low noise to apply to a wider range of vessels and operating speeds, all with lower build and operating costs.
- New transformers, frequency converters, motor & generator designs that benefit from high-speed drives, Permanent Magnet and Super-Conducting component technologies. Electrical actuation of major equipment that provides reduced footprint, installation design flexibility and more controllable, reliable operation for new vessels.
- New electrical power system and ship designs should enable operation from clean shore power supplies to eliminate airborne emissions in harbour.

EXPECTED RESEARCH OUTCOMES

- Electrical power, actuation and propulsion system designs and models that demonstrate increased efficiency and cost effectiveness for existing and new vessel concepts
- New validated component designs for high power generators and propulsion systems
2.2.4.4 Electrical Power Networks

**RESEARCH OBJECTIVES**

Electric systems on board consist of power generation, distribution systems, and power consumers. In order to reduce ship’s building costs and building time the emphasis will be on improvements of the distribution part, where cabling, routing and distribution principles used are key elements. Building in modular sections will be facilitated.

Electrical systems will have to cope with ever increasing demand in power/consumption, leading to the requirement for reduction in consumed power per application (lighting, HVAC, other systems). Overall system reliability must achieve or exceed the present high standard. On board maintainability should be simplified because of expected limited available manpower, capabilities and skill levels. Last but not least vessels must have simplified and standardised shore power connection facilities to switch to shore power when in harbour. This must be integrated with the development of the anticipated shore power facilities infrastructure.

**RESEARCH PROGRAMME**

- Ongoing projects: Several E-Maritime projects under FP7 and DG MOVE
- **Research Timescales:** 2008-2020
- **Budget requirements:** to be determined

**TECHNOLOGY, TOOLS & PROCESSES**

- LV, HV distribution nets
- DC nets and bus bar systems
- Cabling design
- Distribution principles
- Power converters
- Power friendly lighting
- Power friendly HVAC systems
- Shore power connections/implications
- Port facilities interface

Models and calculating/configuration tools for determining optimal system configurations per (type of) vessel are needed.

FMEA/MTBF calculations for overall system configurations

**EXPECTED RESEARCH OUTCOMES**

New electrical power system designs with reduced production, operation and support costs.
2.2.4.5 Modular Control, Navigation & Communication Systems

RESEARCH OBJECTIVES

Next generation automation, navigation and control systems on-board of commercial vessels need to be substantially improved in terms of reduced hardware, and especially installation, commissioning and maintenance costs, by 20% to 30% in order to remain competitive with latest Japanese and US developments. New builds at European shipyards, which are built up by completely pre-manufactured and pre-equipped segments from different locations, require a new concept for electric wiring and control. The key technology of distributed control systems leads to reduced build costs, where one segment can be equipped, tested and set into operation on its own and the completed segments can be commissioned in a few hours.

RESEARCH PROGRAMME

Pre-requisites:
Research Timescales: 2008-2020
Budget requirements: to be determined

TECHNOLOGY, TOOLS & PROCESSES

• Distributed control by agents
• Wireless and self-building networks
• Unified data standard
• Cross-sectional usable hardware platforms
• Industrial based hardware and networks
• Reliable and maintenance free sensors/actuators
• Artificial intelligence
• Ergonomics of information presentation & control
• Distributed network tools, agent builders
• Configuration tools for I/O allocation
• Mimic configuration tools
• Case studies for specific vessels
• Concepts for wireless, self-building networks
• New concepts for data standards

EXPECTED RESEARCH OUTCOMES

• Control functions are completely performed on local level
• Control units communicate by wireless means
• Control units start-up automatically, configure automatically, and implement redundancy automatically
• Control functions can be tested in advance on local level and merged automatically as segments are put together
2.2.4.6 Innovative Materials and Systems

RESEARCH OBJECTIVES

New materials and processing methods are needed to cope with new transport market trends and technological developments regarding:

• Escalation of aggressiveness of transported chemicals requires new materials and coatings
• Innovative duplex steel types with low alloy costs and enhanced corrosion resistance and mechanical properties
• Low-cost, leakage-free LNG insulation
• Enhanced speed of panel line welding and avoid deformation by the use of innovative hybrid laser welding (laser plus MAG welding). New generation of arc welding technology with lower heat input
• Innovative, multi functional coatings (including bio-coatings) are a high priority: They need to be resistant, require little inspection, efficient to apply, reduce drag and have a low impact on working conditions and the environment.

Composites and concrete show great promise. Risk assessments regarding corrosion, lifecycle costs, disposal, and in service inspection need to be carried out in detail. They need to guarantee non-flammability and fire resistance. Development of new materials, such as bio-composites, optimised for the marine environment will support sustainable growth.

RESEARCH PROGRAMME

Pre-requisites:
Research Timescales: 2008-2020
Budget requirements: to be determined

TECHNOLOGY, TOOLS & PROCESSES

Composite materials design and modelling tools

EXPECTED RESEARCH OUTCOMES

• Innovative solutions in composites and matrices
• Intrinsic material fire survivability
• Efficient and affordable manufacture and assembly
• Integrated intelligent systems to monitor the health of structures during their service life
• Light metals (new alloys, nano-scale structures, re-crystallisation models)
• New nano-scaled structures (100-300 nm grain size) formed in Al alloys which increase mechanical strength whilst preserving ductility
• New Al alloys with high-temperature fatigue resistance
• Environmentally-friendly materials
• Smart materials
• Bio-coatings
2.2.5 Effective Waterborne Operations

2.2.5.1 Automated Ship Operations and Life Cycle Cost Reductions

**RESEARCH OBJECTIVES**

All high value equipment needs to have Equipment Health Monitoring (EHM) systems embedded into the design. Equipment through life reliability models will be required to provide the prognostic capability to deliver condition-based maintenance. Development of in service performance databases and innovative intelligent pattern recognition tools will deliver robust maintenance planning information. This will maximise the availability of the ship and its asset value.

EHM systems should simplify operation and allow reduction of staff and engineers onboard. This functionality should be integrated with the ships automation and control system and use common monitoring and communication systems. Remote shore based EHM control centres need to be developed and linked to fleet operators. Consistent with the risk/goal-based approach to design, approval and production it will be necessary to develop risk/goal based techniques and tools to create maintenance schedules.

**RESEARCH PROGRAMME**

Pre-requisites: Completion of initial phase of FLAGSHIP Integrated Project

Research Timescales: 2008-2020

Budget requirements: to be determined

**TECHNOLOGY, TOOLS & PROCESSES**

- Propulsion system condition monitoring system models
- Integrated satellite data links for ship monitoring and cargo management
- Intelligent data analysis algorithms and prognostics
- Smart self monitoring materials
- In service evaluation programmes and case studies are required to validate the modelling tools.
- Models and intelligent algorithms are required to predict system and component condition from multi-parameter databases.

New maintenance processes and business models. Condition Based Maintenance operating procedures need to be developed and linked to classification society rules.

- Class surveys related to the scheme
- Development programmes are required for crew training and shore based support.

**EXPECTED RESEARCH OUTCOMES**

Classification society approved Condition Based Maintenance processes enabled by remote analysis of continuous monitoring of in service equipment performance.
2.2.5.2 Slow Ship Design and Operation

**RESEARCH OBJECTIVES**

Very significant reductions in fuel consumption and therefore CO\(_2\) and other emissions can be achieved by slow steaming. The implementation of slow steaming will have significant impact on the design of the ships and most importantly on the number of ships required and how they are operated. Hull designs optimised for slow speed operation in a variety of sea states will be required. The low power requirements will present opportunities for a mix of energy sources on board including renewables. The operation of larger numbers of ships at sea for extended periods of time will place constraints on crew requirements. This will provide incentives for greater automation and autonomous or remote operation of fleets from a base station. Highly skilled crews could manage a number of separate vessels with all of the wide ranging technical resources available on shore. Operating a fleet of slow steaming ships will emulate a maritime 'pipeline' for bulk cargoes, but could also be applicable to container traffic. The increased number of ships also represent a potential increased market to the shipbuilding and marine equipment industries.

**RESEARCH PROGRAMME**

Pre-requisites: Completion of initial phase of FLAGSHIP Integrated Project

Research Timescales: 2010-2015

Budget requirements: to be determined

**TECHNOLOGY, TOOLS & PROCESSES**

- Modelling of new hull designs for slow steaming
- Integrated satellite data links for ship control and monitoring
- Alternative energy sources on board including renewables
- New operational processes and business models

**EXPECTED RESEARCH OUTCOMES**

- New ship design concepts for slow steaming
- New ‘pipeline’ models for ship operation
- New concepts and requirements for remote and autonomous operation of ships
2.2.5.3 Green Retrofitting

**RESEARCH OBJECTIVES**

Ship power and propulsion systems are highly evolved and represent some of the most efficient power systems in the world. The development of new technologies that can deliver *step changes* in emissions performance will require major changes in the equipment used to power and drive the next generation of ships. It will also impact on the design *and operation* of the ships themselves. A major challenge for the industry is to implement new technology onto ships now that reduces the environmental impact of today’s fleets. Refitting and upgrading existing ships will provide a direct approach and an effective way forward.

The introduction of new emissions reduction technologies will increase the cost of ships. But this can be offset by reducing ship speed. This should be recognised as an opportunity to introduce complementary technology to optimise operations and reduce other operating costs. This could be achieved through increased reliability and reduced maintenance through Equipment Health Monitoring, increased automation and intelligent decision support systems.

**RESEARCH PROGRAMME**

*Pre-requisites:* Inputs from FLAGSHIP, HERCULES and STREAMLINE Integrated Projects

*Research Timescales:* 2010-2015

*Budget requirements:* to be determined

**TECHNOLOGY, TOOLS & PROCESSES**

- Evaluation green technologies which can be fitted to existing ships and development of accurate assessment methods for determination of the environmental and operational benefits of those technologies
- Development of decision support systems for emission controls and energy optimisation in the operation of ships
- Development on innovative waste management solutions that utilize the waste (dry and wet) as a source of energy and integration with other systems
- Development of processes and equipment for “refitting in service” avoiding or reducing lay-off times of ships in services
- Reduction of emissions and optimisation energy efficiency of existing ships through improved hull-propulsion interaction
- Development of modular retrofitting technologies and environmentally friendly processes for yards, including surface protection

**EXPECTED RESEARCH OUTCOMES**

- Identification of most appropriate technologies for retrofit
- Cost benefit analyses of retro-fitting various ship types

Implementation of the Waterborne Strategic Research Agenda - Route Map 2011 - Annex II
2.2.6 Technologies for New & Extended Marine Operations

2.2.6.1 Transport Operations in Cold Northern Waters

RESEARCH OBJECTIVES
The marine activity in the northern areas will increase in the years to come. It will comprise exploratory and production drilling, installation of sub-sea structures, pipe laying and inspection of sub-sea equipment. Oil and gas will be transported from locations in the Barents Sea to the market and will require all support activities, from simple supply to disaster relief. The challenges for ship and offshore operation are low temperatures, atmospheric icing, stability problems and equipment operation. Operational challenges will include different ice conditions, sea ice, ice floes, icebergs, darkness and low visibility. International and national law/regulations have to be updated and brought in line with the real risk factors i.e. the need for goal based regulations is apparent.

Research objectives are:
• Data collection on year round conditions in the specific northern environment (low temperatures, darkness, atmospheric icing, sea ice and drifting icebergs)
• Development of goal based rules for the vessels, equipment and systems at work in the environment
• Utilization of information to define design specifications to enable prolongation of the operational work season

RESEARCH PROGRAMME
Pre-requisites:
Research Timescales: 2008-2020
Budget requirements: to be determined

TECHNOLOGY, TOOLS & PROCESSES
New technology is required for a variety of operations:
• Transhipment
• Vessel/tanks for CNG / LNG
• New vessel designs with ice breaking capability
• River/sea transport in ice
• Sea transport from ice condition to the ice free areas
• At sea gas transfer (STS operation)
• Materials for low temperature operation
• Reduction of atmospheric icing
• Increase automation for remote operation of systems in cold climate

Management of environmental risks and pollution requires:
• Risk analysis and effect modelling in local conditions
• Safety concepts for collisions and collision prevention
• Emergency preparedness plans

EXPECTED RESEARCH OUTCOMES
• Specialised ships and equipment will be available to enable year-round operation in harsh climates
• Efficient technology for exploration, production, transhipment and transport operations in harsh climates will be available
• An inventory of environmental impacts and risks
• Disaster control routines and specifications for specialised equipment are available
2.2.6.2 Offshore Deep Sea Operations & Floating Equipment

RESEARCH OBJECTIVES

With new discoveries in accessible zones, the ultra-deep offshore (1500m to 3000m) is expected to account for a major share of production in the coming years. Technology today cannot produce at depths greater than about 1,800 m. To exceed this depth new technologies must be developed.

Hydrodynamics, structural analysis, risk analysis, mooring and station keeping, risers, topside and sub sea equipment, are essential research topics. New innovative technologies are required to define the future floating structures and operations capability for the exploitation of the deep-sea natural resources. Research topics will be focused in the new innovative ultra deep-sea vessels, ultra deep sub sea equipment and ultra deep robotics technologies.

RESEARCH PROGRAMME

Ongoing projects: Development of the new innovative technologies identified by the thematic network TN3 (Floating Structures Technologies) that was supported by DG Research and in OCEANS of TOMORROW under the Topic Multiuse of Offshore Platforms

Research Timescales: 2008-2020

Budget requirements: to be determined

TECHNOLOGY, TOOLS & PROCESSES

The following critical topics should be developed:

- New tools for hydrodynamic and structural analysis
- Hydro/aerodynamic load and response tools, coupled response model & full-scale testing, ice loading.
- New tools for risk analysis
- Decision making, analytical modelling, testing and qualification, risk assessment methodology.
- New technology for moored and DP systems
- Turret structures, mooring line damping, material and hydrodynamic damping, new types of deep water anchors (torpedo anchors), thruster modelling and power management, fuel saving control technology, simulation for DP assisted mooring.
- New technology for Ultra deep sea vessels
- Integration of new functions, mobility, power generation, propulsion efficiency.

EXPECTED RESEARCH OUTCOMES

The development of innovative technologies described above will make it possible to produce the natural resources with:

- 2000 m within 5 years
- 2500 m within 10 years
- 3000 m within 15 years
2.2.6.3 Environmental Design of Offshore Renewable Energy Systems

**RESEARCH OBJECTIVES**

Offshore renewable energy exploitation touches on a wide range of technology and operations. The most concentrated source of energy is often found in the most arduous environment. Therefore any successful system must be extremely robust. WATERBORNE members must apply their expertise in products for the most arduous marine environments to the design, build, maintenance and eventual end of life removal of new offshore energy installations. The challenge of cost effective marine energy installations for wind, wave, current, tide calls for robust mechanical designs and justifications for novel energy platforms. Through life supportability, the development of support systems and finally disposal are an integral part of the design of such a platform. In addition, solutions to transport the converted energy must also be developed.

**RESEARCH PROGRAMME**

*Pre-requisites:* Scenarios for potential offshore energy installation requirements.

*Research Timescales:* 2010-2015

*Budget requirements:* to be determined

**TECHNOLOGY, TOOLS & PROCESSES**

The following critical topics should be developed:

- New knowledge must be gathered in the field of non-linear waves and of underwater velocity profiles etc.
- Further development of motion stabilized work platforms is required.
- New tools for hydrodynamic and structural analysis
- Hydro/aerodynamic load and response tools, coupled response model & full-scale testing, ice loading.
- New tools for risk analysis, decision making, analytical modelling, testing and qualification, risk assessment methodology

**EXPECTED RESEARCH OUTCOMES**

The development of the innovative technologies described above will make it possible to design, justify and produce cost-effective and reliable offshore energy plants.
2.2.6.4 Support vessels and systems for offshore renewable energy platforms

**RESEARCH OBJECTIVES**
When offshore energy conversion plants are conceived vessels to construct maintain and demolish them will be developed. Such vessels may be integrated in the project. However it is more likely that a new generation of specialised support ships will be developed.

Such ships will be equipped with specialist equipment, DP systems and motion compensated working platforms.

**RESEARCH PROGRAMME**

**Pre-requisites:** None

**Research Timescales:**

**Budget requirements:** to be determined

**TECHNOLOGY, TOOLS & PROCESSES**
Specialist equipment and automation systems for build, maintenance, repair and disposal of offshore energy installations.

Control Systems for motion compensation in extreme conditions

**EXPECTED RESEARCH OUTCOMES**

- Design specifications for specialised support vessels
- Software and know-how for advanced motion compensation systems
- Calculation protocols and software algorithms for ship motion and positioning in extreme waves and high currents

2.2.6.5 New solutions for energy conversion

**RESEARCH OBJECTIVES**

- Research, develop and validate advanced concepts and technologies for the conversion of renewable energy
- Identify new power conversion processes and enlarge the economically viable range of applications by developing system designs and components for a range applications taking advantage of the latest technology
- Maximise the overall efficiency and cost effectiveness of these systems with the most appropriate electric power transmission systems
- Develop new concepts for energy conversion with inherent robustness capable of withstanding extreme environmental conditions

**RESEARCH PROGRAMME**

**Ongoing projects:** supported by DG Research and in OCEANS of TOMORROW under the Topic Multiuse of Offshore Platforms.

**Research Timescales:** 2010-2020

**Budget requirements:** to be determined

**TECHNOLOGY, TOOLS & PROCESSES**
New power generation, control and drive machinery, components and systems, at lower cost, size and weight than what is available today.

**EXPECTED RESEARCH OUTCOMES**

- New concepts for energy conversion with inherent robustness capable of withstanding extreme environmental conditions
- New validated component designs for power generators and transmission systems
2.3 Research Topics to Manage & Facilitate the Growth & Changing Trade Patterns

2.3.1 Accelerated Development of New Port & Infrastructure Facilities

2.3.1.1 Planning Tools for Optimal Logistics Chains & Hinterland Connections

RESEARCH OBJECTIVES

The advantages enjoyed by road transport relative to waterborne transport are primarily speed, limited consignment sizes and the convenience of door-to-door delivery. For waterborne transport, the challenge is to offer multi-modal transport solutions with maritime and/or inland waterway transport often in combination with road and rail hinterland transport being more attractive than sole road or rail transport.

Research efforts are needed with respect to:

• Improvements to major & minor ports’ infrastructures and operations
• Improvements to and enhanced usage of inland waterways
• Improvements/changes in container systems and cargo transfer
• Planning of timely adjusted optimal hinterland connections of ports

The research efforts aim at enhancing the use of inland waterways and de-congesting ports, terminals and roads by application of integrated ICT solutions for optimisation of modal transfer nodes and multi-modal transport solutions, involving all modes of transport (inland navigation, deep sea and short sea shipping as well as road and rail transport).

RESEARCH PROGRAMME

Ongoing projects: CREATE3S, CARGOXPRESS, MARNIS, FREIGHTWISE, ECOPORT, DiSCwise

Research Timescales: 2008 - 2020

Budget requirements: to be determined

TECHNOLOGY, TOOLS & PROCESSES

• Development of terminal planning tools for scheduling of quay occupation, transhipment facilities, storage spaces and transportation of goods to and from terminals (modal transfer nodes)
• Development of information services about physical conditions of transport routes and availability of transport capacities (e.g. up-to-date and forecasted fairway depths, maximum cargo carrying capacity on different stretches of route, availability of routes)
• Development of tools for estimation of transport costs, time and cargo capacity
• Electronic reporting and harmonised document handling, customs procedures, contracting and permitting
• Development of real time voyage planning tools interlinking all modes of transport (inland navigation, rail, road, deep sea and short sea shipping), using ICT technologies (RIS, VTS, transport services of other modes, as well as tracking and tracing) and giving the optimum transport option in terms of costs, time and cargo capacity as well as environmental friendliness
• Assessment of effects of extending inland waterways by extension of voyage planning tool

EXPECTED RESEARCH OUTCOMES

• Real-time voyage planning tool for optimum transport solutions involving waterborne transport
• Increased usage of inland waterway transport
• More efficient cargo handling and storage in modal transfer nodes and less increase of congestion in ports and on roads
2.3.1.2 Advanced Field Measurement Techniques

**RESEARCH OBJECTIVES**

Advanced field measurement techniques are important to deep sea, coastal, and inland navigation. An essential ingredient for successful project construction is the thorough and appropriate investigation of the physical characteristics of the development site. These include: sea conditions, ground conditions, and the local ecology. Failure to collect adequate and accurate data can and often does result in delay and cost over-run. However, the collection of real data in the marine environment is expensive and time consuming, often being restricted to summertime when conditions are less hostile, though still unpredictable.

In this context, in situ continuous measurements is also a major research objective.

**RESEARCH PROGRAMME**

**Pre-requisites:** -

Inventory on existing research programmes on advanced monitoring techniques based on remote sensing such as for example the RESTSCOD project in the Netherlands.

Research Timescales: 2008-2020

Budget requirements: to be determined

**TECHNOLOGY, TOOLS & PROCESSES**

The requirement is to develop improved methods of data collection that are operated remotely, such as by satellite, airborne, or from free moving vessels. These will include:

- Wave height and direction
- Sediment transport
- Temperature
- Coastal changes
- Bathymetry
- Nutrient concentrations
- Water quality indicators

For the continuous measurement topic, technology should focus on buoys and other such devices.

**EXPECTED RESEARCH OUTCOMES**

A reduction in the time and cost of the investigation of the physical conditions within which estuarial, coastal and inland waterway development is planned.

Improvement in the ability for industry to deliver projects within the time frame and budget foreseen and a reduction in the frequency and scale of disputes.

Leading edge technology from European industry marketed worldwide.

- **5 years**: Prototype developments complete
- **5 to 10 years**: Progress from prototypes to off-the-shelf manufactured products.
- **10 to 15 years**: Continued developments with input from field experience by users.
2.3.1.3 Non Intrusive Measurement

**RESEARCH OBJECTIVES**

Intrusive methods of investigation are slow, expensive and weather dependent. As a result, projects are frequently delayed due to inadequate data. More rapid, but reliable methods are urgently required to measure:
- In-situ soil density
- High-resolution geophysical methods of sub-bottom profiling
- Measurement of shellfish population extent and density

The outcome of these research and development programmes will be:
- Reduced time from project conception to construction
- Better design
- Reduced cost and delay
- Reduced risk of dispute.

These are important objectives. It is too often the case that projects suffer programme over-run and increased costs through inadequate advance understanding of the physical conditions at the construction site.

**RESEARCH PROGRAMME**

Pre-requisites: Inventory on existing research programmes on non-intrusive measurements. Special focus on integration of know how from geophysics applied in raw material and energy sources exploration.

Research Timescales: 2008-2020

Budget requirements: to be determined

**TECHNOLOGY, TOOLS & PROCESSES**

**EXPECTED RESEARCH OUTCOMES**

A reduction in the time and cost of the investigation of the physical conditions within which estuarial and coastal development is planned

Improvement in the ability for industry to deliver projects within the time frame and budget foreseen and a reduction in the frequency and scale of disputes.

Leading edge technology from European industry marketed worldwide.

- **5 years**  Assess current state of technology and primary research targets to provide optimum return. Select key research targets. Commence selected research programmes.

- **10 years** Develop prototype tools and subject to field trials. Expand programme to embrace 2nd Phase research topics.

- **15 years** Continue development of tools and methods.
2.3.1.4 Effects of Climate Change on Waterborne Transport

**RESEARCH OBJECTIVES**

Statistical analyses show that climate change is already taking place having a significant impact on natural phenomena, fauna and flora. Changing natural phenomena e.g. more severe storms at sea and in coastal zones, more frequent and severe low and high water periods on inland waterways, melting of glaciers in the Alps and changes in ice conditions in Northern Europe will change the boundary conditions according to which waterborne transport has to be realized. In order to account for these effects, research with respect to the following topics is required:

- Assessment of effects of climate change on waterborne transport in Europe, in particular on inland waterway transport where the severest impact is expected
- Provision of measures and boundary conditions according to which vessels and infrastructure have to be designed and adapted for climate change effects
- Establishment of master plan for European waterborne transport considering climate change

For comprehensive consideration of the task, the inland waterway transport sector, short sea shipping, rail and road transport, organisations dealing with waterway infrastructure building and port (terminal) development, as well as academia and research institutes dealing with analysis and modelling of climate change effects on environment and transportation have to be considered.

**RESEARCH PROGRAMME**

- **Pre-requisites:** none
- **Research Timescale:** 2008 – 2012
- **Budget requirement:** 5 MEuro

**TECHNOLOGY, TOOLS & PROCESSES**

- Application of statistical methods and development of tools and procedures for assessment of climate change effects on existing and future waterborne transport network and infrastructure
- Assessment of changing cargo flows (cargo shift from road to water, emission reduction potential) and introduction of new technologies to waterborne transport associated with mitigation of climate change
- Definition of new boundary conditions according to which vessels and infrastructure have to be adapted and designed (e.g. geometry, weight, structure)
- Definition and examination of future climate change scenarios and specific case studies with focus on inland waterway transport including risk analysis
- Analysis of economic, social and environmental impact of proposed solutions (vessels and infrastructure)
- Establishment of master plan for future development of European inland waterway transport and short sea shipping as part of multimodal transport chain considering climate change

**EXPECTED RESEARCH OUTCOMES**

- New design criteria for vessel design and infrastructure building for optimal coping with climate change
- Improved assessment tools and procedures for evaluation of climate change effects on environment and transportation
- Application of new technologies and transportation strategies (cargo shift from road to water) for reduction of greenhouse gases
- Master plan for future development of European inland waterway transport and short sea shipping
2.3.2 Interoperability between Modes

2.3.2.1 High Quality and Efficient Inter-Modal Services

**RESEARCH OBJECTIVES**

Intermodal transport requires high quality and very efficient services from all modes. Technology platforms and other initiatives like ERRAC, EIRAC and ERTRAC promote research that is needed for the single mode. Research goals are therefore proposed related to the interlinking of modes on the European coastal and inland waterways.

To be competitive with single mode transport, inter-modal transport should deliver a high quality service (seamless, fast, and reliable) and be highly efficient. Though 'Integrated Freight Transport Management Logistic Systems' have been examined and developed in a number of projects, there is still an apparent need to ensure that these issues are further developed.

**RESEARCH PROGRAMME**

**Ongoing projects:** CREATE3S, CARGOXPRESS, MARNIS, FREIGHTWISE  
**Research Timescales:** 2008-2020  
**Budget requirements:** to be determined

**TECHNOLOGY, TOOLS & PROCESSES**

- Information technology and logistics must be integrated to form the “smart supply chain”, embedded in a common EU inter-modal, cross-border strategy
- IT system to control all points in the supply chain (based on harmonized information availability and automated tracking & tracing features), including terminals and trans-shipment points
- Methodologies and tool for global repositioning of loading units
- Co-operation and liabilities between transport operators (service quality, reliability, cargo conditions of carriage, legal, competition and insurance issues, loss and damage issues)
- Electronic reporting and harmonisation of document handling and customs procedures, contracting, and permitting

**EXPECTED RESEARCH OUTCOMES**

An improvement in the efficiency of door-to-door transport with opportunities for an increase in the market share for small to medium ports

- **5 years** Identify weaknesses in existing systems  
  Develop web-based software and trial at selected ports
- **10 years** Install system in all major European ports
- **15 years** Install system throughout Europe

Implementation of the Waterborne Strategic Research Agenda - Route Map 2011 - Annex II
2.3.3 More Effective Ports & Infrastructure

2.3.3.1 Ship / Shore Systems Integration and Fast Cargo Handling

**RESEARCH OBJECTIVES**

The ship/shore interface needs to be designed as an integrated system for maximum efficiency. Ship time in port needs to be minimised for maximum operational cost effectiveness. The research and development must include pilotage, tug assistance, mooring technology, the design of link spans and ramps for ro-ro traffic, automated guided vehicles and cargo handling equipment. Improved personnel safety during all harbour operations will be a key objective. ICT systems for preparation of operations, increased levels of automation, including intelligent control and monitoring must be developed in order to increase port effectiveness and reduce risk to the operational workforce (personnel) and support onboard ships or in ports, locks etc.

The design of the vessel links to the shore should investigate integrated bunkering and shore power supplies. Modularised systems are required so that the optimum design of port facilities can be developed to suit port size and cargo volumes. Emphasis needs to be put onto improved methods of handling large amounts of containers, bulk cargoes, in order to reduce the number of cargo handling operations carried out between supplier and customer and to keep an emphasis on regularity time in the treatment of goods flows.

**TECHNOLOGY, TOOLS & PROCESSES**

A holistic approach is needed to docking automation and cargo handling. It also includes sensors and intelligent monitoring, prediction and control systems.

- Automated manoeuvring and mooring of vessels
- Modularised links between vessel and quay (link span, ramp, etc) with integrated harbour services
- Cargo handling processes and equipment, interacting with the processes and equipment for port terminal cargo handling
- Enabling ultra large container vessels in ports
- VTS/RIS traffic management and slot entrance planning on the basis of vessel risk indices and safety assessment
- Role of tugs as essential part of the effective and safe port with ever increasing number and size of vessels and extending into exposed areas

**EXPECTED RESEARCH OUTCOMES**

- New procedures to ensure safety and security of operations.
- Modularised designs of docking systems available for a range of port requirements
- The majority of new European short sea and inland waterway vessels are equipped with automatic mooring devices

**RESEARCH PROGRAMME**

Ongoing projects: ECOPORTS, EFFORTS, PEARL

Research Timescales: 2008-2020

Budget requirements: to be determined
2.3.3.2 Vessel Shore Energy Systems

RESEARCH OBJECTIVES

• Minimise local pollution caused by diesel generated power sources on ships in port and from industrial activities inside port areas
• Develop an integrated and innovative clean energy supply in port with the infrastructure and corresponding vessel interfaces, for both major and small ports and use of alternative and renewable energies

RESEARCH PROGRAMME

Pre-requisites:
Research Timescales: 2008-2020
Budget requirements: to be determined

TECHNOLOGY, TOOLS & PROCESSES

• Infrastructure design and construction
• Energy facilities design and construction
• Vessel-shore energy interfaces
• Vessel energy equipment

EXPECTED RESEARCH OUTCOMES

• Reduced, clean and more efficient use of energy by ships when in port and by industrial activities in the port area, and a consequent reduction in greenhouse effect gas emissions
• All vessels, while in ports, will be able to receive from, or to deliver energy to specific port facilities. This should lead to an immediate emission reduction in the port area.
• Lead to be taken by port authorities together with energy industry, port construction works and terminal operators
2.3.3.3 New Generation Inland Navigation

RESEARCH OBJECTIVES

In order to compete successfully on the worldwide market and to contribute efficiently to EU transport policy (NAIADIES) as well as to accommodate the forthcoming economical growth and transport demand of Europe, in particular, in the new Member States, the trans-European inland waterways including the Danube Corridor have to be considered. They offer tremendous potential for transport of goods due to significant free transport capacities. Development of European inland navigation requires consideration of:

• Innovative vessel concepts and modernisation of existing vessels for local conditions, logistic concepts, maximum cost efficiency and minimum Life Cycle Costs (LCC)
• Improved port and hinterland logistics, including cargo handling, and integrated concepts for door-to-door transport
• Reduced fuel consumption and environmental impact, emissions to air and water
• Reduced weight for increased cargo carrying capacity or less draught
• Safe and acceptable operation addressing changes of floating position, manoeuvring, and interaction between vessels and surroundings
• Improved safety with respect to collision and grounding, including the consideration of failure mechanisms and residual strength

One or two large-scale projects or, alternatively, five medium scale projects are required in order to account for European inland navigation as a whole. Due to the rather old fleet, immediate actions are requested for the Danube and Rhine fleets.

RESEARCH PROGRAMME

Pre-requisites: Completion of CREATING EU Project
Research Timescales: 2008 - 2020
Budget requirements: to be determined

TECHNOLOGY, TOOLS & PROCESSES

• Development of concepts for new and modular inland vessels (Container, Tanker, RoRo, Bulk and General Cargo) and modernisation of existing vessels
• Operational analysis and simulation of integrated transport chains, including LCC considerations
• Improved and innovative cargo handling systems
• New hull forms and technologies for reduced fuel consumption and wash, and enhanced manoeuvrability in restricted waters
• Emission-reduction techniques, and new propulsion and auxiliary energy systems (e.g. but not limited to fuel cells), as well as improved waste water management and environmentally friendly coatings
• Improved hull structures and new materials (e.g. double hull, sandwich structures and composite) for weight reduction and improved crash worthiness
• Development and implementation of unified rules and guidelines for inland vessel design, preferably goal based

EXPECTED RESEARCH OUTCOMES

• Availability of new modular inland-vessel designs with optimal hydrodynamic and safety properties and increased efficiency of transport
• Modernisation of the existing fleet focused on efficiency, environment, safety and cargo handling
• Increased transport of goods on the inland waterways, relieving congestion on road and rail and fostering incentives for international industrial investors
• Unified rules and guidelines for the inland vessel design
2.3.4 Intelligent Transportation Technologies and Integrated ICT Solutions

2.3.4.1 Ports Network and Data Exchange

RESEARCH OBJECTIVES
To achieve a secure Web-based system of vessel and cargo tracking accessible to all operators and users.

To maximise the efficiency of the real time transport opportunities and vessel utilisation it is necessary to develop a web-based system of port networking to identify and exchange vessel locations, planned routes, cargo facilities and dates and times of movement. This will allow users to quickly identify the most efficient and cost effective waterborne transport opportunities with the potential for increased market share, improved vessel utilisation and reduced costs. The system will also provide increased security by allowing vessel location, course and speed to be tracked at any time through satellite positioning and unique vessel identification code.

RESEARCH PROGRAMME
Pre-requisites: Finalisation of EFFORTS
Research Timescales: 2008-2020
Budget requirements: to be determined

TECHNOLOGY, TOOLS & PROCESSES
Multi-user Web-based software system development, taking into account VTS and RIS

EXPECTED RESEARCH OUTCOMES
5 years Software development and testing
10 years Installation with key ports and users
15 years Refinement and Installation with all ports and users
An increase in the speed, efficiency and security of vessel utilisation and cargo movement
2.3.4.2 Cargo Logistic Management

RESEARCH OBJECTIVES

Integrated ICT (Information and Communication Technologies) and ITS (Intelligent Transport Solutions) are required for more efficient planning, booking, simulation, routing and control of cargo along the different transport modes as well as supporting efficiency, safety and security. The objective is to achieve efficient and effective inter-modality. Automated control of vessels approaching/departing port using intelligent systems and improved navigational aids could increase efficiency and safety of ship handling. The technological aspects of such development should be investigated along with a consideration of the legal and regulatory aspects.

Improved control and decision-making requires introduction of new management tools to ensure the maximum utilisation of vessels at all times. Such systems could be used to predict real-time customer demand and to optimise the price and availability of products and services.

Programme could be integrated with Ports network & Data Exchange.

RESEARCH PROGRAMME

Ongoing projects: CARGOXPRESS
Research Timescales: 2008-2020
Budget requirements: to be determined

TECHNOLOGY, TOOLS & PROCESSES

- Ship and port design
- Cargo handling re-engineering
- Tracking and tracing
- Logistics simulation
- Planning and scheduling tools

EXPECTED RESEARCH OUTCOMES

5 years
New real-time scheduling systems

10 years
New cargo handling equipment and re-engineered processes with better, fit for purpose ship and port designs enabling smooth processing of goods
2.3.5 Understanding the Environmental Impact of Infrastructure Building & Dredging

2.3.5.1 Determination of Real Baseline Conditions against which the Effect of Infrastructure Development may be Measured

**RESEARCH OBJECTIVES**

To provide a proper understanding of the effect on the aquatic environment of natural events and unrelated anthropogenic activities, so that the true relative effect of infrastructure development may be properly evaluated. Research is urgently needed to improve understanding of events and activities within the marine environment and inland waterways that occur independently of construction and infrastructure. These will include the naturally occurring effects of storms and floods, but also the effects of commercial fishing. Improved understanding of these will provide a baseline against which the potential impact of construction activity may be properly judged. This is a major challenge that will be best met by the combined and coordinated work of Europe’s leading academics and scientific practitioners.

**RESEARCH PROGRAMME**

Pre-requisites: Inventory of existing research programmes on anthropogenic effects on the marine environment.

Research Timescales: 2008-2020

Budget requirements: to be determined

**TECHNOLOGY, TOOLS & PROCESSES**

- Pan European ‘State of the Art’ review of knowledge and on-going research on the effects and impact of natural and anthropogenic activity in the wet environment.
- Coastal, estuarial and inland waterway sediment suspension and dispersion during storm conditions.
- Coastal and estuarial sediment suspension and dispersion during high river flows.
- Coastal and estuarial sediment suspension and dispersion resulting from commercial fishing.
- Environmental monitoring and indicators of the environmental status.

**EXPECTED RESEARCH OUTCOMES**

Improved understanding of the effects of natural events within the marine environment, plus the effects of regulated activities, such as commercial fishing. Thus providing ‘benchmark’ conditions against which the potential effects of proposed and actual developments may be properly judged. This will allow more rapid and efficient planning processes.

2 years: Implement and complete ‘State of the Art’ review.

5 years: Establish and report a programme of field measurement at representative selection of European coastal and inland sites to accurately measure the effects of storms, floods, global warming, water extraction, pollution and commercial fishing.

15 years: Continuation of the above, but with greater refinement through focus on subjects of highest impact, or greatest uncertainty.
2.3.5.2 Improved Understanding of the Potential Impact of Development

RESEARCH OBJECTIVES

The short-term effects of marine and inland waterway construction on ecosystems need to be investigated by extensive field measurements and laboratory research. The results of which can be used to prepare predictive models. Research will involve physical, chemical and biological disciplines in effect chain analysis. In order to develop a better understanding of long-term effects of coastal and river engineering on the environment it is essential to use an integrated approach and look at cumulative effects over the lifetime of a marine infrastructure project. This type of research and monitoring will result in a better understanding of the dynamic effects in marine eco-systems and provide the basis for eco-friendly design of marine and inland waterway infrastructure. The objective is to develop the detailed understanding to support the goals of the marine strategy and also provide instruments for marine and inland waterway ecosystem management.

RESEARCH PROGRAMME

Pre-requisites:
Research Timescales: 2008-2020
Budget requirements: to be determined

TECHNOLOGY, TOOLS & PROCESSES

• Source research into coastal, estuarial and inland waterway sediment suspension, re-suspension and dispersion resulting from dredging and construction activities
• Long-term field measurements as function of the development of new ports and waterways
• Ecosystem dynamics
• Development and validation of predictive mathematical models

EXPECTED RESEARCH OUTCOMES

Improved understanding of the effects of engineering in the marine and aquatic environments, with identified ‘safe’, ‘marginal’ and ‘unsafe’ thresholds, such that projects may be designed with minimum impact, or enhancement of the environment and be fully in tune with the aspirations of the Habitats and Water-framework Directives

2 years: Implemented research program on physical impacts, sediment behaviour and ecosystem dynamics related to port development and waterway construction

5 years: Established and ongoing program of field measurements at representative selection of European port development projects

15 years: Continuation of the above, but with greater refinement on subjects of highest impact, or greatest uncertainty. Established models to predict ecological effects
2.3.5.3 Refinement of Environmental Regulation to Remove Inconsistency, Conflict & Duplication

RESEARCH OBJECTIVES

In the past decade the regulatory system in Europe has expanded rapidly. The objective of these various regulations is to maintain, or improve, the natural environment within which man, wildlife and flora must co-exist and to avoid damage to eco-systems. This is undeniably good, but only if regulation and its application is properly conceived and interpreted in a consistent way.

So that the aspirations of commerce and the concerns regarding the environment may be mutually satisfied, it is necessary to streamline and standardise the planning process and the implementation of regulations. Two essential steps are necessary to achieve this: to identify (and later eliminate) duplication and conflict between different regulations and to provide a Europe-wide agreed system to steer projects expediently through regulations via a logical, efficient and consistent route.

Research is needed in the form of analysis and comparison of the relevant European Directives and National regulations concerning the environmental impact of maritime, esturial and inland waterway development and maintenance. This will identify the conflict and anomalies within regulations and provide a step-by-step guide to the achievement of harmonious compliance with all relevant regulations in a cost effective and expedient way.

RESEARCH PROGRAMME

Ongoing projects: To establish a strong dialogue with the European Institutions to pool resources to intervene timely on rules making processes (especially in the IMO) by using, when appropriated, R&D instruments.

Research Timescales: 2008-2020

Budget requirements: to be determined

TECHNOLOGY, TOOLS & PROCESSES

EXPECTED RESEARCH OUTCOMES

A substantial reduction in the time scale for the planning, consent and implementation of new developments of waterborne infrastructure.

A substantial reduction in resources given to the investigation and study of proposed projects and in particular the elimination, or at least reduction, in wasted high level resources.

5 years Identify anomalies and conflict with existing regulations, quantify the adverse effects, propose appropriate amendments, and draft a coordinated road map to lead industry efficiently and expediently from project conception to the granting of all necessary consents and compliance without unnecessary delay and cost.

Establish permanent ‘Expert Advisory Group’ with watching brief to monitor new or amended legislation and Directives to avoid conflict or impossible, or impractical requirements.

10 years Continue permanent ‘Expert Advisory Group’ with watching brief to monitor new or amended legislation and Directives to avoid conflict or impossible, or impractical requirements.
2.3.5.4 Marina & Leisure Facility Development

**RESEARCH OBJECTIVES**

One of the critical factors limiting the further growth of the recreational craft and marine leisure industry is the lack of space to moor new craft. This drives up prices and places barriers to participation for many people. More stringent planning and environmental controls make the expansion of current facilities and the creation of new facilities increasingly difficult. Developing new and innovative ways to ensure that users can access the water cost effectively is an important issue that must be addressed. This is an issue both for coastal and inland facilities.

**RESEARCH PROGRAMME**

**Pre-requisites:**

**Research Timescales:** 2008-2020

**Budget requirements:** to be determined

**TECHNOLOGY, TOOLS & PROCESSES**

Identify and develop efficient and compact mooring, handling and storage systems of small craft harbours.

**EXPECTED RESEARCH OUTCOMES**

Increased capacity for leisure craft within the constraints of existing land space with a consequent increased opportunity for participation on waterborne recreation.
### 3. Research Topics Sponsors

<table>
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<tr>
<th>Research Topic</th>
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<tr>
<td><strong>2.1.1.1 Goal Based Regulations and Approval</strong></td>
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<td><strong>2.1.1.2 Risk Based Ship and Ship System Design</strong></td>
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<td><strong>2.1.2.1 Accident and Incident Data Reporting and Analysis</strong></td>
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<td><strong>2.1.2.2 Systems Integration for Safety and Security</strong></td>
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<td><strong>2.1.2.3 Survivability of Smaller Vessels in Extreme Weather Conditions</strong></td>
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<td><strong>2.1.3.1 Research with Respect to Collision and Grounding</strong></td>
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<td><strong>2.1.3.2 Failure Mechanism Research and Modelling</strong></td>
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<td><strong>2.1.4.1 Marine Fuel Cell - Fuel Operation Test Facility</strong></td>
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<td><strong>2.1.4.2 Fuel Supply and Fuel Systems</strong></td>
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<td><strong>2.1.4.3 Eco-Ship Systems</strong></td>
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<td><strong>2.1.4.4 Minimising Wash, Noise and Vibration</strong></td>
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<td><strong>2.1.4.5 The Future Sustainable Recreational Craft</strong></td>
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<td><strong>2.1.5.1 Environmental and Economical Maritime Security</strong></td>
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<td><strong>2.1.5.2 Future Ship Designs for Short Sea</strong></td>
<td>CESA</td>
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<td><strong>2.2.1.2 BEST: Breakthrough in European Shipping and Shipbuilding Technology for Cruise and RoPax</strong></td>
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<td><strong>2.2.2.1 More Efficient Propulsion</strong></td>
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<td><strong>2.2.2.3 Next Generation Power and Propulsion Concepts</strong></td>
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<td><strong>2.2.3.1 State of the Art Design and Analysis Tools</strong></td>
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<td><strong>2.2.3.3 Leading Edge Integrated Shipbuilding Production</strong></td>
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<td><strong>2.2.4.1 Human Factors in the Shipbuilding Process</strong></td>
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<td><strong>2.2.4.2 Slow Ship Design and Operation</strong></td>
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<td><strong>2.2.4.4 Electrical Power Networks</strong></td>
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<td><strong>2.2.4.5 Modular Control, Navigation &amp; Communication Systems</strong></td>
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<td><strong>2.2.4.6 Innovative Materials and Systems</strong></td>
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<td><strong>2.2.5.1 Automated Ship Operations and Life Cycle Cost Reductions</strong></td>
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<td><strong>2.2.5.2 Slow Ship Design and Operation</strong></td>
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<td><strong>2.2.5.3 Green Retrofitting of Ships</strong></td>
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<td><strong>2.2.6.1 Transport Operations in Cold Northern Waters</strong></td>
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<td><strong>2.2.6.2 Offshore Deep Sea Operations &amp; Floating Equipment</strong></td>
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<td><strong>2.3.1.1 Planning Tools for Optimal Logistics Chains and Hinterland Connections</strong></td>
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<td><strong>2.3.1.2 Advanced Field Measurement Techniques</strong></td>
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<td><strong>2.3.2.1 High Quality and Efficient Inter-modal Services</strong></td>
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<td><strong>2.3.2.2 Ship/ Shore Systems Integration &amp; Fast Cargo Handling</strong></td>
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<td><strong>2.3.3.1 Vessel Design and System Integration</strong></td>
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<td><strong>2.3.3.2 Cargo Logistic Management</strong></td>
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<td><strong>2.3.3.3 New Generation Inland Navigation</strong></td>
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<td><strong>2.3.3.4 Ports network and Data Exchange</strong></td>
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<td><strong>2.3.5.4 Marina &amp; Leisure Facility Development</strong></td>
<td>ICOMIA</td>
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</tbody>
</table>
Annex 3: Large Project Initiatives

1 INTRODUCTION ................................................................. 81
   Table 1 Large project initiatives ......................................... 81
   Table 2 Mapping of Large Project Initiatives under the Pillars. ................................................ 83
## 1. Introduction

Research topics have been prepared from a consolidation of a simultaneous ‘bottom-up’ development from the VISION and Strategic Research Agenda priorities and a ‘top-down’ assessment of product, service and infrastructure needs by industry. The ‘top-down’ approach generated a number of ‘Large Project Initiatives’ that cover many of the SRA priority areas.

The current list of large project initiatives is presented in Table 1 below and a mapping of the topics to the SRA priorities is given in Table 2 below.

The Research Topics and Large Project Initiatives are consolidated under the three pillars of the WSRA Overview.

### Table 1: Large Project Initiatives

<table>
<thead>
<tr>
<th>LPI title</th>
<th>Description</th>
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<tbody>
<tr>
<td>Future Ship Design for Short Sea Operation</td>
<td>Project cluster supporting and facilitating the necessary renewal of the European SSS fleet (development, design, production of SSS)</td>
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<tr>
<td>BE SST</td>
<td>Cruise and Ferry Sector large project (new innovative product elements, including the equipment + systems suppliers), addressing minimization of resources, emission, maintenance, risk etc., to enhance the European leadership in the Cruise &amp; Ferry sector</td>
</tr>
<tr>
<td>New Generation Main Propulsion</td>
<td>Project cluster for future energy efficient power generation and propulsion (increased efficiency, radical new propulsor technologies, engines and equipment for new fuels etc.), addressing the need for energy/resources saving and the change in future available fuels</td>
</tr>
<tr>
<td>Innovative Marine Equipment</td>
<td>Project cluster around a range of ship systems &amp; equipment with the objective to develop, validate and demonstrate new equipment and on board decision support systems incorporating latest basic technologies, to increase efficiency in production, operation and support</td>
</tr>
<tr>
<td>Risk/Goal Based Design and Regulations</td>
<td>Cluster of projects to support implementation of a risk based regulation framework at international level, addressing enhanced safety but also to enhance competitiveness through design for the synergy of safety and economy</td>
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<tr>
<td>Enhanced Integrated Support Systems for Shipping and Waterborne Operations</td>
<td>Projects for development, validation and demonstration of automated operations and decision support systems, addressing complex operations to minimise human errors, thereby enhancing safety and operational reliability whilst reducing operating expenses</td>
</tr>
<tr>
<td><strong>New generation Inland Navigation</strong></td>
<td>Cluster of projects around the development of the main inland navigation routes (e.g. Danube corridor). Technical developments of ships and infrastructure, integration in logistic chains, transport management, navigational aids, aiming at a step change in inland waterway transport, to contribute to future better transport distributions without congestion</td>
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<tr>
<td><strong>Future Advanced Hull Structures</strong></td>
<td>Projects dealing with exploitation of opportunities for innovative technologies. This includes: enhanced fatigue properties through new joining methods, new architecture possibilities created by innovative materials, weight saving and reduction of maintenance costs (incl. supporting modernization of respective rules and regulations). This is aimed at reduction of life cycle cost, improvement of fatigue and safety and enabling new freedom for creative ship layout enhancing European design leadership</td>
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<tr>
<td><strong>Accelerated Port- and Infrastructure Development</strong></td>
<td>Projects supporting the faster planning, decision making and construction of ports and infrastructure for waterborne transport, e.g. baseline for environmental checks. Other projects include innovative layouts, facilities and ship-/cargo handling equipment, future advanced ship-/shore interfaces (e.g. for Electrical shore power supply) and automated operations; all addressing the growth problems of waterborne transport and cargoes in Europe</td>
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<tr>
<td><strong>The Future Recreational Craft</strong></td>
<td>Projects around making recreational craft and their production processes more sustainable. These include minimisation of emissions (production waste streams, waste management, noise vibrations, exhaust gases &amp; coatings), energy efficiency through life (minimisation of wash, hull efficiency, fuel efficiency &amp; power train optimisation) and minimising carbon tariffs (end of life disposal new materials &amp; coatings)</td>
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<tr>
<td><strong>Transport and Operations in Cold Climate and in Northern Environment</strong></td>
<td>Projects addressing new challenges from the future energy exploration and transport opportunities in arctic and northern waters (sustainable transport concepts and ship-/platform designs, reliable climate proof technologies, materials, minimizing emissions/environment impact, reduction of atmospheric icing, maximize safety, crew qualification etc)</td>
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<td><strong>Maritime Security</strong></td>
<td>Projects dealing with concepts for long range maritime security (control of waters, e.g. special concepts, sensors, data fusion from the various sensors, platforms/ships, software), others with prediction / prevention of piracy, economically viable security concepts for the logistic chain etc</td>
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<tr>
<td><strong>Leading Edge Integrated Shipbuilding Production</strong></td>
<td>Projects aiming to integrate latest developments in ICT, logistics, and technology into the local as well as distributed shipbuilding process, with the goal to be constantly on the leading edge of productivity and efficiency against a world wide benchmark</td>
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<tr>
<td><strong>Offshore: Deep Sea Operations and Floating Equipment</strong></td>
<td>Projects dealing with new challenges from offshore operations in increasing water depths (enhanced design and simulation tools, procedures, new platform and equipment types etc)</td>
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### Table 2 Mapping of Large Project Initiatives under Pillar I, II & III

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