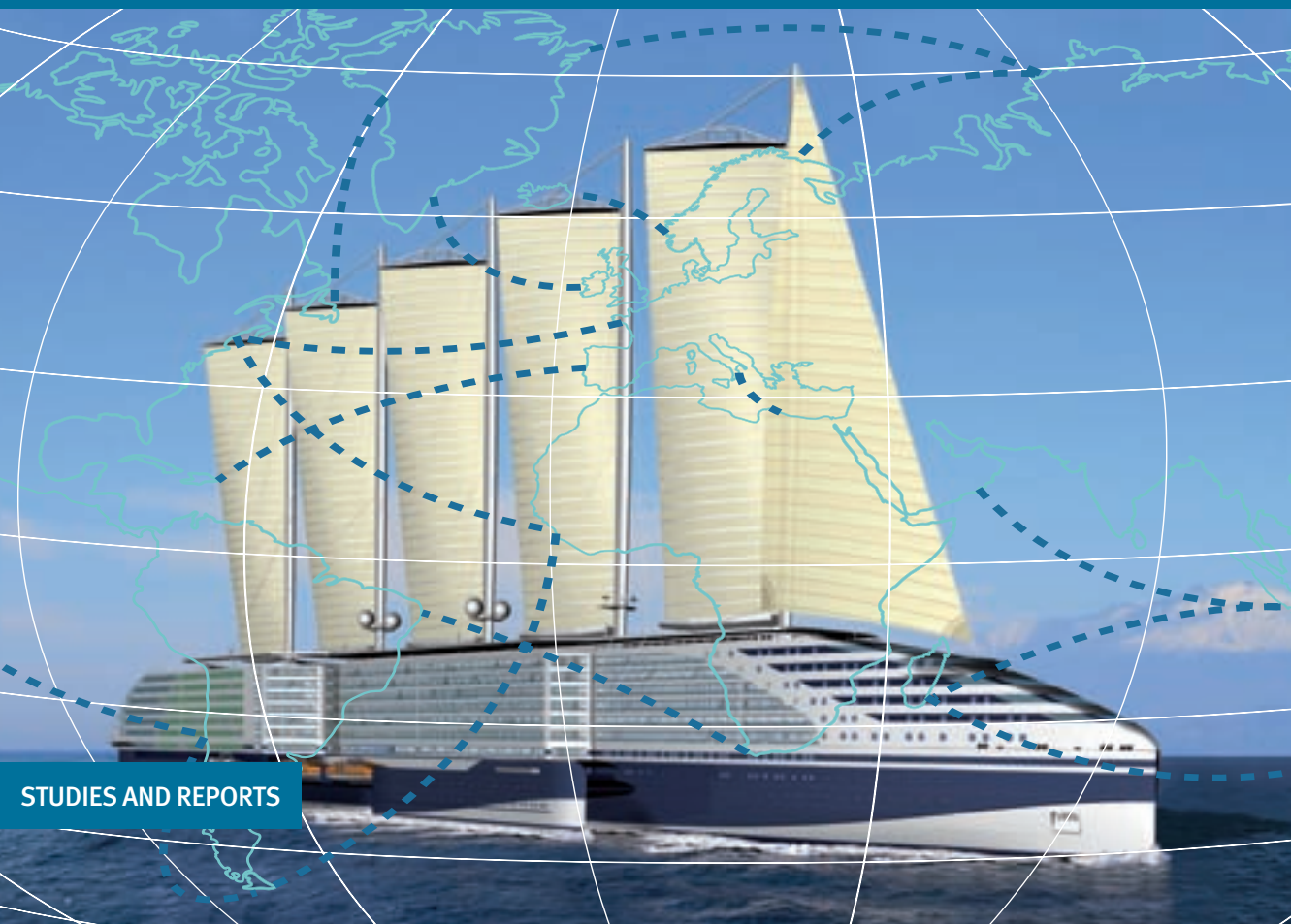


Staying ahead of the wave

Towards greener, safer, and more competitive waterborne transportation



EUROPEAN COMMISSION

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Towards greener, safer, and more competitive
waterborne transportation

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Introduction

Shipping is a vital link in Europe's economy, ferrying millions of people and billions of tonnes of goods from place to place every year. Yet Europe's shipping industry faces multiple challenges in the form of stiff competition from overseas and increasingly stringent safety and environmental legislation. Research and development (R&D) activities are a vital part of the industry's effort to rise to these challenges.

The EU and maritime transport research

The seas and waterways are essential for the health of Europe's economy and society, and research into waterborne transport is a priority for the EU. In its strategy for maritime transport policy up until 2018 ⁽¹⁾, the EU sets out its goal to become the 'world leader in maritime research and innovation'. According to the strategy, 'there is wide scope for improving energy efficiency in ships; reducing their environmental impact; minimising the risks of accidents; and providing better quality of life at sea.'

The EU invested around EUR 154 million in maritime transport research and research coordination actions under the Sixth Framework Programme for Research and Technological Development (FP6), which ran from 2002 to 2006. In the first 4 years (i.e. from 2007 to 2010) of the Seventh Framework Programme (FP7) alone, it granted approximately EUR 136 million to maritime transport research projects. FP7 runs until 2013.

Numerous EU-funded projects have already delivered results that are helping boost the competitiveness of Europe's maritime industries and make the seas surrounding us safer and cleaner. EU-funded projects bring together experts from across the continent, helping to avoid duplication of research on maritime transport issues and ensuring that any gaps in our knowledge are addressed in a coherent way.

Priorities for research derive from EU policies and priorities and take into account the Strategic Research Agenda (SRA), and implementation route maps developed by the Waterborne Technology Platform (WATERBORNE^{TP}). The WATERBORNE^{TP} brings together a broad range of stakeholders from the waterborne transport sector: shipyards, equipment manufacturers, the marine leisure industry, research and university institutions, classification societies, and associations active in the maritime sector. A Mirror Group with government-appointed delegates also forms part of the platform structure. The Technology Platform has developed a vision for the year 2020 (Vision 2020), followed by an SRA setting out the work needed for Europe's waterborne transport sector to become safe, sustainable, efficient and competitive, while adjusting to growing and changing trade patterns.

However, many challenges remain and further research and innovation are essential if Europe is to maintain its status as a world leader in shipping.

⁽¹⁾ European Commission, Strategic goals and recommendations for the EU's maritime transport policy until 2018. COM(2009) 8 final. Brussels, 21 January 2009.

Shipping: keeping Europe's economy moving

A quick glance at a map reveals that the EU is a largely maritime region: bound by the Arctic Ocean in the north, the Atlantic to the west and the Mediterranean in the south, while taking in much of the North, Baltic and Black Seas. The EU boasts tens of thousands of kilometres of coastline, and almost half of the EU's population lives within just 50 km of the sea⁽²⁾.

Today, 90 % of the EU's external trade and 40 % of its internal trade are carried by sea, and every year 3.5 billion tonnes of cargo and 350 million passengers pass through the EU's 1 200 seaports⁽³⁾. The level of seaborne trade has quadrupled in the past four decades and is predicted to increase even further in the coming years. Passenger numbers are also rising steadily. In addition, 43 000 km of navigable inland waterways such as rivers and canals crisscross the EU⁽⁴⁾. These waterways cover just under 6 % of inland freight transport⁽⁵⁾.

The EU is a world leader in shipping; over 9 000 merchant vessels, accounting for a quarter of the world's tonnage, sail under EU flags, and the European shipping industry controls an additional 4 000 ships flying foreign flags⁽⁶⁾.

Some 184 000 people are directly employed in the sea transport sector, and 43 000 in inland water transport⁽⁷⁾. In addition, many more jobs have been created to support the ship transport sector. For example, several ports are centres of regional development, forming the focus of industries linked to marine transport. These include shipbuilding, ship broking, cargo handling and other port services.

The shipbuilding sector in Europe employs over 500 000 people in some 300 shipbuilding and ship repair yards; it yields an annual turnover of around EUR 30 billion. European shipyards excel in producing more complex, often specialised vessels such as cruise liners, fast ferries, naval vessels, mega yachts and dredgers. To maintain their competitive edge, they typically invest around 10 % of their turnover in R&D activities⁽⁸⁾.

The European marine equipment sector represents in market shares around 36 % of the estimated value worldwide. Some of the key areas in Europe are mechanical engineering (26 % of European production value), electrical engineering/electronics (18 %) and steel products (18 %)⁽⁹⁾. Similarly to yards, the equipment manufacturers rely on innovation to maintain their competitive position.

⁽²⁾ Figures taken from the European Commission's Maritime Affairs website; see http://ec.europa.eu/maritimeaffairs/index_en.html

⁽³⁾ Ibid.

⁽⁴⁾ European Commission – Directorate-General for Energy and Transport, *Energy and Transport in Figures 2010*, Section 3.5.7. See also www.emee-marine-equipment.org

⁽⁵⁾ Ibid, Section 3.2.3.

⁽⁶⁾ European Commission's Maritime Affairs website; see http://ec.europa.eu/maritimeaffairs/index_en.html

⁽⁷⁾ European Commission, Directorate-General for Energy and Transport, *Energy and Transport in Figures 2010*, Section 3.1.5.

⁽⁸⁾ Community of European Shipyards Associations (CESA).

⁽⁹⁾ Study on Competitiveness of the European Shipbuilding Industry. See <http://ec.europa.eu/enterprise/sectors/maritime/documents/index.en.htm>



Facing multiple challenges

To remain a player in industrial competition, but also to ensure that the impact of transport on the environment is limited, the waterborne transport sector will have to address many challenges. Some of these are environmental concerns in light of climate change, societal pressure for cleaner transport modes, increased competition from emerging economies, rising oil prices, potential oil shortages in the long term, and increased traffic congestion.

Tough competition

The global economic crisis that started in 2007 hit the entire shipbuilding industry hard as orders for new ships fell dramatically. The European shipbuilding industry also faces tough international competition.

Overseas shipbuilders benefit from lower labour costs, lower steel prices and easier access to capital. At the same time, the shortage of suitably qualified professionals in Europe's largely high-tech shipping industry is becoming a pressing problem. Within the framework of the LeaderSHIP 2015 initiative⁽¹⁰⁾, the European shipbuilding and ship repair industry has denounced some forms of trade distortions.

For many years, the Organisation for Economic Co-operation and Development (OECD) sought to broker an agreement on fair competition in the shipbuilding sector. However, in December 2010 the OECD announced that it was terminating negotiations due to irreconcilable differences of opinion among the parties on the issue of pricing distortions.

Meanwhile, the EU is reviewing its own state aid rules for the shipbuilding sector; for most matters, shipping is subject to the same state aid rules as other sectors. However, because of specific factors affecting the shipbuilding sector, such as the nature of ships as very large, capital goods, which raises the potential of State-supported credit facilities to distort competition or because of over-capacity and trade distortions in the world shipbuilding market, the shipping sector enjoys special provisions with regard to state aid for innovation, aid for yards in less developed regions, the closure of non-viable facilities, export credits, development aid and employment aid.

For their part, ship owners and operators are increasingly interested in the competitiveness of ships once they are operating. Research efforts in this area focus on reducing vessel running costs and life-cycle costs, for example by improving the energy efficiency of vessels, optimising sail plans, or through the development of innovative vessels based on holistic designs that reduce operation and maintenance costs.

⁽¹⁰⁾ <http://ec.europa.enterprise/sectors/maritime/shipbuilding/leadership2015>



Environmental challenges

Although shipping is generally an efficient mode of transport in terms of energy consumption, using around one tenth of the fuel (per tonne mile) of road transport, emissions of greenhouse gases (GHG) and other substances such as sulphur dioxide (SO_2), nitrous oxides (NO_x) and particulate matter are rather large due to the use of unrefined bunker oil.

On climate change, the transport sector as a whole is responsible for around 23 % of GHG emissions in the EU, and shipping is responsible for just over 15 % of such emissions from transport⁽¹¹⁾. Furthermore the maritime transport industry accounts for up to 8 % of SO_2 and up to 15 % of NO_x emissions into the atmosphere. Both compounds are major causes of acid rain, while NO_x can also contribute to algal blooms.

According to the conclusions of the EU FP6 Specific Support Action ATTICA and the EU FP6 Integrated Project (IP) QUANTIFY, nearly 70 % of ship emissions occur within 400 km of coastlines, causing air quality problems through the formation of ground-level ozone problems, sulphur emissions and particulate matter in coastal areas and harbours with heavy traffic⁽¹²⁾. These emissions could potentially damage both human health and the environment at sea and ashore.

Despite cleaner technologies used on board vessels or optimisation processes to reduce air emissions, the foreseeable increase of traffic in the next 10 years puts pressure on the sector to implement tougher emission standards. In the EU-27 alone, maritime transport is expected to grow from the 2006 figure of 3.8 billion tonnes to 5.3 billion tonnes in 2018⁽¹³⁾.

⁽¹¹⁾ European Commission, Directorate-General for Energy and Transport, *Energy and Transport in Figures 2010*, Sections 4.2.2 and 4.1.5.

⁽¹²⁾ Eyring, V. et al., *Transport impacts on atmosphere and climate: Shipping*, Atmospheric Environment (2009), doi:10.1016/j.atmosenv.2009.04.059.

⁽¹³⁾ European Commission, *Strategic goals and recommendations for the EU's maritime transport policy until 2018*.



Meanwhile, ships have been responsible for spreading invasive species around the world. One such instance is when ships take on ballast water to provide stability when they are not weighted down by cargo; numerous species often make it into the ballast tanks along with the water. Although most of these stowaways die en route, some survive and are released when the ship discharges its ballast tanks, which may be far from the location where the water was taken on board. If the environment suits the new arrivals, they may quickly reproduce and spread, causing havoc in the local environment and in industries such as fisheries. International Maritime Organization (IMO) Member States adopted an International Convention for the Control and Management of Ship's Ballast Water and Sediments (BMW Convention) in February 2004. The Convention will enter into force 12 months after ratification by 30 States, representing 35 % of world merchant shipping tonnage. As of October 2010, 27 States – amongst them Spain, France, the Netherlands, and Sweden – have ratified the Convention, representing 25.32 % of global merchant shipping tonnage⁽¹⁴⁾.

The shipping sector therefore needs to take urgent steps to reduce the environmental impacts of its activities. It can do this in a number of ways: by making its engines cleaner and propulsion more efficient; by improving ship design (so that they glide through the water more smoothly, or have no ballast systems); by using alternative fuels; and by applying technologies to clean exhaust before it is emitted into the environment. The EU, for its part, is actively supporting numerous research projects that aim to develop more efficient, cleaner, greener ships.

⁽¹⁴⁾ See <http://www.imo.org/OurWork/Environment/BallastWaterManagement/Pages/Default.aspx>



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Safety at sea

The sea can be a treacherous environment, and despite increasingly stringent safety legislation, many lives are still lost at sea. In 1987, almost 200 people perished when the *Herald of Free Enterprise* capsized in shallow water shortly after leaving the Belgian port of Zeebrugge. Just a few years later, in 1994, over 850 people were killed when the *Estonia* went down in heavy seas off the coast of Finland.

The sinking of a ship can also wreak havoc in the environment and the economy; when the oil tanker *Erika* sank in 1999, 20 000 tonnes of oil were released into the Bay of Biscay, much of which ended up on France's Breton beaches. As well as killing marine life on a massive scale, the incident was disastrous for the local fishing and tourism industries.

The *Erika* disaster prompted the EU to set up the European Maritime Safety Agency (EMSA)⁽¹⁵⁾. The EMSA's goals are to reduce the risk of maritime accidents, marine pollution from ships and the loss of human lives at sea. In addition, the EU has passed legislation designed to limit the risks posed by ships carrying hazardous or polluting cargoes, among other things. Meanwhile, the loss of the *Estonia* led to the introduction of new safety requirements for certain ferries.

In its White Paper Roadmap to a Single European Transport Area⁽¹⁶⁾ adopted in March 2011, the European Commission underlines that the EU should be a world leader in safety and security. The EC communication on the EU's maritime transport policy until 2018 emphasises that with the adoption and subsequent implementation of the third Maritime Safety Package, the EU has one of the most comprehensive and advanced regulatory frameworks for shipping. It also stresses that EU maritime administrations and European shipping have invested heavily in the implementation of safety and security requirements.

EU-funded research has supported these efforts for more than 10 years. Research into safety focuses on the prevention of accidents (through better navigation aids and safer vessel structures) as well as on improving rescue procedures.

⁽¹⁵⁾ See <http://www.emsa.europa.eu>

⁽¹⁶⁾ Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system - COM(2011) 144 final.

Dealing with accidents, oil spills and ship dismantling

Despite increasingly strict legislation, EMSA reports that hundreds of accidents and incidents still occur every year. In 2008, 36 accidents caused pollution from oil or other hazardous and noxious substances (HNS)⁽¹⁷⁾.

Besides accidental oil spills, 80 % of the discharges from ships originate from illegal operations, i.e. discharges of waste oils or cleaning operations.

In relation to marine pollution, preparedness, detection and response, EMSA has identified 265 EU-funded and national R&D projects in its 2009 inventory⁽¹⁸⁾. Some of those projects – investigating innovative ways of detecting and cleaning up oil spills – are illustrated in this brochure.

Worldwide, between 200 and 600 large end-of-life ships are broken up and recycled every year, as their steel, other scrap metal and equipment constitute valuable raw materials. Most of this ship dismantling nowadays takes place in South Asia, on tidal beaches and under primitive conditions. While the industry provides thousands of jobs for migrant workers, a lack of environmental protection and safety measures leads to high accident rates, health risks and extensive pollution of coastal areas. Older ships contain many hazardous materials, including asbestos, polychlorinated biphenyls (PCBs), tributyltin and large quantities of oils and oil sludge. As many ships sail under the flag of an EU Member State, and even more are owned by European companies, the situation is a cause of concern for the EU⁽¹⁹⁾.

EU-funded research is promoting innovative means of dismantling old ships so as to protect both workers and the environment.

⁽¹⁷⁾ EMSA Report: Quality Shipping, Safer Seas, Cleaner Oceans – 2009.

⁽¹⁸⁾ EMSA Inventory of R&D projects relevant to marine pollution preparedness, detection and response.

⁽¹⁹⁾ See <http://ec.europa.eu/environment/waste/ships/index.htm>



Courtesy of PORTLINE (via Flagship)

Policy and regulatory frameworks

Most regulations governing maritime transport come from the International Maritime Organization (IMO), a specialised agency under the aegis of the United Nations (UN). The IMO's remit covers safety, the environment, security, the efficiency of shipping and legal issues (e.g. liability and compensation issues). Since 1960, the IMO has driven the adoption of over 50 conventions and protocols and more than 1 000 codes and recommendations covering all aspects of maritime transport.

All 27 EU Member States are members of the IMO. In addition, the European Commission has observer status at the IMO and works closely with the body on a number of issues.

The EU is active in supporting the work of the IMO and is generally active in translating IMO rules into its own binding legislation. For example, the EU is currently supporting IMO efforts to introduce a suite of technical, operational and market-based measures that will lower the impact of shipping on the climate – at present, greenhouse gas (GHG) emissions from ships are not covered by international climate change agreements.

The EU is also overseeing the implementation of the amendments adopted by the IMO in 2008 to the International Convention for the Prevention of Pollution from Ships (MARPOL), Annex VI, to reduce sulphur oxides and nitrogen oxides emissions from ships, by assessing those areas that would qualify as Emission Control Areas.

The EU has adopted a range of legislation which inter alia relates to safety, environmental protection, the internal market, employment and working conditions, and security⁽²⁰⁾.

Meanwhile, the EU has developed a strategy for maritime transport up to 2018. Launched in 2009, the aim of the strategy is to ensure the long-term competitiveness of Europe's shipping and related industries by promoting safe, secure, clean and efficient shipping⁽²¹⁾.

⁽²⁰⁾ See http://ec.europa.eu/transport/maritime/index_en.htm

⁽²¹⁾ European Commission, Strategic goals and recommendations for the EU's maritime transport policy until 2018. COM(2009) 8 final. Brussels, 21 January 2009.

The EU is particularly keen to promote short sea shipping as part of its efforts to tackle climate change and reduce congestion on the roads. It has created the concept of 'Motorways of the Sea', which would integrate four major European shipping routes into broader logistics chains, a commercially more efficient and sustainable alternative.

Efforts are also underway to reduce the often complex administrative burdens associated with the maritime transport of goods within the EU. Currently, trips between ports in two EU Member States are considered international even when the cargo being transported would otherwise be covered by the EU's internal market rules. By simplifying the system, the EU hopes to entice more businesses to move their freight from the road to the sea.



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Inland waterways

Europe's thousands of kilometres of inland waterways offer many advantages over other forms of transport. As well as being more environmentally friendly than road and rail, waterways offer high levels of reliability and low levels of congestion. They are also extremely safe, making them ideal for the transport of dangerous goods.

The EU is working hard to promote the use of inland waterways for freight transport and to ease their integration into wider transport networks. In 2006, the Commission set out an Integrated European Action Programme for Inland Waterway Transport, NAIADES ⁽²²⁾.

PLATINA, the Platform for the Implementation of NAIADES, has developed a Strategic Research Agenda for inland waterway transport, including the infrastructure. This agenda is considered when developing research priorities at EU level.

⁽²²⁾ SEC(2006)34.

About this brochure

This brochure offers a snapshot of research projects funded under the EU's Fifth, Sixth and Seventh Research Framework Programmes in the waterborne transport domain.

Projects are presented in four chapters addressing the main challenges faced by the waterborne transport industry:

1. A competitive European waterborne industry
2. Towards greener ships
3. Safe waterborne transport
4. Dealing with accidents, oil spills and ship dismantling.

The selection of projects has been made on the basis of their illustrative merits for a specific challenge or for potential technological solutions. The selection made for this brochure does not imply that research projects not mentioned lack interest or quality.

Research addressing multi-modality, security, information technology (IT) aspects, environmental impacts and materials funded under other topics or themes of the Research Framework Programmes are part of other Commission publications.

A competitive European maritime industry

Innovation is key to the waterborne sector, not only to ensure the durability of the shipbuilding sector in Europe, but also to strengthen the competitive position of European equipment manufacturers, ship owners and operators. In its Maritime Transport Strategy 2018, the European Commission reaffirms the historic role of shipping in Europe as a key stepping stone to economic growth and prosperity, and sets research and innovation as one of its key priorities. EU funds have been allocated to research that aims to enhance the competitiveness of the ship production sector through improved innovative ship designs, design tools, novel materials and innovative construction techniques as well as the optimisation of ship operation and reduction of life-cycle costs.

The shipbuilding sector in Europe employs over 500 000 people in some 300 shipbuilding and ship repair yards and yields an annual turnover of around EUR 30 billion. According to statistics from the Community of European Shipyards Associations (CESA)⁽²³⁾, ship production in Europe (as measured by weight) has remained relatively stable over the past two decades, while production in other parts of the world has expanded significantly. Nevertheless, European shipyards have boosted their turnover by focusing on specialised vessels such as cruise ships, ferries, mega yachts and dredgers as well as submarines and naval vessels. They further maintain their competitive edge in these niche markets by investing around 10 % of their turnover in R&D.

Improving research, development and innovation is a key pillar of the LeaderSHIP 2015 initiative⁽²⁴⁾. This initiative, developed by industry and supported by EU policymakers in 2002 and 2003, aims to help the shipbuilding sector address the competitive, environmental and social challenges it faces. Key issues tackled by LeaderSHIP 2015 include establishing a level playing field in world shipbuilding, boosting R&D investments, the need for advanced financing schemes, promoting safer and more environmentally friendly ships, naval shipbuilding, intellectual property rights (IPR) protection, securing a skilled workforce, and building a sustainable industry structure.

According to the LeaderSHIP 2015 progress report, the initiative has stimulated the targeting of legitimate support to innovation by making the EU's rules responsive to the needs of the sector⁽²⁵⁾. New rules were tailored to meet the specific needs of shipyards – where one out of four deliveries are based on completely new and innovative designs.

⁽²³⁾ See www.cesa.eu

⁽²⁴⁾ See http://ec.europa.eu/enterprise/sectors/maritime/shipbuilding/leadership2015/index_en.htm

⁽²⁵⁾ SEC2007 (517). See <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2007:0220:FIN:en:PDF>



Within the Framework on State Aid to Shipbuilding, which entered into effect in 2004, the Commission has approved innovation aid for five Member States. Meanwhile, the Commission is considering a review of the state aid framework for the shipbuilding sector. For most matters, shipping is subject to the same state aid rules as other sectors. However, because of specific factors affecting the shipbuilding sector, such as the nature of ships as very large, capital goods, or over-capacity and trade distortions in the world shipbuilding market, or the existence of agreements within the OECD, the shipping sector enjoys special provisions with regard to state aid for innovation, aid for yards in less-developed regions, the closure of non-viable facilities, export credits, development aid and employment aid.

Within its Research Framework Programmes, the EU funds numerous research projects to boost the competitiveness of shipbuilding and shipping industry through support to innovative ship-design concepts, design tools, advanced construction and maintenance technologies. Together, these projects are helping to advance the ship design process and shipbuilding technologies and bring down production and life-cycle costs. In addition, most research projects described in Chapter 3 aiming at the development of more energy efficient ships have also a positive impact on the competitiveness of ship operations, while improved ship inspection technologies described in Chapter 4 will – besides safety issues – help reduce maintenance costs and down time.

Smarter tools give ship design a boost

Many EU-funded projects focus on the design process. Work here aims to integrate different activities and processes within shipyards, as well as stakeholders involved in ship design and production such as naval architects, equipment suppliers, ship owners and classification societies, in order to most efficiently design optimised vessels ⁽²⁶⁾. Some 80 % of the building costs of a ship are defined in the initial design stages. Improving the tools used in ship design could result in better designs and bring down design and construction costs, boosting the competitiveness of shipyards and the ship design sector.

An example of a project in this area is IMPROVE, which has come up with a decision support system for ship design, with a particular focus on the structural aspects. Very often, optimising one aspect of ship design will cause problems elsewhere; for example, a ship with low production costs may have higher maintenance costs in the long term. Similarly, a lighter ship will probably be faster and use less fuel, but may have higher construction costs than a heavier ship.

The IMPROVE system combines information on the ship's weight, production costs, fuel efficiency and life-cycle operation costs, and allows designers, along with shipyards and ship owners, to optimise vessels and resolve trade-offs according to their needs. The IMPROVE team tested their system on three key ship types: a liquefied natural gas (LNG) carrier, a roll on/roll off passenger (RoPax) ferry and a chemical tanker. The shipyards involved in the project are now using the IMPROVE tools in their daily work, with ongoing support from the project's academic partners.

The design of a ship has a significant influence on its hydrodynamics; ships that glide smoothly through the water are more fuel efficient. The hull form also affects a vessel's stability and its ability to manoeuvre safely. The hydrodynamic aspects of ship performance are typically tested in ship basins, using small-scale models. Needless to say, producing a scale model is complicated, expensive and time consuming. Recent years have seen the development of increasingly complex computer programmes that apply computational fluid dynamics (CFD) and effectively provide ship designers with a virtual ship basin.

An early project in this area was FANTASTIC ⁽²⁷⁾, coordinated by Fincantieri (Italy), which developed a series of CFD tools designed to optimise hull forms. Ship designers take a trial and error approach, manually altering the hull form and running the programme to gauge its effect on the ship's performance. The FANTASTIC project came up with a way of automatically generating new concepts. Systems based on these early CFD programmes are still being used by some of the project partners.

More recently, the VIRTUE project has made great strides in CFD technology. 'At the start of the project, what we were lacking were accuracy and user friendliness,' recalls project coordinator Jochen Marzi of the Hamburg Ship Model Basin (HSVA) in Germany. The tools developed by the project address these issues. They were tested and validated against experiments and many project partners are now using them in routine projects. 'We have examples where the quality of the numerical results is as good as what we produce in an experiment,' states Dr Marzi. However, further work is needed to improve the accuracy of some tools, so model basins will still be needed for some time yet.

Besides accuracy, today CFD research focuses on increasing computational speed while bringing down the computational costs of numerical tools.

⁽²⁶⁾ Classification societies ensure that vessels comply with international standards.

⁽²⁷⁾ Functional design and Optimisation of Ship Hull Forms



© Improve

IMPROVE – Support for designers

Design of improved and competitive products using an integrated decision support system for ship production and operation

The project partners applied an innovative design decision support system to three ship types. In the LNG carrier's case, the project changed the shape of the ship's hull so that it no longer needs ballast water except in very heavy seas, thereby reducing operation costs. For the RoPax ferry, the team designed a propulsion system that cuts fuel use by 10 %. Finally, the team brought down the cost of the chemical tanker by redesigning the tanks to minimise the use of expensive duplex steel (which is more resistant to corrosion than ordinary steel).

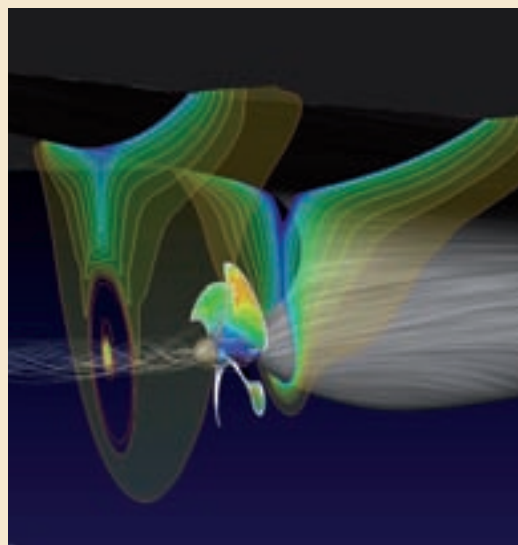
Coordinator | University of Liège (Belgium)

Total budget | EUR 3.4 million

EU funding | EUR 2.5 million

Start/end | 01/10/2006 – 30/09/2009

Website | <http://www.improve-project.eu/>



© Virtue

VIRTUE – Model ship basins go virtual

The virtual tank utility in Europe

As well as developing a suite of computing tools that effectively provide researchers with a virtual ship basin and that are already being applied by the project partners, the VIRTUE project generated an integration platform that allows users to easily combine different tools. In addition, the project delivered a set of best practice guidelines providing specific support to the CFD specialists and naval architects for four application cases: towing tank, seakeeping tank, and manoeuvring and cavitation tank.

Coordinator | HSVA, Hamburg Ship Model Basin (Germany)

Total budget | EUR 17 million

EU funding | EUR 10.5 million

Start/end | 01/01/2005 – 31/05/2009

Website | <http://www.virtual-basin.org/>



Working together to boost competitiveness

Following the recommendations of the LeaderSHIP 2015 initiative, seven major European shipyards joined forces in 2003 within the InterSHIP Integrated project (IP) to primarily retain and even increase the European share of its core cruise-ship and RoPax markets.

The InterSHIP consortium addressed the whole ship-production chain (from design to procurement) with a view to optimising all steps of the chain. Notably, innovative concepts and tools were developed to integrate the shipbuilding working environment, as were specific tools for the management of knowledge, production simulation tools for hull fabrication, methods and solutions for modular design, and systems for e-procurement. Logistics as well as the entire supply chain in shipyards were also investigated, and management software for planning or quality assurance developed.

Meanwhile, some 30 research groups of marine structural engineering have pooled their expertise and joined forces within the MARSTRUCT Network of Excellence (NoE) to improve the comfort, effectiveness, safety, reliability and behaviour of ship structures. The programme includes aspects that are essential to improve knowledge on materials and fabrication of structures, as well as on methods and tools for structure design and optimisation, and tools to assess loads and load effects and structural fatigue of ageing ships.

The project provided the partners with the opportunity to cooperate and compare working methods on an unprecedented scale, with the objective of strengthening the competitiveness of the shipbuilding sector. Today, the project's legacy is a fledgling virtual institute for marine structures (dubbed the MARSTRUCT Virtual Institute), which organises conferences and specialised short courses.

InterSHIP – The art of constructing complex ships

Integrated collaborative design and production of cruise vessels, passenger ships and RoPax

InterSHIP aimed to increase EU shipbuilders' competitiveness by better integrating tools and methods for the design and manufacture of complex one-of-a-kind vessels. The project enabled shipyard engineers to draw on cutting-edge knowledge in environmental aspects, safety, comfort and cost efficiency in simultaneous engineering, making sure that optimum solutions can be obtained for the total life-cycle of complex ships. The Integrated Project also focused on improving horizontal cooperation between shipyards and vertical integration between shipyards, owners, and classification societies.

Coordinator | Aker Yards Oy (Finland)

Total budget | EUR 38.5 million

EU funding | EUR 19 million

Start/end | 01/11/2003 – 31/03/2008

Website | <http://www.intership-ip.com>

MARSTRUCT – Linking up Europe's marine structural engineers

Network of Excellence in marine structures

The objective of this Network of Excellence was to strengthen European shipbuilding competitiveness through a programme for jointly executed research in the area of structural analysis of ships, the creation of research facilities and platforms and a continuous programme of dissemination. The MARSTRUCT project resulted in the establishment of the MARSTRUCT Virtual Institute, which links over 30 research groups working on marine structural engineering from across Europe.

Coordinator | Technical University of Lisbon (Portugal)

Total budget | EUR 6 million

EU funding | EUR 6 million

Start/end | 01/02/2004 – 31/01/2010

Website | <http://www.mar.ist.utl.pt/marstruct/>

New techniques in ship construction and life-cycle performance

Significant improvements in production techniques and the use of innovative technologies such as innovative joining techniques, use of lightweight materials or new anti-fouling technologies or painting processes have contributed to making shipyards more competitive and ships more efficient, from both an environmental and a life-cycle perspective. Attention has also been paid to the greening of production in shipyards.

Due to the predominant use of metallic materials, welding is the most important joining technique in shipbuilding. After years of partly EU-funded intense research on low-heat-input welding, mainly laser and laser hybrid – a technique combining a pure laser with traditional gas metal arc welding – laser welding was widely introduced in yards. Today, about 50 % of the welds are performed with this technology in leading yards, resulting in a productivity increase of about 50 % in pre-manufacturing.

While lasers are widely used in stationary systems, their application for more complex shapes and in small shipyards remains a challenge. The DOCKLASER project developed mobile laser hybrid welding equipment for use in the dock area of the shipyard. According to the project partners, the new system allows for faster welding than conventional systems and results in fewer distortions. 'We have used this system several times in our production,' says Guido Pethan of Meyer Werft in Germany. Many of the results of DOCKLASER are being further refined in a new EU-funded project, BESST.

Glues are widely used in other transport industries, including the train and car sectors, yet their usage on board ships has remained limited. However, the increasing use of lightweight materials in shipbuilding has prompted shipyards to take a closer look at the application of adhesives. The BONDSHIP ⁽²⁸⁾ project looked into the use of adhesives in shipbuilding.

Specifically, the team tested the potential of adhesives in key areas of ship construction where welding techniques are not ideal. For example, they successfully applied adhesives to join lightweight aluminium superstructures to the steel deck.

Partners also successfully used adhesives to clad the steel frame of hybrid ship superstructures in aluminium panels. 'Here the attraction is that you get some really smooth surfaces, so you don't have to do finishing work afterwards,' explains Dr Weitzenböck of Det Norske Veritas in Norway. Savings in production costs of 30 % were expected for the assembly of small structures. The consortium concluded the project with the elaboration of a comprehensive book on the use of adhesives in shipbuilding.

Within the framework of the project CREATE3S, lightweight materials were implemented along with modular design to create an innovative ship particularly well suited for short sea shipping. The new ship concept consists of two basic modules: a ship-platform module and standardised interchangeable cargo-containing modules that can be easily swapped in harbours. The idea behind the modular design was to enable the use of advanced manufacturing techniques, thereby reducing lead time and labour costs.

The use of lightweight material in shipbuilding was also explored by the project DE-LIGHT ^(29, 30) coordinated by the Centre of Maritime Technologies e.V. (Germany). Six application cases for the maritime, road and rail sector were developed by the project, demonstrating the immense potential of lightweight solutions for the competitiveness of manufacturers and transport providers. A tool, now commercially available, was developed for life-cycle cost assessment of lightweight structures, embedded into a design tool. Dr Roland from CMT emphasises: 'Considering the importance of an improved payload to weight ratio for fuel and emission reduction of transport, the wide use of different materials and material combinations for the structural and outfitting components will be a dominant feature of future ships.'

⁽²⁸⁾ Bonding of Lightweight Materials for Cost-Effective Production of High-Speed Craft and Passengers Ships

⁽²⁹⁾ Developing Lightweight Modules for Transport Systems featuring Efficient Production and Life-cycle Benefits at Structural and Functional Integrity using Risk-based Design

⁽³⁰⁾ See <http://www.delight-trans.net>

Europe’s shipyards owe their competitiveness to their use of innovative building techniques and materials, and their specialisation in niche market vessels such as cruise ships, mega yachts and RoPax ferries. However, coupled with higher European labour costs, this means that ships built in Europe might come with a hefty price tag. Nevertheless, these ships often work out cheaper in the long run, because they are more efficient and have lower life-cycle costs.

The BESST project is working to boost European shipyards’ competitiveness by developing innovative vessels – cruise ships, mega yachts and ferries – that will save their owners money over the lifetime of the ship, be safer and have a lower impact on the environment. One of the key elements of this integrated project (IP) involves developing a holistic design that reduces the overall operation costs. Technical solutions will be delivered to improve the performance of key ship systems and ultimately bring down the life-cycle costs of the vessel.

According to the project team, implementing just some of these solutions will make up for the higher purchase price of a European ship compared to a ship built elsewhere in the world. ‘A first detailed analysis of the potential life-cycle benefits through the implementation of project results has shown cost reductions per ship of around EUR 120 million over a 30-year lifetime,’ explains project coordinator Paolo Guglia of Fincantieri in Italy. Furthermore, BESST’s solutions could cut ship’s carbon dioxide (CO₂) emissions by some 12 %.

Elsewhere, the project is working on a tool that can carry out a holistic life-cycle assessment on a planned ship, taking into account economic aspects as well as environmental, safety and social benefits. The tool will allow shipyards to assess the impact of any new innovation of the ship’s life-cycle performance.

Due to labour costs and the price of steel scrap, ship dismantling has not been considered for a long time as a business sector for Europe. However, new international regulations (in the form of the Hong Kong Convention) have been adopted, including standards that cover the whole life-cycle of a ship from design, construction and operation right through to the recycling stage. This is discussed further in Chapter 5.

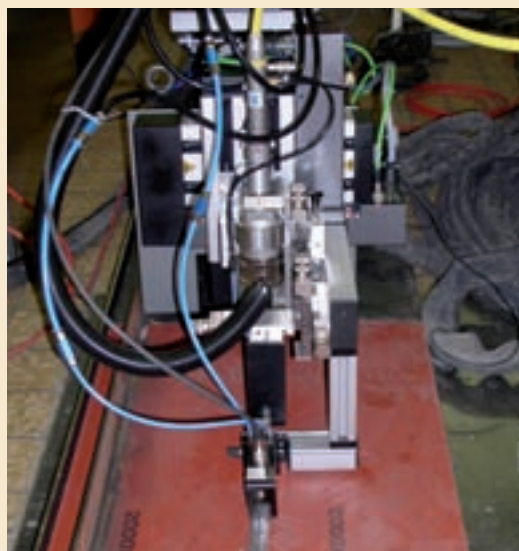
CREATE3S – A new impulse to European short sea shipping

Creative Concepts Realised by Advanced Design & Production to improve total Efficiency of Short Sea Shipping

The project developed advanced manufacturing concepts based on modularisation leading to an innovative ship concept. The ship consists of two basic modules: a ship-platform module and interchangeable cargo-containing modules. Once at the destination the cargo-containing modules are discharged and replaced by other modules. This concept allows for more efficient freight management, contributes to a reduction of time in port and provides a better link with inland waterways by assembling the cargo barges into push units.

**Coordinator | GeestNorth Sea Line b.v.
(the Netherlands)**

Total budget	EUR 4.2 million
EU funding	EUR 2.5 million
Start/end	01/11/2006 – 30/04/2010



© Docklaser

DOCKLASER – Wonderful welding

Increasing efficiency and quality in shipbuilding and ship repair by developing mobile laser equipment for dock area

Making faster welding systems was the goal of the DOCKLASER project, which developed mobile laser hybrid welding equipment that is particularly useful for long linear welds. The mobile system is better and faster than traditional systems. Furthermore, the DOCKLASER team came up with a hand-guided pure laser welding system for application in the outfitting area.

Coordinator | Meyer Werft (Germany)

Total budget | EUR 4 million

EU funding | EUR 2.6 million

Start/end | 01/09/2002 – 28/02/2006

Website | <http://www.docklaser.com/>



© By courtesy of Fincantieri
Cantieri Navali Italiani SPA

BESST – Keeping European shipyards ahead of the pack

Breakthrough in European ship and shipbuilding technologies

BESST is creating innovative technologies to drastically bring down the life-cycle costs of European-built ships (cruise ships, ferries and mega yachts) while also cutting the vessels' environmental impacts and improving safety and security. Meanwhile, the ship life-cycle performance assessment tool will allow shipyards to evaluate the pros and cons of different technical options over the entire lifespan of the ship.

Coordinator | Fincantieri (Italy)

Total budget | EUR 29 million

EU funding | EUR 17.5 million

Start/end | 01/09/2009 – 28/02/2013

Website | <http://www.besst.it>

Towards greener ships

Compared to other modes of transport, shipping has clear advantages, particularly in terms of its energy efficiency and emissions per tonne-mile. However, the volume of traffic on our seas and waterways is set to rise sharply in the coming years, and the industry is under pressure to curb its emissions. To address these concerns, researchers are designing ships with less resistance, cleaner engines and engines based on alternative fuels, as well as with novel ways of navigating. Ballast water, responsible for spreading invasive species, and noise reduction have also received attention.

Ships emit various kinds of pollution. For one, ships are a major source of sulphur oxides (SO_x) and nitrous oxides (NO_x). The average sulphur content of some ship fuels stands at 3 %, which is almost 3 000 times higher than the sulphur content of diesel used in road vehicles. Meanwhile, NO_x causes acid rain, contributes to algal blooms, and, when NO_x is mixed with volatile organic compounds (VOCs) in sunlight, the result is ozone, which is harmful to human, animal and plant health alike.

Climate change is another issue for the shipping sector; just under a quarter of the EU's greenhouse gas emissions come from transport and, of these, 15 % come from shipping. For CO₂ only, emissions from shipping in 2006 have been estimated by the IMO at 3.3 % of global emissions.

As the amount of trade carried by sea and waterways is set to soar over the coming years, emissions from shipping are likely to increase in spite of technological measures to make vessels more energy efficient.

In response, the IMO has already put in place legislation to lower SO_x and NO_x emissions from ships, mostly through MARPOL. Annex VI of the Convention, which came into force in 2005, limits the sulphur content of fuel to 4.5 %; this will fall to 3.5 % in 2012 and 0.5 % in 2020.

Under MARPOL, governments may also designate special emission control areas in which ships are required to use fuel with a much lower sulphur content. Currently, the limit in these protected areas stands at 1 %, and this will fall to 0.1 % as of 2015. In Europe, the Baltic Sea, North Sea and English Channel have been declared emission control areas. Only some of these provisions on marine fuels are incorporated into

EU law⁽³¹⁾ and discussions are currently under way to align the provisions of the directive on the sulphur content of certain liquid fuels with the new limits set by the IMO.

More recently, the IMO put in place measures to bring down NO_x emissions from shipping. Vessels built between 2000 and 2010 must limit their NO_x emissions to 17 g/kWh (grams per kilowatt hour), a figure that drops to 14.4 g/kWh for ships built on or after 1 January 2011. An even stricter limit of 3.4 g/kWh will be applied to ships built after 2016 sailing in emission control areas; this is equivalent to an 80 % reduction compared to current emission limits. Outside these protected zones, the 14.4 g/kWh limit will continue to apply.

Greenhouse gas emissions from shipping are currently not covered by any international climate change agreements. The EU is heavily involved in IMO efforts to broker an international deal on the matter. As an IMO agreement is still a long way off, the European Commission has announced plans to take steps at EU level to address the issue.

Besides legislative measures to reduce emissions from shipping, the EU is supporting research to increase the energy efficiency of vessels, thereby reducing emissions or improving engine and after-treatment technologies. Elsewhere, efforts focus on designing engines that use alternative fuels. Finally, projects are seeking to bring down shipping emissions by altering the way ships operate and navigate.

⁽³¹⁾ Directive 2005/33/EC of the European Parliament and of the Council of 6 July 2005 amending Directive 1999/32/EC as regards the sulphur content of marine fuels.

Reducing resistance

The shape of a ship's hull has a major impact on its energy use; a well-designed ship will glide through the water smoothly and so consume less energy. Recent years have seen a rise in the use of computing tools that allow ship designers to refine hull shape to optimise energy efficiency, among other things⁽³²⁾.

Combined with hull shape, other techniques have been developed to reduce the viscous resistance of the hull. One project that is trying to dramatically reduce drag on ships is SMOOTH, which has come up with an air-lubricated hull.

The principle behind the idea is simple. 'If you try to run in a swimming pool, it is hard, but running in air is easy,' points out project coordinator Cornel Thill of the Development Centre for Ship Technology and Transport Systems in Germany. 'One reason is the friction resistance of air is much lower than in water.'

Maintaining a layer of air around a ship's hull is far from easy. The SMOOTH team, which worked closely with a Dutch consortium called PELS2 ('Project energy saving lubricated ships'), found that the most effective option was to inject air into numerous cavities built into the bottom of the hull; trials on a full-scale inland ship demonstrated that this results in a net reduction in energy use of 15 %. Although this result was obtained in inland waters, where waves tend to be smaller, trials at sea showed that the system still generates energy savings, albeit smaller ones. 'It was very difficult to become worse than a traditional ship, even in heavy seaways,' notes Dr Thill.

A dockyard that was involved in the project is now in the process of commercialising the technology, so air-lubricated ships could become a reality in the not too distant future.



© Marin

SMOOTH

Sustainable methods for optimal design and operation of ships with air-lubricated hulls

The SMOOTH project exploited the fact that the friction of air is much lower than the friction of water. The team tested three different ways of coating a ship's hull in air. One technique involved surrounding the hull in a layer of tiny bubbles, while another involved treating the hull surface with a paint that attracts air, creating an air carpet round the hull. Although these techniques worked well at the model scale, they were less effective at full scale. The third technique, however, which entailed pumping air into cavities in the bottom of the hull, was successfully tested at full scale and delivered energy savings of 15 %.

Coordinator | Maritime Research Institute (Netherlands)

Total budget | EUR 2.5 million

EU funding | EUR 1.44 million

Start/end | 01/09/2006 – 31/08/2009

Website | <http://www.smooth-ships.eu/>

⁽³²⁾ More information on these tools is provided in Chapter 2.

Improving propulsion

A vessel's propeller also affects the overall energy efficiency of the ship, yet the basic design of propellers (and by extension their efficiency) has changed very little in recent years. Working to change that is the STREAMLINE project, which is developing three radically different propulsion systems.

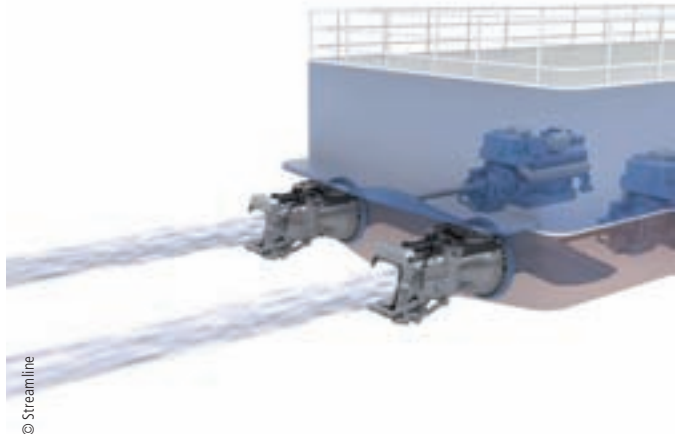
'We are looking at creating technology that will produce a step change in the efficiency of propulsors that are used onboard vessels, both at sea and on inland waterways,' says project coordinator Paul Greaves of Rolls Royce in the United Kingdom. 'We're not looking for incremental improvements – we're looking for changes in efficiency in the order of around 15 %.'

Specifically, STREAMLINE is examining three innovative ways of propelling ships through the water. The first would see the installation of a large propeller far behind the vessel. 'Basically, by operating beyond the back of the vessel we can dramatically increase the size of the propeller and lower its speed,' explains Mr Greaves.

The second concept under investigation mimics the action of a fishtail. This technology is already fairly advanced and will be tested at full scale on an inland waterway vessel. Because the device moves large amounts of water through relatively small changes in velocity, it could potentially result in extremely large increases in efficiency.

The third system comprises an array of small propellers. In this system, the propellers are aligned in such a way that water coming out of one propeller set enhances the efficiency of the next propeller set, and so on. The big challenge here is to develop the highly complex computational fluid dynamic (CFD) tools capable of simulating the way water flows around the different sets of propellers.

Meanwhile, the STREAMLINE team is also applying CFD tools to ordinary propellers with a view to improving their efficiency by up to 7 %. 'Propeller efficiency has changed very little over the past few years,' comments Mr Greaves. 'The key to getting the best efficiency is to get the water to flow as smoothly as possible into the propeller.'



© Streamline

STREAMLINE – Perfecting propulsion

Strategic research for innovative marine propulsion concepts

The STREAMLINE project is investigating the potential of three radically different propulsion systems, including one which mimics the motion of the tail of a fish! At the same time, the team is looking into ways of improving the efficiency of ordinary propellers and researching ways of boosting the efficiency of water jet propulsion. Attention is also put on the optimisation of hull-propeller interaction.

Coordinator | Rolls Royce (United Kingdom)

Total budget | EUR 10.9 million

EU funding | EUR 8 million

Start/end | 01/03/2010 – 28/02/2014

Website | <http://www.streamline-project.eu/>

Cleaner engines

Through the EU-funded HERCULES and HERCULES B projects, engine manufacturers MAN Diesel and Wärtsilä have joined forces to spearhead efforts to make ship engines cleaner and more energy efficient. Between them, the two companies cover about 90 % of the world market for ship engines, and as 99 % of the world's ships have diesel engines, the project outcomes will be of relevance to vessel owners worldwide.

The HERCULES team, which counts more than 30 partners, has set itself the ambitious goal of cutting fuel consumption (and by extension CO₂ emissions) by 10 %, NO_x emissions by 70 % and other emissions (such as particulate matter) by 50 %, all by 2020.

In its first phase, HERCULES investigated a range of technologies designed to meet these goals; the most successful ones are being developed further under the second phase of the project, dubbed HERCULES B. Among other things, the initiative has resulted in an exhaust gas recirculation system that includes a gas cleaner and could cut NO_x emissions by up to 85 %. A prototype of this system has now been installed on a small container vessel. The project has also come up with after-treatment units that can be retrofitted to existing engines to tackle NO_x emissions.

Computer simulation tools that model the combustion process are another useful project outcome; these shed new light on ways to reduce emissions under different operating conditions. Elsewhere, the project is working to boost efficiency by bringing together the right combination of components. While a lot of effort goes into optimising the design of turbines, boilers and engines, this research has revealed that selecting the optimal combination of components can improve overall efficiency by up to 5 %.

Friction has a major influence on engine efficiency, and HERCULES has developed a new, non-metallic-bearing material and system that effectively cut losses due to friction.



Courtesy of MAN Diesel & Turbo

HERCULES – Cleaner diesel engines on ships

High-efficiency engine R&D on combustion with ultra-low emissions for ships

The overall aim of the HERCULES project was to improve the efficiency of diesel engines on ships by 10 %. The project united the expertise of the world's two leading ship-engine manufacturers who have set up a unique management structure for the project that allows them to cooperate on research while still competing with one another on the business front. HERCULES identified a number of promising technologies that will help the shipping industry meet its environmental targets.

The second phase of the project – Hercules B – is making major strides in the development of technologies designed to clean up diesel engines used on ships. Ultimately, HERCULES B aims to cut carbon emissions from shipping by 10 % and slash NO_x and other emissions (such as particulate matter) by 70 % and 50 % respectively.

Coordinator | ULEME EEIG (Germany)

Total budget (Phase I and II) | Phase I: EUR 58.3 million

EU funding (Phase I and II) | EUR 30 million

Start/end (Phase I and II) | 01/03/2004 – 31/08/2011

Website | <http://www.ip-hercules.com/>



TEFLES

Technologies and scenarios for low-emissions shipping

The overall goal of TEFLES is to cut fuel consumption by ships and thereby lower emissions and costs. It will achieve this through a combination of novel technologies and impact models that allows owners to evaluate the emissions and cost implications of fitting different technologies to their boats. The project has a particular interest in reducing emissions during port operations such as docking, loading and unloading. The project will also develop compact advanced after-treatment technologies to reduce SO_x , NO_x and PM.

Coordinator | Inova (Spain)

Total budget | EUR 3.1 million

EU funding | EUR 2.3 million

Start/end | 01/02/2011 – 31/01/2014

Website | <http://www.tefles.eu>

After-treatment technologies

Another method to cut shipping emissions is through the use of after-treatment systems that remove pollutants from the exhaust. The TEFLES project is developing and integrating a novel after-treatment product and other technologies with a view to reducing emissions both at sea, and in and around ports. In addition to after-treatment solutions, the team is looking into the application of other technologies in areas such as shore power connection, power generation and propulsion, which offer the potential for deep emissions cuts.

After-treatment technologies are also at the core of the HERCULES projects.

Alternative fuels

Currently, most ships run on diesel, but EU-funded researchers are actively investigating ways of making use of cleaner alternatives such as gas, electricity, methane and fuel cells.

The HELIOS project is developing a two-stroke low speed engine that runs on compressed natural gas (CNG) or liquefied natural gas (LNG) instead of conventional heavy fuel oil. Compared to present diesel engines, the technology should almost eliminate sulphur emissions, cut carbon emissions by over 20 %, NO_x emissions by up to 15 % and particulate matter emissions by as much as 70 %.

The first challenge for the team will be to obtain full electronic control over the high-pressure gas-injection technology involved in the system. They will then need to optimise the combustion process so that it runs as efficiently as possible.

Conventional fuel oil is high in sulphur, which causes high temperature corrosion in waste heat systems and boilers. The fact that LNG is practically sulphur free means that the new system can tolerate higher temperatures. This makes the use of a waste heat recovery system more feasible, which in turn will make the system more energy efficient. However, the absence of sulphur in the system poses another challenge for the team; normally, sulphur acts as a lubricant in engine combustion, so the researchers will have to find alternative lubricants.



POSE²IDON – Towards an electric future

Power-optimised ship for environment with electric innovative designs onboard

The ultimate aim of the POSE²IDON project is to bring down the size and cost of equipment needed for the electrical propulsion of ships. This will encourage a wider range of ships to switch to electric systems, something that will save ship owners money on fuel and cut the emission of harmful pollutants both at sea and in port.

Coordinator | BMT Defence Services Ltd. (United Kingdom)

Total budget | EUR 21.5 million

EU funding | EUR 10.1 million

Start/end | 01/01/2009 – 31/12/2012

Website | <http://www.poseidon-ip.eu/>



HELIOS – Going for gas

High pressure electronically controlled gas injection for marine two-stroke diesel engines

The HELIOS team aims to dramatically cut carbon, NO_x, sulphur and particulate matter emissions by designing engines that operate on compressed LNG instead of highly polluting conventional fuel oil. The researchers hope to have a demonstration model ready by the end of the project. The team is also working on ways of retrofitting the technology to existing ships.

Coordinator | Man Diesel & Turbo (Germany)

Total budget | EUR 5.1 million

EU funding | EUR 2.3 million

Start/end | 01/09/2010 – 31/08/2013

Website | <http://www.mandieselturbo.com/0001277/Products/Marine-Engines-and-Systems/Low-Speed/HELIOS.html>

While most ships are still powered by diesel, some, such as cruise ships and certain highly specialised vessels like anchor-handling ships, cable-laying ships and offshore support vessels are already starting to switch to electric propulsion.

The main motivation for ships to go electric is fuel economy; ships that benefit most from running on electricity are those that regularly switch speeds, such as cruise ships, and those that require a lot of generating capacity when the ship is not moving fast, such as cable-laying ships.

In fact, many ships meet these criteria, but are sticking to diesel because of the size, weight and cost of the equipment involved in electric propulsion. At the forefront of efforts to overcome these barriers is the EU-funded POSE²IDON project.

Part of the project is devoted to simply identifying the kinds of ships that have the most to gain by going electric. Meanwhile, the team is working on the development of high-temperature superconducting (HTS) technology to bring down the size and cost of electric propulsion systems, so as to make them more economically attractive to a broader range of vessel types.

Furthermore, the POSE²IDON partners are investigating ways of electrifying the auxiliary systems, for example the steering system, anchor handling, winches, stabilisers and rudders. Today, these are usually moved by hydraulic systems, which come with a number of disadvantages. As well as being difficult to install and maintain, hydraulic systems can pose a hazard to the environment if their oil leaks into the sea. An electric system would overcome these problems. The challenge here, as with the ships' power systems, is size. The force needed to turn a ship's

rudder is immense, so POSE²IDON's efforts are focused on developing small motors that are powerful enough to exert the forces required for auxiliary equipment to function properly.

POSE²IDON is also tackling the issue of emissions from ships at berth. 'The problem here is that the merchant ship comes into port, ties up alongside, [and] runs a small diesel engine to get power for its electrical systems while it's not at sea, and that produces a lot of emissions,' explains project coordinator Professor Chris Hodge of BMT Defence Services in the United Kingdom. 'One way to get rid of that is to take the power from the shore, and that explains why another major objective of the POSE²IDON programme is green shore supplies, as they're called.'

The team is working on a system that will allow ships to switch off their engines and plug themselves into the local electricity grid while in port. This will result in much cleaner air in ports and coastal areas.

Of course electricity is not the only potential power source under investigation by the shipping industry. There is a good deal of interest in the use of fuel cells to power ships. Fuel cells convert energy in a fuel like methanol, hydrogen or LNG into electrical energy; as they are more efficient than combustion engines, they offer the potential to cut down on energy use and, ultimately, emissions.

The EU has funded a number of projects in the fuel cell area. A case in point is FELICITAS ('Fuel-cell powertrains and clustering in heavy-duty transports'), which set out to develop fuel cell systems able to stand up to the heavy-duty requirements of the marine, rail and road transport sectors. It focused on developing high-power fuel cell clusters that group fuel cells with other technologies, such as batteries, thermal energy and energy recuperation.

The METHAPU ('Validation of a renewable methanol-based auxiliary power system for commercial vessels') project explored the feasibility of using solid oxide fuel cells (SOFCs) that run on methanol – a readily available and easily handled chemical that can be produced from renewable sources. The team developed a prototype unit and installed it on a commercial vessel.

The first commercial ship to obtain a significant chunk of its power from a fuel cell, the Viking Lady, was on show in Copenhagen, Denmark, at the same time as the UN's climate change conference there in 2009. The fuel cell installation on board the merchant ship is the result of a Norwegian research initiative (FellowSHIP), which started in 2003.

Ships in operation

One way of reducing a vessel's fuel consumption and, by extension, its carbon emissions, is to simply slow it down. In fact, rising fuel prices mean that many ship owners are already cutting their speeds in a bid to save money; if a ship that normally travels at 18 knots slows down to 14 knots, it can reduce its emissions by 40 %. This dramatic difference is due to the fact that even small increases in speed require a ship to overcome large increases in water resistance.

The EU-funded ULYSSES project is working to exploit this phenomenon by designing ships and machinery that run efficiently at low speeds. Part of the project focuses on existing ships; here the emphasis is on safety, manoeuvrability and machinery. When an engine does not run at the speed for which it is designed, it is less efficient and this needs to be addressed. The measures designed under this part of ULYSSES will allow ships to lower their speeds to 10 knots.

In the longer term, the team is working on a ship that would be ready in 2020 and designed to travel at 7.4 knots. Here, they plan to design a new hull form that is more efficient and works well at slow speeds in heavy waves. The ship will also feature a novel engine and a wind propulsor.

Finally, ULYSSES is looking into a ship for the year 2050 with a speed of 5 knots. Here the team envisions a convoy of unmanned vessels following defined shipping routes. Challenges here include securing such vessels against the risk of piracy, for example.

Another way to reduce fuel consumption is to optimise sailing plans taking into account sea states, currents and winds. The project NAVTRONIC will use real time data and remote observations combined with state-of-the-art nowcast and forecast numerical models to optimise sail plans. These plans will be automatically and continuously communicated to the vessel and will help the sea master take appropriate decisions.

On the other hand, the FLAGSHIP project ⁽³³⁾ has developed an energy efficiency monitoring system – FLAGSHIP-EEM (Energy Efficiency Monitoring). The system enables data acquisition and analysis to continuously evaluate power requirements during voyage in order to improve fuel consumption, thereby reducing both operational costs and environmental impact. In parallel the data are analysed also on shore. In a different approach FLAGSHIP developed a ship-shore coordinated Technical Condition Index Tool for monitoring and enhancing ship performance of vessels and fleets under management at large. Mr Herman de Meester, coordinator of FLAGSHIP, commented: 'FLAGSHIP-EEM works in parallel with current initiatives such as the IMO's energy efficiency index (EEDI). EEDI currently addresses new vessels only, while FLAGSHIP-EEM is applicable to both new and existing vessels ensuring that energy efficiency can be optimised in both situations.'

⁽³³⁾ See Chapter 4.



NAVTRONIC – Sailing at the optimum

Navigational system for efficient maritime transport

The project expects to develop a sail planning system, which uses ship-specific data collection and real-time local and remote observations (3D-radar, Earth Observation data etc.) combined with several state-of-the-art nowcast and forecast numerical models to help sea masters optimise sailing time, reduce fuel consumption and greenhouse gas emissions and minimise maintenance cost.

Coordinator | Advanced Computer Systems SpA (Italy)

Total budget | EUR 5.4 million

EU funding | EUR 3.6 million

Start/end | 01/09/2009 – 31/08/2012

Website | <http://www.navtronic-project.eu>

ULYSSES – Taking it slow

Ultra slow ships

Slow ships are environmentally friendly ships, yet today's vessels are not designed to travel optimally at low speeds. ULYSSES is designing ships that will be able to ply the seas at ever lower speeds, dramatically lowering emissions of CO₂ and other pollutants in the process. The project is focusing its efforts on bulk and tanker vessels as these account for 60 % of the shipping sector's emissions.

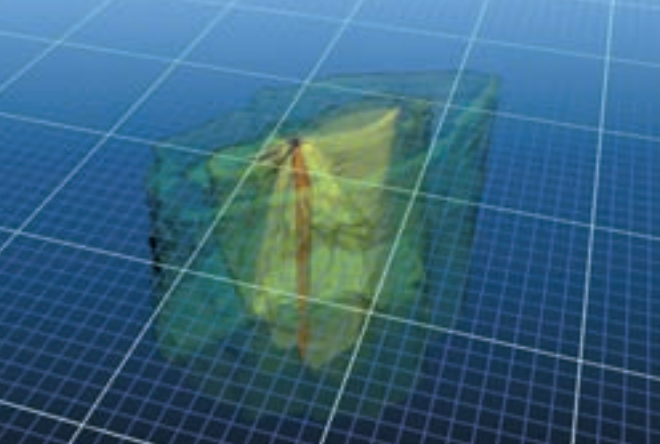
Coordinator | Bureau Veritas (France)

Total budget | EUR 3.7 million

EU funding | EUR 2.6 million

Start/end | 01/01/2011 – 31/12/2013

Website | www.ultraslowships.com



SILENV

Ships oriented innovative solutions to reduce noise & vibrations

SILENV is tackling the growing issue of noise from shipping. As well as developing technical solutions to the problem, it is designing a kind of acoustic green label that would set noise limits for different kinds of ships. In addition, the researchers are developing suggestions to help the ship builders and owners to meet these targets.

Coordinator | DCNS (France)

Total budget | EUR 5.1 million

EU funding | EUR 3.5 million

Start/end | 01/10/2009 – 30/09/2012

Website | <http://www.silenv.eu>

Towards quieter seas

Ships generate noise and vibrations, causing problems for people and wildlife alike. The noise can represent a considerable nuisance both for passengers, crew and, when ships are in port, local people. For certain categories of crew, exposure to noise and vibration can cause fatigue and ear impairment.

One EU-funded project working to tackle this problem is SILENV. As well as measuring the noise emitted by different kinds of ships on board, in port and under water, the team is working on tackling the four main sources of noise, namely the propeller, machinery, exhaust and hull (it is the hull that radiates sound into the environment).

Technical solutions to the noise problem include altering the shape and even form of propulsion systems and the active control of sound. This involves introducing a 'counter sound' between the source of the noise and the environment. The counter sound emits vibrations that effectively cancel out those produced by the machine.

The integrated project BESST⁽³⁴⁾ is also addressing the problem of noise and vibration, not only to increase the comfort and attractiveness of cruises but also to respond to environmental concerns in the vicinity of ports and those related to the impacts of underwater noise on marine life.

The issue of noise at sea has not escaped the attention of decision makers; the IMO has a working group on noise from shipping, whereas the EU is looking at the impact of underwater noise from shipping on marine animals within the framework of the Marine Framework Directive⁽³⁵⁾. Noise onboard is regulated by Directive 2003/10/EC, which sets minimum health and safety requirements regarding the exposure of workers to risks arising from physical agents (noise).

⁽³⁴⁾ See Chapter 2.

⁽³⁵⁾ OJ L 164, 25/06/2008, p. 19.

Combating invasive species

When ships offload their cargo, they often take up water into their ballast tanks to maintain their stability. However, all too often local marine life enters the tanks along with the water; an estimated 10 000 species of plants and animals are transported around the world in ships every day. Although most organisms do not survive the journey, enough do to cause often serious problems. The North American comb jellyfish, for example, has all but wiped out anchovy and sprat stocks in the Black Sea and is now spreading through the Caspian, North and Baltic Seas. The Chinese mitten crab has made itself at home in both Europe and North America, and is responsible for damage to river banks, fishing gear and industrial water systems. The invasive crab has caused EUR 80 million in damage in Germany alone⁽³⁶⁾.

IMO Member States adopted an International Convention for the Control and Management of Ship's Ballast Water and Sediments (BMW Convention) in February 2004, followed in 2005 by guidelines for the implementation of legislation requiring all ships (new and existing) to implement a Ballast Water and Sediments Management Plan, to carry a Ballast Water Record Book and to raise Ballast Water Management Procedures to a certain standard.

Further to these international measures, the BAWAPLA project set out to develop a safe, economically viable and technically competitive onboard ballast water management system that meets the requirements of the IMO.

As mentioned in Chapter 2, the project IMPROVE has looked at design solutions that would not require the use of ballast water to stabilise the ship.



BAWAPLA – Better ballast management

Sustainable ballast water management plant

Designing ballast water treatment systems that meet the IMO's requirements was the goal of the BAWAPLA project. In the end, the team came up with two alternative systems, one based on filtration plus UV treatment, the other based on filtration plus electrochlorination. Other project goals were to reduce the costs of cleaning ballast tanks and disposing of sludge that accumulates in the tanks.

Coordinator | ttz Bremerhaven (Germany)

Total budget | EUR 2.5 million

EU funding | EUR 1.7 million

Start/end | 15/11/2006 – 14/05/2010

Website | <http://www.bawapla.com/>

⁽³⁶⁾ WWF, *Silent invasion: the spread of marine invasive species via ships' ballast water*, Gland, Switzerland, 2009.

Safe waterborne transport

The sea poses many dangers, and while international legislation sets high safety standards, accidents still happen. Today, research in this crucial area focuses on integrating questions of risk and safety into the earliest stages of the design process. Scientists are also working to improve the inspection and maintenance of ships, and designing systems to help seafarers navigate and run their ships as safely as possible.

The European Maritime Safety Agency (EMSA) mentions that accidents have steadily been growing in the last few years reflecting the increase in numbers of ships sailing and vessel traffic density⁽³⁷⁾. Poor weather conditions as well as insufficient training, lower manning levels and fatigue are also common causes of accidents.

The opening of new shipping routes, in particular in the Arctic, or the occurrence of extreme weather events pose additional challenges for the safety of navigation.

At the international level, safety at sea is regulated by the International Maritime Organization (IMO)⁽³⁸⁾ through the International Convention for the Safety of Life at Sea (SOLAS). SOLAS has chapters covering all aspects of shipping, including construction, fire protection, life-saving appliances and arrangements, communications, navigation and the carriage of cargo, including dangerous goods. In addition, there are a number of chapters devoted to specific kinds of vessels, including nuclear-powered vessels, high-speed craft and bulk carriers.

Many amendments to SOLAS are adopted in response to specific maritime disasters; in fact, the first version of SOLAS, which dates back to 1914, was adopted in response to the Titanic disaster two years earlier. More recently, the sinking of the Herald of Free Enterprise off the Belgian coast in 1987 triggered the adoption of stricter rules concerning the stability of passenger ships that have been damaged, as well as the requirement that the bow doors of ferries be locked before the ship leaves its berth. The loss of the Estonia en route from Estonia to Sweden prompted the adoption of a new regulation designed to reduce the risk of capsizing for ships with over 400 passengers along with a requirement for all passenger ships to be fitted with public address systems.

As well as converting amendments to SOLAS into European legislation, the EU promotes safety at sea through the EMSA. EMSA itself was set up in the aftermath of the 1999 Erika disaster, in which 20 000 tonnes of oil were spilled into the Bay of Biscay, polluting French beaches and causing havoc in the local economy and wildlife alike.

EMSA provides the European Commission and EU Member States with technical assistance with regard to inspections and monitoring the application of EU maritime safety legislation, among other things. Tasks carried out by EMSA include the training of seafarers, the design of methodologies for marine accident investigation, and assisting in the implementation of port state control legislation, which has to do with the inspection of ships in ports. The agency also has responsibilities in diverse areas such as vessel traffic monitoring and oil pollution preparedness.

⁽³⁷⁾ EMSA, 'Quality Shipping, Safer Seas, Cleaner Oceans' (2010)

⁽³⁸⁾ See www.imo.org





Research for safer shipping

Research to improve the safety of shipping covers a wide range of priorities: from the design of safe ships to rescue operations. A lot of effort goes into better integrating safety and risk analysis into ship design, and into improving the crashworthiness of vessels. Another research priority concerns ships' inspection and maintenance routines. Human error remains a leading cause of shipping accidents, and a good deal of research aims to provide ships' crews with navigation aids as well as decision support systems to help seafarers take rapid, safe decisions both under normal conditions and during an emergency. Finally, research focuses on rescuing people when a ship has to be abandoned.

From reactive to proactive – the rise of risk-based design

For much of the history of shipping, new safety rules and systems have been set up in response to specific maritime disasters. However, while these rules have enhanced safety at sea, they are often highly prescriptive and limit the ability of ship designers to be truly innovative in their work and explore novel and economically attractive solutions. Today, there is an increasing trend towards so-called risk-based design in shipping, in which safety and risk analysis are integrated into the wider design process and subsequently considered as part of a goal-based approach to regulation.

The SAFEDOR project set out to apply risk-based design to a number of ship types and applications. In a book produced by the project, the SAFEDOR team explains the benefits of risk-based design. 'With the introduction of safety as an objective into the design optimisation process rather than being treated as a constraint, new technical solutions will be explored: the design solution space becomes larger,' they write. In other words, with risk-based design, naval architects have greater freedom to innovate, and that is good for safety as well as competitiveness.

Of course, a new design approach needs a new approval approach; currently, safety rules were largely designed to be applied to ships designed in a traditional way. SOLAS already contains provisions allowing for alternative designs. To support the IMO's work in this area, SAFEDOR submitted a set of guidelines on approving risk-based design ships; these are now under discussion.

Elsewhere, the project developed tools to test ship safety in five key scenarios, including collision, grounding, loss of structural integrity, damage stability, loss of intact stability and fire. This work was largely successful and many of the SAFEDOR tools are now being used by the project partners in their daily work.

The team also applied their knowledge to certain types of ships (such as ferries, cruise ships, container vessels and tankers), as well as to applications like power distribution, navigation and life-saving systems. 'Many of our ideas have been taken up by our industry and are now being followed in other projects,' comments Pierre Sames of Germanischer Lloyd and Chair of the SAFEDOR Steering Committee.

However, he cautions: 'There is still a long way to go before we see a full risk-based design ship. All of the applications that we have today are partially risk-based design, so elements of the ship are built and approved according to these approaches, but the overwhelming part of the vessel is still traditional.'

The project GOALDS⁽³⁹⁾ further looks at the possibilities of implementing the risk-based approach for grounding accidents and intends to answer concerns surrounding the calculation of survival probability of a roll on/roll off passenger (RoPax) ferry and mega cruise vessels. The consortium intends to integrate collision and grounding survivability formulation into a single framework and submit their findings to IMO.

The SAFEDOR probabilistic models are being carried forward in another EU-funded project concerning fire safety. Researchers in the FIREPROOF project are working on a risk-based approach to fire safety on passenger vessels.

⁽³⁹⁾ GOAL Based Damaged Stability

Fires are the most common incidents on board ships, and although they usually have less severe consequences than collisions and groundings, their relative frequency damages the image of the industry at large.

The international regulations designed to reduce the risk of fires on ships place a lot of constraints on ship designers. Although many novel ship designs are not inherently unsafe, they are simply too different to fit in with the rules.

'The regulation does not address the sequence of events that will lead to a catastrophic situation, but goes directly to the catastrophic situation and focuses on the end result alone,' explains George Mermiris of Strathclyde University in the UK, who is involved in the project. 'All the intermediate stages related to fire development are therefore disregarded at a stroke and along with them any chance to prevent fires from occurring in the first place.'

FIREPROOF aims to turn this around by developing recommendations to allow the approval of fire safety aspects of innovative risk-based designs. The recommendations will be submitted to the IMO at the end of the project. Ultimately, the hope is that the project will result in the relevant IMO regulations being updated.

SAFEDOR – Smart solutions for safer ships

Design, operation and regulation for safety

SAFEDOR spearheaded the application of risk-based design to various ship types and applications. It demonstrated how integrating risk analysis into the design process can ensure the safety of innovative vessel designs and generated guidelines to help the IMO assess the safety of risk-based design ships.

Coordinator | Germanischer Lloyd AG (Germany)

Total budget | EUR 20.1 million

EU funding | EUR 12 million

Start/end | 01/02/2005 – 31/07/2009

Website | <http://www.safedor.org>



FIREPROOF – A new approach to fire safety

Probabilistic framework for onboard fire safety

The FIREPROOF project is hoping to introduce risk-based design concepts to the IMO regulations concerning fire safety onboard passenger vessels. If successful, it will pave the way for more innovative ship designs, while minimising the risk of fire to acceptable levels.

Coordinator | University of Strathclyde (United Kingdom)

Total budget | EUR 4.2 million

EU funding | EUR 2.9 million

Start/end | 15/05/2009 – 14/05/2012

Website | <http://www.fireproof-project.eu/>



MINOAS – Robots to the rescue

Marine inspection robotic assistant system

By using robots to carry out parts of the ship inspection process, MINOAS hopes to make the process quicker and cheaper as well as safer. Using robots also means that tests are carried out in a more standardised way, resulting in more reliable inspections and, ultimately, safer ships.

Coordinator | Rina Services (Italy)

Total budget | EUR 3 million

EU funding | EUR 2.1 million

Start/end | 01/06/2009 – 31/05/2012

Website | <http://www.minoasproject.eu/>

Classification, inspection and maintenance

Correct maintenance and regular inspections are key to ship safety. Organisations called classification societies set and apply technical standards relating to the design and construction of ships and offshore structures and carry out extensive surveys of ships and their main systems; if a ship meets a society's standards, it is awarded a certificate. Ships must undergo regular surveys if they wish to maintain their class rating.

The EU currently recognises 13 classification societies worldwide. The EMSA is in turn responsible for assessing the performance of classification societies in Europe.

Vessels are classified according to their compliance with specific standards for design, structure, machinery and equipments. Common rules and standards are adopted by the classification societies in line with goals set by IMO. Rules and regulations are subject to revisions based on research and experience. In relation to the opening of new routes in the North, class standards are reconsidered.

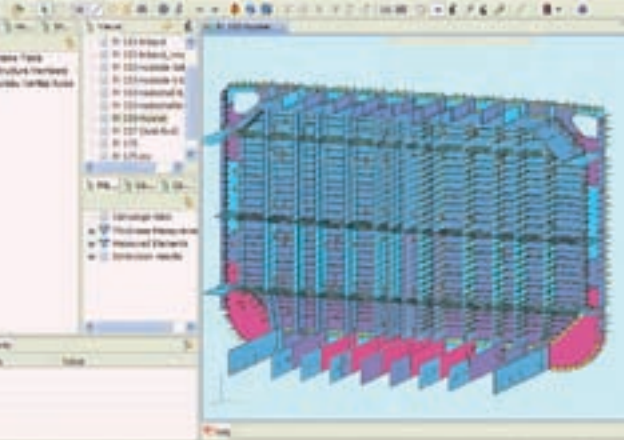
The SAFEICE project set out to make navigation in icy seas safer by shedding new light on the way ice affects a ship's hull. The team gather data on ice loading and ice damage from around the world. Studying ice loading is not easy; there are many different kinds of ice, and the ice load varies from one part of a ship to another. Nevertheless, the team succeeded in laying the foundations for a new set of evidence-based rules for ice class ships. The project's findings have already triggered amendments to the rules for ice class ships in the Baltic Sea, and a working group is studying the project outcomes with a view to forwarding them to the IMO. It is also expected that the results of the project will contribute to a unified international ice classification standard and will improve the safety of polar navigation.

The ship inspection process is not without problems – it takes some time, and while the ship is being inspected it is not earning its owners any money. In addition, ship inspectors regularly have to clamber up high scaffolds and enter parts of the ship that are difficult to access, dark, dirty and, in many cases, dangerous.

EU-funded research seeks to improve the ship inspection process and make it safer, faster and cheaper.

Working on a robotic solution to the problem is the MINOAS project. It is assembling a fleet of robots and associated tools capable of carrying out diverse inspection-related tasks, in many cases removing the need to send humans into hazardous environments. The project has also drafted procedures for classification societies on the use of robots during surveys. Ultimately, MINOAS should make the inspection process quicker, cheaper, safer and more reliable.

For its part, the ROTIS II consortium developed a robotic system design to perform remote inspections of ship ballast tanks with minimum human intervention and without the need to empty the ballast tanks. In order



CAS – Speedier safety surveys

Cost-effective inspection and structural maintenance for ship safety and environmental protection throughout its life cycle

CAS developed a communications standard that makes it easier for different organisations to share information and data during ship inspections. CAS partners are now working to get their system approved as an IACS (International Association of Classification Societies) standard. This would cement its legitimacy as a tool and pave the way for its wider use in ship inspections around the world.

Coordinator | Bureau Veritas (France)

Total budget | EUR 3.2 million

EU funding | EUR 1.7 million

Start/end | 01/02/2005 – 31/01/2008

Website | <http://www.shiphullmonitoring.eu/content/cas/home/>



FLAGSHIP – Helping seafarers take smarter, safer decisions

European framework for safe, efficient and environmentally friendly ship operations

FLAGSHIP is working to make the shipping sector safer as well as more competitive and environmentally friendly. Its suite of decision support tools will make it easier for captain and crew alike to remain focused and take decisions that will enhance maritime safety.

Coordinator | European Community Ship Owners' Association (Belgium)

Total budget | EUR 19.4 million

EU funding | EUR 10.2 million

Start/end | 01/01/2007 – 31/12/2010

Website | <http://www.flagship.be>

to facilitate communication and data transfer among different bodies involved in ship inspections, such as classification societies, owners, repair yards and service companies, the CAS project has developed a system that dramatically speeds up the inspection process. For example, measuring the thickness of the steel in a ship's hull forms a major part of the inspection. Previously, measurements were noted on a piece of paper and then copied over onto more pieces of paper before being entered manually into different computer programmes.

Under the CAS system, things are simpler; the measuring device transmits its findings directly to a computer, where the data is taken into the CAS programme, which

automatically runs various tools that assess the result against different factors (e.g., rule checks and stress checks).

CAS' system has other advantages; it allows users to visualise the entire ship in three dimensions (3D). Users can rotate the image and inspect it – areas where something appears to be wrong can be highlighted in a different colour.

Since CAS ended, two project partners have refined the system and turned it into commercial products. The system is also being used by researchers in other projects.

Safety support systems for seafarers

Over 50 % of incidents at sea can be attributed to human error or poor decision making. Seafarers often have multiple tasks and face a heavy administrative burden. The FLAGSHIP project has been targeting safety and efficiency by simplifying and streamlining seafarers tasks. Among other results, the integrated project has generated a series of decision support systems to make it easier for seafarers to take rapid decisions, particularly in emergency situations.

The project's holistic decision support system helps prioritizing remedial actions. For example, if there is a fire and the ship is listing and taking on water, deciding which emergency takes priority can be difficult; a fire in a location where there is a risk of explosion would take higher priority than a fire in a less sensitive area. Meanwhile, the bridge decision support system integrates data from multiple sources to provide one single, clear picture of the ship's operations as well as surrounding traffic.

With this, FLAGSHIP has also come up with an alarm filtering system. In an emergency situation, a flood of alarms will sound at the same time, making decision-making very complicated and stressful. The alarm filtering system 'shelves' warnings on categories of defunct systems and suppresses continuing alarms, allowing the crew to focus on the most important ones.

Elsewhere in FLAGSHIP, researchers are investigating the feasibility of making greater use of the expertise of people on shore, for example the ship management or owners. This could be useful for both general maintenance decisions as well as during a crisis. Certain administrative tasks could also be transferred from ship to shore, giving the crew more time to focus on operating the ship safely.

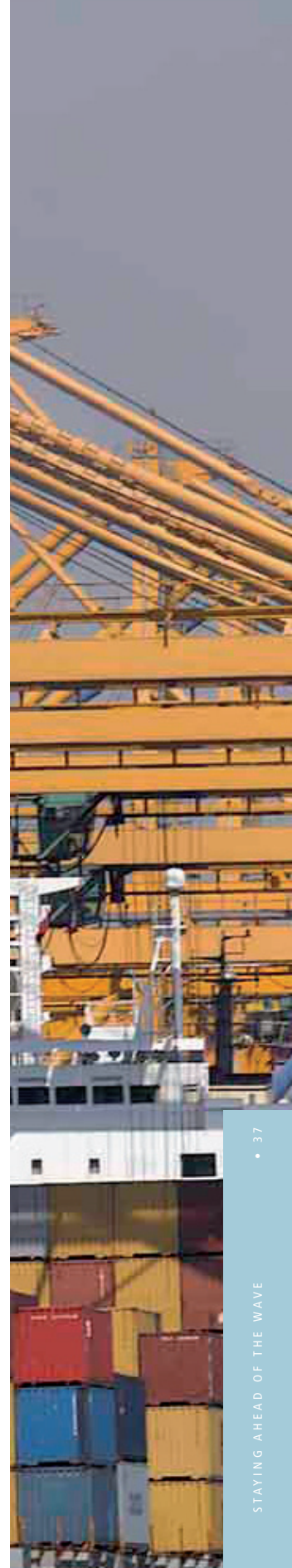
Many of the FLAGSHIP technologies are at a fairly advanced stage, and some have already been installed on working ships. In fact, a novel decision support system relating to elements such as stability and fire is in use on the Oasis of the Seas, the world's largest cruise ship. Some of the project's results are being transmitted to the IMO for further discussion at the international level. In addition, FLAGSHIP is also working on initiatives to make shipping more competitive and environmentally friendly.

In extreme weather conditions, dense traffic or when a ship has been damaged decision support systems are precious tools for reducing the risk of incorrect decisions that might cause an accident or aggravate a delicate situation.

The HANDLING WAVES⁽⁴⁰⁾ consortium developed an onboard decision support system for tactical decisions of ship handling waves that enable the master to improve performance and minimise the likelihood of structural damage. For its part, the DSS-DC⁽⁴¹⁾ project aimed to develop decision support systems for handling crisis situations, for example in cases of hull damage and intentional grounding or propulsion problems. Cooperation tools for use onboard and between ship and shore will be developed.

⁽⁴⁰⁾ See <http://www.mar.ist.utl.pt/handlingwaves>

⁽⁴¹⁾ Decision-support System for Ships in Degraded Condition.





Another EU-funded project that is set to make navigation easier and safer, especially in busy areas such as ports and heavily used shipping lanes and waterways, is ARIADNA. The project is pioneering the development of an advanced navigation system that draws on diverse data, such as positioning, wind, weather, waves and the ship's manoeuvring capabilities, to create a 3D 'safety envelope' around the ship. The ship's own envelope is displayed on an onboard user terminal along with the safety envelopes of nearby vessels. Local control stations in ports or at docks can also monitor the safety envelopes of ships in the area, as well as those of major infrastructure obstacles.

The system represents a major advance over current systems that simply mark vessels as dots. Because ARIADNA generates an envelope it will help to minimise the risk of both collisions and groundings. In addition, by providing a clearer picture of ships in the area, ARIADNA will make it easier to safely increase the capacity of infrastructures like ports, as well as busy channels and inland waterways, and lead to more environmentally friendly operations.

Crucially, ARIADNA's concept will be based on existing navigation systems, so ships would just have to add ARIADNA's new functionalities.

A pilot of the system will be tested on the River Danube in Austria and at the Port of Barcelona in Spain. Potential users of the system are enthusiastic about it. 'We have a pool of 20 end-users who are interested and participating very actively in defining user requirements and validating these,' comments project coordinator Ana Maria Gomez Arche of Isdefe in Spain.



SAFEICE – Towards safer ice class ships

Increasing the safety of ice-bound shipping

SAFEICE brought together researchers from Europe as well as Canada, Japan and Russia to carry out the research needed to improve the rules governing ice class ships. By gathering existing data and carrying out additional studies, SAFEICE was able to generate the first complete, detailed picture of the ice load distribution on ships' hulls.

Coordinator | Helsinki University of Technology (Finland)

Total budget | EUR 2.2 million

EU funding | EUR 1 million

Start/end | 01/09/2004 – 31/10/2007

Website | <http://www.tkk.fi/Units/Ship/Research/Safelce/Public/>

SAFECRAFTS – Lifeboats for big boats

Safe abandoning of ships – life-saving appliances

The aim of the SAFECRAFTS project was to improve current lifesaving appliances and develop new ones so as to facilitate the evacuation of large passenger vessels (carrying hundreds or even thousands of people) in an emergency. In addition, SAFECRAFTS developed an innovative system to facilitate comparisons among various ship evacuation systems.

Coordinator | TNO Building and Construction Research (Netherlands)

Total budget | EUR 5.1 million

EU funding | EUR 2.8 million

Start/end | 01/02/2004 – 31/05/2009

Website | <http://www.safecrafts.org/>



ARIADNA – A nifty navigation system for safer shipping

Maritime-assisted volumetric navigation system

ARIADNA, based on the Volumetric Navigation System (VNS), is developing a navigation system that combines current conditions (such as wind, waves and weather) with a vessel's position, course and manoeuvrability to generate a 3D picture of the vessel's 'safety envelope'. As well as lowering the risk of collisions, ARIADNA will make it easier to maximise the use of ports and shipping lanes.

Coordinator | Isdefe, Systems Engineering for the Defence of Spain SA (Spain)

Total budget | EUR 3.4 million

EU funding | EUR 2.5 million

Start/end | 01/11/2009 – 31/10/2012

Website | <http://www.ariadna-fp7.eu/>





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SAFEGUARD – Fast response for efficient evacuation

Ship evacuation data and scenarios

The aim of the SAFEGUARD project responds to the invitation of the IMO Fire Protection Sub-Committee to provide information on scenarios for evacuation analysis and full scale data to be used for validation and calibration of ship-based evacuation models.

Coordinator | British Maritime Technology Group, BMT Group Ltd (United Kingdom)

Total budget | EUR 3.5 million

EU funding | EUR 2.1 million

Start/end | 01/04/2009 – 31/03/2012

Website | <http://www.safeguardproject.info>

Towards easier evacuation

There is currently a trend for constructing cruise liners and ferries capable of carrying thousands of passengers. If such a ship were to catch fire or sink, the consequences could be nothing short of catastrophic. SOLAS requires ships to follow numerous rules and regulations regarding escape routes and the provision of life-saving appliances (LSAs).

The EU-funded SAFECRAFTS project focused on developing new and improved LSAs. The project partners came up with two novel, affordable lifeboats, both of which can hold up to 400 evacuees and be easily stored on board the mother ship without taking up too much valuable deck space.

Passenger response time is a key parameter specified in the IMO evacuation analysis protocol. This protocol specifies an assembly time and congestion criteria for safe evacuation in essentially four scenarios. The project SAFEGUARD will build on the FIRE EXIT project and continue to acquire an adequate volume of quality sea-based data on passenger response times and assembly times to permit model calibration, verification and validation. The project will collect human performance data in full-scale ship trials. The ultimate aim is to improve the IMO evacuation analysis protocols.

Cleaning up after accidents, oil spills and ship dismantling

Oil is routinely transported around the world by sea. Despite increasingly stringent safety measures on ships and offshore installations, accidents can and do occur, sending oil spilling out into the ocean where it harms marine life and pollutes shorelines. Some ship owners are also guilty of deliberately discharging oil into the sea. EU-funded researchers are developing ingenious solutions to rapidly detect and clean up oil spills. Elsewhere, other projects are working for a cleaner, safer ship-breaking industry worldwide.

Every year, 1 billion tonnes of oil pass through EU ports and are borne through EU waters. While most of this oil reaches its destination without mishap, accidents do occur with sometimes catastrophic consequences for the environment and economy alike. In fact, there are some 60 accidents in European seas annually, of which around 15 result in oil or chemical spills.

Two recent disasters that have spurred a good deal of EU activity in this area are the Erika and the Prestige. The Erika broke in two and sank during a storm in the Bay of Biscay in December 1999, spilling her cargo of 20 000 tonnes of oil into the Atlantic Ocean. As well as killing wildlife, the resulting oil slick polluted 400 km of French coastline and harmed the local tourism and fishing industries.

Barely three years later, in November 2002, the Prestige sank off the coast of Galicia, Spain, releasing some 17 000 tonnes of oil into the environment, much of which washed up on the Galician coastline. When she went down, the Prestige had been carrying over 77 000 tonnes of oil. Initially, it was suggested that the rest of the tanker's cargo would remain trapped inside the ship, which was lying on the seabed at a depth of almost 4 000 m. However, it soon became clear that oil was still escaping from the wreck, and in 2004 an operation was launched to remove the oil from the ship. This was done by shuttle tanks controlled by a remotely operated vehicle (ROV). Despite this exercise, it is estimated that over 80 % of the oil on board the Prestige was spilled.

Meanwhile, on the other side of the Atlantic, the 2010 explosion of the Deepwater Horizon drilling platform in the Gulf of Mexico, which resulted in oil gushing into the ocean for a number of months, highlights the fact that offshore installations also represent potential sources of pollution.



Prevention is better than cure!

In response to the Erika and Prestige tragedies, the EU tightened legislation designed to prevent accidents from happening in the first place and penalise ships that pollute the marine environment. For example, the EU is pioneering efforts to phase out single-hulled tankers worldwide. It has also established a notification system for ships carrying dangerous or polluting goods to or from EU ports. In addition, the EU set up the European Maritime Safety Agency (EMSA) and tasked it with providing technical and scientific advice to the European Commission on matters relating to maritime safety and pollution prevention.

One of the EMSA's main jobs involves ensuring that EU legislation relating to ship safety is applied consistently and correctly throughout the EU. The EMSA also assists the European Commission and EU Member States in the implementation of legislation design to prevent pollution from ships. Finally, the organisation is compiling a database of marine accidents in the EU and offers support to Member States investigating serious marine accidents.

EMSA has also developed a satellite-based monitoring system for marine oil spill detection and surveillance in European waters – the CleanSeaNet service, which entered into operation in 2007⁽⁴²⁾.

At the international level, the International Maritime Organization (IMO) is investigating ways of reducing the risk of pollution. For example, subdividing tanks minimises the amount of oil that can flow into the sea if the hull is breached, while installing a back-up engine lowers the chances of a ship running aground if the first engine fails. Here the challenge is to identify the most cost-effective measures to prevent pollution.

Investments in research to clean up oil spills

As well as taking steps to cut the risk of major oil spills occurring in EU waters, the European Commission has invested in the development of novel technologies to improve the clean-up process.

Retrieving oil from shipwrecks is far from easy; hoses are sometimes used in shallow water to do the job. The attempts to salvage oil from the sunken Prestige

highlighted the difficulties of cleaning up wrecks lying in deep water; shuttling the containers between the wreck and the surface was a slow, laborious process. The DIFIS project has come up with a deceptively simple system that can easily remove oil from wrecks in water that is 2 000 m deep.

First, an umbrella-like structure 100 m across is placed over the wreck. This guides oil floating up from the wreck towards a riser tube, which snakes upwards towards the surface. At the top of the riser tube, the oil emerges into a bell-shaped device called the buffer that lies some 50 m below the sea's surface to protect it from the wind and weather. The oil becomes trapped in the top of the buffer bell, while any water coming up the riser tube escapes from the bottom of the device. The buffer bell has buoyancy and is responsible for holding up the entire structure.

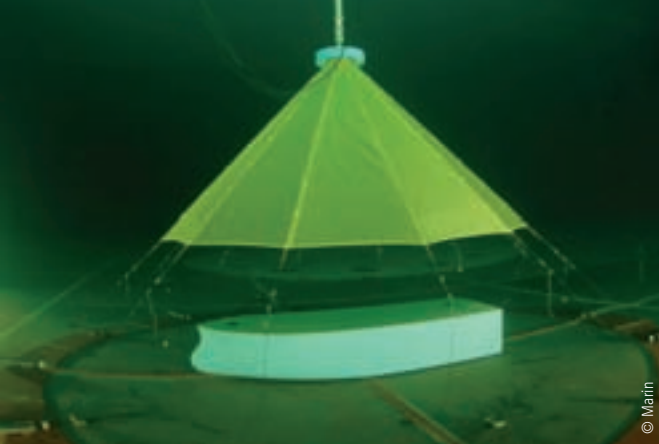
When the bell is full, the oil can be offloaded onto a ship. The system offers numerous advantages. Firstly, it is entirely passive, relying on the fact that oil is lighter than water. The rate of oil flow from the wreck can be simply controlled by patching up or puncturing holes in the wreck to slow down or speed up the process respectively, as required. In addition, it does not require a ship to be constantly present at the surface.

'Once it's installed there's only a need for periodic offloading and inspection but other than that it will do its work by itself,' explains project coordinator Hans Cozijn of the Maritime Research Institute Netherlands (MARIN). The system proved successful on the model scale, coping well with wind, waves and currents. The next step is to build a prototype and see how it performs on an existing wreck out at sea.

Smart solutions for smaller spills

Although it is the big spills that hit the headlines, the overwhelming majority of spills are in fact relatively small in nature. Most ships have some fuel on board to power their engines, and if they are involved in an accident this fuel may be released into the sea. For example, when the cruise ship The Sea Diamond struck rocks and sank just off the Greek island of Santorini in April 2007, the fuel tanks quickly started to leak their contents into the environment, resulting in a small oil slick.

⁽⁴²⁾ See <http://cleanseanet.emsa.europa.eu>



DIFIS – A promising solution to a big problem

Double inverted funnel for intervention on shipwrecks

The DIFIS project has created a simple system in which oil from shipwrecks lying in deep water is literally funnelled to a storage reservoir just below the surface. The whole system is held up by the buoyancy of a bell-shaped reservoir, and once installed it can be left to do its work until the bell buffer is full.

Coordinator | MARIN, Maritime Research Institute Netherlands (Netherlands)

Total budget | EUR 3.2 million

EU funding | EUR 1.8 million

Start/end | 01/09/2005 – 31/05/2009

Website | <http://www.difis.eu>

ARGOMARINE – Sleuthing for spills

Automatic oil-spill recognition and geopositioning integrated in a marine monitoring network

The ARGOMARINE project is working on the creation of a marine monitoring system for use in environmentally sensitive areas. The system will allow coast guards and other bodies involved in marine conservation to detect spills as soon as they happen. This is important because a rapid response gives teams more time to contain the damage.

Coordinator | National Park of the Tuscan Archipelago (Italy)

Total budget | EUR 4.3 million

EU funding | EUR 3.3 million

Start/end | 01/09/2009 – 31/08/2012

Website | <http://www.argomarine.eu/>

Some ships deliberately release oil into the ocean, for example by pumping out their bilge water without treating it to remove the oil first. Although small, these pollution events can be extremely harmful to the environment, particularly if they happen in sensitive areas boasting high levels of biodiversity.

The EU-funded ARGOMARINE project is developing a marine information system to ensure that these illegal spills are detected rapidly so that a response can be mounted as quickly as possible. The system will draw on data from diverse sensors to detect oil spills and monitor traffic, especially illegal traffic, in marine protected areas.

Data from synthetic aperture radar (SAR) systems onboard satellites will feed into the system, as will thermal, acoustic and other sensors mounted on aeroplanes, boats and buoys as well as autonomous underwater vehicles (AUVs), which could be used to patrol environmentally sensitive areas. The team is even developing an electronic nose (e-nose) capable of detecting the presence of a wide range of hydrocarbons in the water. The device would be attached to floating buoys and AUVs.

The marine information system will act as a decision support instrument for coast guards and other institutions responsible for environmental and civil protection. 'Our idea is that the people who are in charge of handling emergencies should have privileged access to this data,' explains project coordinator Michele Cocco of the National Park of the Tuscan Archipelago in Italy. While the ARGOMARINE system is designed primarily for coastguards, the scientific community will also be able to access and use the data for research purposes.

Obviously, once a spill has been detected, it needs to be cleaned up. This is where the EU-MOP project comes in. It has created a fleet of autonomous boats that work as a team to clean up small oil spills.

The EU-MOP boats range in size from 1 m to 6 m and are equipped with sensors to locate oil. When a patch of oil is detected, it is taken up via a skimming device at the front of the vessel and stored in a tank at the back of the boat. When the tank is full, the unit goes back to the command centre to offload its cargo. The units are also able to communicate with each other to coordinate their work.

If the spill is near land, the fleet can be launched from the shore. Otherwise, the units are launched from a ship. In any case, a human controller oversees their operation.

‘One of the advantages of this concept from a cost consideration is that it is far less labour intensive than other systems,’ comments project coordinator Harilaos Psaraftis of the National Technical University of Athens in Greece. ‘You can place these units in locations which would be very difficult for a human to access, like under a pier, or even in environments that are not safe for human beings.’

EU-MOP’s efforts are complemented by work going on in the HOVERSPILL project. Oil spills can wreak havoc on coastlines, and very often the affected areas are difficult to access.

HOVERSPILL is developing a hovercraft that would be able to clean up oil along coastlines. Once ready, the vessel will be relatively cheap and easy to maintain, and will be capable of travelling at over 30 kn.

For its part, the project OSH (Oil Sea harvester) (has developed a fast ship, which can arrive quickly at the scene of an accident and recover oil when the spill is still concentrated. This ship will be able to operate in high seas.



EU-MOP – Robots to the rescue!

Elimination units for marine oil pollution

The EU-MOP project has created a fleet of autonomous units that work together to clean up small oil spills. Being small and unmanned, they are ideal for use in locations that are inaccessible to larger, manned vessels. The EU-MOP team is now keen to develop the technology further.

Coordinator | National Technical University of Athens (Greece)

Total budget | EUR 2.9 million

EU funding | EUR 1.9 million

Start/end | 01/02/2005 – 31/01/2008

Website | <http://www.martrans.org/eu-mop/index.htm>

HOVERSPILL – Hoovering up oil spills with a hovercraft

Multi-environment air cushion oil spill fast response & post emergency remediation system

HOVERSPILL is working on a kind of hovercraft that would be able to clean up oil along coastlines, where features such as rocky shoals and mudflats make access tricky for other vehicles. Able to move seamlessly between land and sea, the hovercraft does not need to be launched from a harbour; instead it can be transported directly to the affected area by road and start work straight away.

Coordinator | Innova (Italy)

Total budget | EUR 3.5 million

EU funding | EUR 2.6 million

Start/end | 01/12/2009 – 30/11/2012

Website | <http://www.hoverspill.eu/>



Towards a cleaner, safer ship-breaking industry

When ships reach the end of their lives, they are typically dismantled. In Europe and North America, ship breaking is a hi-tech affair; most ships are carefully taken apart in dry docks, and the health of workers and the surrounding environment is given a high priority. However, the vast majority of vessels are broken up in southeast Asia; India and Bangladesh alone account for 80 % of the world market. Here, although there has recently been much progress, workers are still exposed to a variety of dangers including falling from heights, explosions, toxic chemicals and substances like asbestos. The local environment also suffers as there is insufficient awareness in the local ship-dismantling communities of the potential for dangerous substances found on ships to pollute surrounding areas.

Action has been taken at international level through the adoption by IMO in May 2009 of the International Convention for Safe and Environmentally Sound Recycling of Ships (also known as the Hong Kong convention). This Convention, which should help to promote higher standards in the industry, covers the whole life-cycle of a ship from design, construction and operation through to the recycling stage. The Convention is currently open for signature and ratification by individual country members of IMO.

In a Communication adopted in 2010⁽⁴³⁾, the EC has expressed its strong encouragement to Member States to ratify the Hong Kong Convention as a matter of priority.

The convention is expected to come into force around 2015, and the DIVEST project is already putting together a comprehensive database of legal, technical, social and environmental information relating to ship breaking – both in Europe and elsewhere in the world. It has a strong focus on identifying and promoting best practices, particularly in southeast Asia.

The DIVEST team is engaging with managers in Indian ship-breaking facilities to gain their support for and input in specialised training schemes. The hope is that the training programmes will last beyond the end of the project and help Indian yards to comply with future requirements of the Hong Kong Convention. As DIVEST's David Calder of TWI in the UK explains, 'The more enlightened yards will gain competitive advantage by being ahead of the curve.'

Steps can be taken to reduce risks to shipyard employees and the environment. For example, ships should be pre-cleaned to remove the most dangerous chemicals and substances, and gas tanks should be emptied to reduce the risk of explosions. Part of the DIVEST project is also looking at how simple tools can be used in novel ways to make ship dismantling safer.

⁽⁴³⁾ An assessment of the link between the IMO Hong Kong Convention for the safe and environmentally sound recycling of ships, the Basel Convention and the EU waste shipment regulation. – COM(2010) 88 final.

The EU-funded SHIPDISMANTL project also generated a set of guidelines for innovative ship-dismantling and recycling operations that set out the optimal design for a ship-breaking site and offer advice on how to optimise ship-breaking facilities and dismantling processes with regard to environment, cost and energy issues, as well as workers' health and safety.

In addition, the team created a web-based decision support system that takes into account a ship's characteristics and history as well as the ship-breaker's facilities to help users determine the best way to go about dismantling a particular ship. The project partners expect that this decision support system will cut operational costs by up to 30 %.

A number of project partners have implemented the SHIPDISMANTL decision support system, including Leyal, an active member of the Turkish Ship Breakers' Association. Leyal quickly transmitted the project results to its fellow Turkish ship breakers. Many have implemented the project results and some have even invested in newer ship-breaking technologies such as cold-cutting, which is safer than torch cutting.



SHIPDISMANTL – Dismantling ships with care

Cost-effective and environmentally sound dismantling of obsolete vessels

The SHIPDISMANTL project came up with a set of guidelines for ship dismantling and recycling that covers environmental, cost, energy and worker safety issues, as well as a decision support system for ship breaking that could cut costs by as much as 30 %. SHIPDISMANTL's results also fed into the IMO's guidelines on ship breaking and the work on the Hong Kong Convention.

Coordinator | Naftosol SA (Greece)

Total budget | EUR 2.6 million

EU funding | EUR 1.6 million

Start/end | 01/02/2005 – 31/01/2009

Website | <http://www.shipdismantl-project.org:81/>

DIVEST – A helping hand for the ship-breaking industry

Dismantling of vessels with enhanced safety and technology

One of the most important outcomes of the DIVEST project will be an online information system through which all kinds of users can access data on diverse aspects of ship dismantling worldwide and share information with one another. With partners in India, the DIVEST project should help the southeast Asian shipbuilding industry to raise its safety and environment standards and start to prepare for the implementation of the Hong Kong convention.

Coordinator | V.Navy (France)

Total budget | EUR 3.4 million

EU funding | EUR 2.4 million

Start/end | 01/08/2008 – 31/07/2011

Website | <http://www.divest-project.eu>

Conclusions

A healthy waterborne transport sector is essential to Europe's economy and European society. EU-funded research contributes to the success of the sector by making it more competitive, greener and safer. Further efforts will be needed in the future to support these challenges and prepare the maritime industry for long-term challenges such as oil shortage. To remain competitive, the European shipping industry will need to be ready for the development of new maritime business opportunities, such as the rise of renewable maritime energy sources and deep sea exploration.

A competitive European maritime industry

The global shipbuilding sector is highly competitive, and the European industry needs to continually produce highly specialised, innovative vessels for niche markets to stay ahead of the game. EU-funded research has resulted in novel computing tools that are helping ship designers refine their designs and produce better, more hydrodynamic vessels that are cheaper and easier to maintain throughout their lives. In shipyards, EU-funded projects have delivered innovative ways of putting ships together.

Looking to the future, further research is needed to adapt computing design tools so that they can run on the latest computing architectures – this will make them faster and better. Work is also needed to further improve shipbuilding processes.

From the operational point of view, continued efforts are needed to improve life-cycle performance as well as to reducing operational costs.



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Towards greener ships

Although shipping presents environmental advantages compared to other modes of transport, notably due to its energy efficiency, the rise in shipping traffic means the sector's environmental impact is set to rise. EU-funded research is helping to bring down emissions of CO₂, sulphur oxide and nitrous oxide by designing cleaner diesel engines as well as engines that run on alternative fuels such as gas, electricity, methane and fuel cells. In addition, research is investigating ways of making ships more hydrodynamic by addressing hull lubrication and propeller design. Other ways of cutting emissions include optimal ship operation and applying after-treatment technologies to exhausts. Technologies to limit the spread of invasive species or limit the impacts of noise still need to be developed and improved.

Although research carried out so far has resulted in significant emissions savings, more research is needed to cut emissions even further. In addition, although a lot of work goes into the design of new vessels and their machinery, attention needs to be paid to the integration of energy systems on board and to retrofitting existing ships with state-of-the-art technologies.

Safe, sustainable and efficient waterborne transport

Despite dramatic improvements in recent years, safety at sea remains an issue. EU-funded research is generating innovative ways of improving maritime safety by facilitating navigation, improving the inspection process and tackling evacuation procedures.

EU-funded researchers have also been involved in the emerging trend towards risk-based design, in which safety aspects are integrated into the entire design process. However, while elements of ships are now designed using risk-based design techniques, more research is needed before ships can be designed entirely using a risk-based approach.

Cleaning up after accidents and dismantling

The Deepwater Horizon disaster in the Gulf of Mexico dramatically highlighted the urgent need for novel technologies to clean up oil pollution in our oceans. A number of EU-funded projects have developed innovative systems to detect and clean up spills, both deliberate and accidental, on a range of scales, but in most cases further development is needed before they can be deployed at full scale. Research is also needed into the issue of how to evaluate the economic consequences of oil spills or other hazardous substances and, crucially, what measures can be taken to further minimise the risk of spills occurring in the first place.



Putting Europe ahead of the wave

In its maritime policy until 2018⁽⁴⁴⁾, the EU underlines the importance of continuing research and innovation on waterborne transport. For its part, the Waterborne Technology Platform describes research, development and innovation as ‘key to European competitiveness’ in its Strategic Research Agenda (SRA).

‘The industry’s competitiveness strategy is based on high productivity, the superior performance of its innovative products and services, and an ongoing commitment to developing and implementing new knowledge,’ the SRA reads.

Today, the waterborne transport sector faces two major challenges. Firstly, it is still feeling the effects of the recent economic crisis, although there are signs of recovery. Secondly, the level of maritime transport is predicted to rise over the coming years. On the other hand, there are new opportunities on the horizon – the shipbuilding sector could find a use for its technologies in emerging sectors such as renewable maritime energy (wave and tidal power) and exploration of the deep sea. The opening up of routes around the Arctic is also set to have impacts on the sector.

Ongoing research will enable the industry to meet these challenges head on and capitalise on new opportunities. As European research forges ahead, future generations will continue to benefit from cost-effective, green and safe waterborne transport for many years to come.

⁽⁴⁴⁾ European Commission, *Strategic goals and recommendations for the EU’s maritime transport policy until 2018*. COM(2009) 8 final. Brussels, 21 January 2009.

Find out more

More information on EU-funded waterborne transport research projects can be found on the following sites:

Maritime Transport Database (EU-funded MARPOS Project):

<http://www.maritimetransportresearch.com>

Transport Research Knowledge Centre (TRKC):

<http://www.transport-research.info/web/>

Transport research pages on the EU's Europa website:

http://ec.europa.eu/research/transport/index_en.cfm

Transport research under FP7 (CORDIS):

http://cordis.europa.eu/fp7/transport/home_en.html

European Commission

Staying ahead of the wave

Towards greener, safer, and more competitive waterborne transportation

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The seas and waterways are essential for the health of Europe's economy and society. This is why the EU has invested almost EUR 300 million in maritime transport research and research coordination actions since 2002.

This brochure offers a snapshot of research projects funded under the EU's Fifth, Sixth and Seventh Research Framework Programmes in the waterborne transport domain. It gives an overview of the challenges facing waterborne transport, but most of all of Europe's response: research and innovation that assure a competitive European waterborne industry, greener ships, safe waterborne transport, and sound ways of dealing with accidents, oil spills and ship dismantling.



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