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Vessels for the future

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Abstract

The European research association Vessels for the Future was launched in November 2014. It has members has 59 members (as of May 2015) in 14 EU Member States. Members represent ship owners, ship yards, ship system suppliers, classification societies, research institutes, university departments and industry associations. Hence Vessels for the Future brings together a leading group of maritime stakeholders with a common interest to ensure that European maritime research has a strong and vibrant future sustaining a competitive maritime industry. This will be achieved through agreeing collaborative research and with the support of public and private financing.

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1. What will the future look like?

What vessels, equipment and systems will Europe need in the decades to come? Imagine automated ships arriving in our ports with zero emissions. Will ferries with diesel engines be a relic of our past? Can we rely on high-tech construction vessels to grow our Blue Economy while protecting our ocean? This is the European

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Commission's vision for our future, but it is only achievable if our best marine engineers and researchers focus on the necessary maritime technologies. The approach to innovation that we decide today will shape our ocean space and business tomorrow. The European Research Association Vessels for the Future will capitalise on the European strengths in R&D and leading position in high value ship segments, whilst also recognising opportunities for growth through the deployment of new and developing technologies, across the maritime sector.

2. What is at stake?

2.1. Jobs and innovation

The maritime technology sector is a strong strategic partner for the European Commission, solving societal challenges while growing the Blue Economy. Cutting edge research directly benefits Europe's maritime industry cluster and supports essential trading arteries for the EU, whilst generating €1 billion per year and sustains 500,000 jobs. Europe is the global leader in high added-value vessels, high-tech systems and specialist equipment. This sector in turn facilitates the EU's Blue Economy, which supports 5.4 million European jobs and represents a gross added value of just under €500 billion per year covering wide ranging shipping operations, ports facilities, a host of coastal industries, off-shore operations, inland and seagoing passenger and cargo trades and European security.

However, the prevailing approach to private and public funding has created a fragmented maritime Research Development and Innovation (RDI) landscape across Member States. Without more collaborative research specifically aligned with EU priorities, we cannot improve the profitability of industrial innovation. Plus, the narrowing knowledge gap with other parts of the world sees research opportunities and investment shifting away from the EU. That is why we are committed to world class RDI in partnership with the EU. In Vessels for the Future we believe we have the right combination of stakeholders to make a significant impact on the EU's policies for Job creation, development of the Digital market and Energy union.

2.2. Safe, efficient and clean transport

We live in a fast moving era when systems and services are changing at mega pace. Transport is no exception and all modes of transport are under the spotlight to reduce loss of life, both directly by reducing accidents and indirectly through the effects that emissions have on our environment and consequently on human life.

Looking at a longer timeframe, the volume of seaborne trade is expected to at least double by 2030 with a corresponding increase in the world shipping fleet. This will create an unprecedented demand for new technology that can reduce overall emissions and increased levels of safety that can only be met through the increased collaboration and funding provided by the Vessels for the Future envisaged cPPP. Thus, safer, efficient, cleaner shipping brings a double benefit, it not only makes for a safer world but can produce economic benefits for business.

Like other industries, tapping into the digital economy will be crucial in the maritime industry's endeavour to improve safety and protect the environment and meet the expectations of the European Union and society at large. We foresee smart ships of the future operating in EU waters delivering cargo without delay and at reduced cost to industry and society.

In addition to this, ships are major producers and consumers of energy. A major part of the work envisaged within the Partnership will therefore include improving the use of energy. But when considering long term horizons, managing the connections to the grid in port could provide benefits for both emissions reduction or, in reverse, supplying emergency power to the grid in times of crisis.

3. Solutions in partnership

To maintain Europe's market leadership and deliver on Europe's flagship policies, the maritime community believes there is a strong case for the European Commission to establish a contractual Public Private Partnership (cPPP) to promote, coordinate and facilitate pre-competitive RDI of waterborne technologies.

Through this partnership, the recently launched 'Vessels for the Future Research Association' aims to facilitate joint industry projects. These projects bring together the multi-disciplinary consortia needed to develop key

maritime technologies, demonstrate their benefits to investors and speed up introduction to market. The multi-annual RDI roadmap of Vessels for the Future aligns with the strategic research agenda developed through the Waterborne Technology Platform.

3.1. Prioritise RDI

Through the Partnership, the industry has more influence on the RDI priorities being called and the European Commission can ensure that RDI topics are relevant for the industry which in turn means faster technology uptake. With long-term commitment from the maritime industry and the EU Commission, the envisaged Partnership facilitates addressing larger societal and industrial challenges through assembling a critical mass of research resources.

3.2. Innovate with transparency

The Partnership not only facilitates more cross-border collaboration, it also provides transparency and promotes wider consortia with more participation, including larger representation of the sector's many SMEs.

3.3. Leverage the effect of public and industry funding

Particularly given the shortage of technical skills, it makes sense for the maritime community to pool together specific competences into consortia to research effective solutions, fulfilling business and policy objectives and promoting lasting cooperation.

3.4. Demonstrate innovation to investors

The Partnership will deploy a large-scale, industry-wide demonstrator to test and showcase new system technologies at ship level. This will accelerate the market uptake of technologies of both breakthrough and incremental RDI.

3.5. Economic impact

Investment in R&D is essential for the long term future of any area of business and especially in the maritime sector where the challenges and competition are high. For Europe it is critical to protect and grow a thriving sector. Looking at the maritime market segmentation, Europe has the highest value technology rich products and these rely on a strong pipeline of technological ideas. Investing in front end R&D has the potential to deliver significant impact when the output is translated downstream into new market leading products. The impact in development of new equipment, ship types and sophisticated systems linked to the needs of the Blue Growth economy could be several orders of magnitude higher than what could be achieved through direct investment in manufacturing. The European maritime industry cannot hope to stay competitive with other parts of the World if it fails to invest in future vessels and the infrastructure that supports trade. Research and Development investment provides a strong leverage in protecting this industry. Even a 1% uplift would create 50,000 new jobs and protect a substantial European workforce.

4. Societal and industrial challenges and technology focus areas

Planned development activities address the societal challenges of creating safer and more efficient maritime transport as well as sustain a competitive industry able to create new high-tech jobs for Europe. The following target technology areas have been identified for the period towards 2020:

- Towards safer maritime transport through better accident avoidance, more resilient ships and their systems and by improving lifesaving and rescue

- Towards more efficient and environmentally friendly maritime transport through reducing ship resistance, using cleaner fuels, energy storage and propulsion systems as well as advanced energy management to optimise the mix of available power sources and consumers
- Towards a more competitive industry through integration of advanced materials, automated production, new vessel concept addressing new transport and Blue Growth-related services, a virtual vessel demonstrator and by embracing big data in the maritime industry

5. Business growth opportunities and challenges

5.1. Blue growth

Europeans use their ocean space for more than transport. Opportunities exist in food and energy production, mineral exploitation, manufacturing, urban dwelling, leisure and tourism. The Partnership focuses RDI on developing the technology to make Europe's Blue Growth ambitions technically and economically viable by development of the required vessels.

5.2. Increased global competitiveness

There is fierce competition in the shipbuilding sector from the Far East, however, it is important to recognise European strengths in some leading market segments. These include 90% global share of the cruise shipbuilding, 80% in the mega yachts, around 50% market share of the marine equipment and systems manufacturing sector, 35% share of the military construction and a wealth of expertise in the building and equipping of technology rich specialist vessels. None of this is possible without significant investment in research and development. In Europe this comes from a strong maritime heritage and investment in universities, world renowned research establishments and leading maritime industries. Increased investment in maritime R&D will create not only additional technology based jobs, but help marine manufacturers to continue to compete on the world stage. With appropriate targeting of funds, the research will have a direct impact on European shipbuilding and the marine supply chain competitiveness and align with the European priorities.

6. Technology arenas

6.1. Technology arena 1: energy management

Given today's economic climate focus on energy and environmental performance will give the EU shipping industry an added edge to maintain and further promote its leading position internationally. There is clear and well-argued evidence that any process aimed at improving the performance of both manufacturing and service industries cannot solely be achieved by technological development but also through the careful management and operational procedures. This has been recently acknowledged for safety in S.M.S. Code and for security in the ISPSP Code.

On the same line the introduction of the Ship Energy Efficiency Management Plan (SEEMP) enshrines operational energy management as a key pillar enable vessels operators to meet the challenging and stringent goals proposed by the IMO. This will bring about the implementation of indexes and procedures, the definition of logics for the optimization of the energy management on board, the efficiency of the main movers and of the services and auxiliaries on board and the use of energy from renewable sources. The development of a holistic approach for vessels' energy management remains a challenge where, if addressed, significant efficiency gains can be achieved. Designing and managing ships for optimum efficiency could significantly reduce energy demand. Increasing use of renewable energy and sustainable fuels – as alternative to fossil fuels – is a viable tool to meet these goals. Management of power peaks, optimization of the sailing regime and of ship fuelling, use of storage devices, etc., coupled with the operational procedures can also allow for significant energy efficiency improvements, reduction of pollution, and costs.

6.2. Technology arena 2: hull/water interaction

Hull-water interaction encompasses hydrodynamic science and it is the distinguishing key factor of waterborne in respect with other modes of transport. Energy used by a vessel to advance through water accounts for 60% to 90% of the total vessel energy consumption. In recent years major efforts have been made to reduce the wave resistance. The fundamental mechanism of friction resistance generation still has to be fully understood. Research is essential for looking at viscous resistance mechanisms and its control options, advance antifouling paints, air lubrication techniques and overall improvements of CFD modelling tools. Moreover most of the safety related issues stem from operations in harsh weather conditions (such as large waves in heavy seas, ice navigation, etc.); therefore research is foreseen to develop tools for operation in real environmental conditions enlarging and making it safer. While addressing viscous resistance contributes to the achievement of the IMO targets as set in the Energy Efficiency Design Index regulation, environmental benefits are expected by developing noise mitigation design and operational techniques aiming to reduce noise generated by cavitation, flow, structure vibrations and prime movers.

6.3. Technology arena 3: digital waterborne traffic

Digital waterborne transport and logistics includes e-Maritime and e-Navigation, it offers a framework vision to make maritime transport safer, more secure, more environmentally friendly and more competitive. Value added digital information products and services are therefore needed for ship operation and shipping, to better exploit available data and the use of advanced information and communication technologies (ICT). These products and services will also help to increase ship automation and the control of operational processes, such as compliance management and remote maintenance, and facilitate the streaming of synthesised information from disparate sources to assist decision making.

Digital waterborne transport is based on information and communication technologies for the functioning of the European maritime transport space without barriers and to improve safety and overall efficiency of the maritime activities. The EU's e-Maritime initiative is aimed at making maritime transport *safer, more secure, more environmentally friendly, more effective and more competitive by improving knowledge, facilitating business networking, and dealing with externalities*. Greater progress in the use of advanced information and communication technologies, for working and doing business in the maritime transport sector, will deliver benefits in terms of competitive advantage and sustainability for the European maritime industries.

By 2020 the majority of the shipping fleet will have adopted e-Navigation and e-maritime technologies for all aspects of ship operation: from intelligent ships with automated processes, smart real-time maintenance and condition monitoring, advanced navigation systems, smart sensors for piracy avoidance, and actuator networks. Improved real-time monitoring and collection of information on ships' environmental performance, integrated into the SafeSeaNet vessel traffic monitoring and information system, will also support maritime transport safety and security, as well as protecting the environment from ship-source pollution.

6.4. Technology arena 4: materials, design and production

Research on new materials, for a vessel's structural and non-structural components, can meet the safety and eco-efficiency targets set in Vessels for the Future. The research strands focus on reducing the weight; improving performances in terms of strength, corrosion and fatigue resistance; low or high temperature behaviour; aptitude for manufacturing processes (joining, deformations, systems installation); the life cycle performance and the recyclability, etc. of the vessel. The achievements are expected to lead to lighter and more environmentally friendly vessels, offering important opportunities for breakthrough solutions. The research includes non-metallic structures, bio-material structures, high quality high strength steel, alloys and composite structures for vessel hull and for vessel components.

By adopting new materials research is needed in the area of the vessel production technologies, for the development of low distortion welding techniques, especially for low thickness plates; for three dimensions structures; wider introduction of bonding techniques; low cost flexible joining techniques; simple mobile automation tools; extended automation in hull assembly and outfitting phases; composites and metal sandwich processing. The

changing waterborne markets are also implying research is needed in the areas of new business concepts for a cooperative production; sophisticated planning tools; e-production tools for managing multi-site work.

In the area of design a significant part of research activities need to be dedicated to a holistic approach in order to identify shipping related risks, to develop safer and more environmentally friendly vessels and support operators to maintain safety levels during the entire life cycle. Safety (risk) management will be a continuous process, starting from the concept design phase (risk reduction – mitigation) and continuing through the vessel operational life (managing residual risks) and in case of accidents (crisis management). ICT improved solutions tools will have to represent essential instruments for the vessel designer in the various phases of their activities. The basic design phase will use simulation combined with 3D models. The detail design phase will develop new platform solutions. The production and work programming phase, will promote proper instruments for the production engineering and hull and outfitting production simulations, up to the vessel delivery phase. RDI results stemming from this TA should also be adapted to allow for the retrofitting process (from procurement to delivery) of vessels in order to meet existing and forthcoming regulation

6.5. Technology arena 5: propulsion systems and fuel

As recognised in the Clean Fuel Strategy announced by EC 24/1/13 the shift from heavy fuel oil to a mix of alternative and cleaner fuel will reduce the overdependence on oil and develop a Waterborne industry that is ready to respond to the demands of the 21st century. The primary objective of the research is to develop marine propulsion systems and auxiliary engines capable of lowering the ship emission footprint in a sustainable way. This will result in a greener fleet by improving marine power plant integration and optimisation.

RDI activities will enable fuel flexible engines by developing and demonstrating technologies able to cope with the emerging clean fuels such as LNG, bio-fuel and synthetic fuels. At the same time, where these options are not yet available (i.e. ocean going vessels) RDI efforts are planned on post-treatment technologies e.g. emission abatement. This will add to a paradigm shift in marine propulsion with the aim of working towards a zero emission engine.

It has been identified that there is a constant need for adaptation of different services and new operational practices of engines; RDI to develop such adaptive marine power plants is foreseen with the aim to deliver systems capable to implement learning logics, predictive and integrated model based controls. R&D results stemming from this TA should also be adapted to allow for the retrofitting of ships in service in order to meet existing and forthcoming regulations. Given the operational life of a vessel (approximately 30 years) this can give an added value to ship owners by making it cost efficient and lowering fuel consumption.

6.6. Technology arena 6: new vessels and systems concepts

The sea is offering a host of opportunities to be exploited. Given the sometimes challenging accessibility of natural resources and harsh environment in which vessels have to operate in, new concepts to harness these opportunities need to be explored, e.g. arctic operation, vessels for activities at far or deep seas, maintenance vessels, research and survey vessels, etc. Traditional waterborne activities should not be forgotten and therefore the improvement of vessel concepts e.g. fishing vessels, cruise liners, should also be given due attention.

Moving beyond vessels, multi-purpose platforms and specific tooling products (UVs, robots, services, etc.) to harness the economic opportunities from the sea e.g. fish farming, marine energy conversion, sea operations, etc. need further research. Proposed activities include feasibility studies (concept definition, simulation and model testing, etc.), definition studies, and demonstrators for some of the key technologies. More specifically RDI should look at architecture and integrated solutions; positioning and attitude control; and energy production and management.

6.7. Technology arena 7: safety

Ship safety permeates all physical and temporal boundaries and as such it is the most influential factor in ship design and operation. As a result, the subject of ship safety is one of the fastest changing topics, absorbing all forms of knowledge in the strife to respond to unrelenting societal pressure for higher safety standards and do so cost-effectively. All human activity in a “risky” environment, such as the sea, is fraught with wide-ranging problems that tend to undermine safety. This calls for a “safety system” that is generic and flexible for ease of adaptation to change, holistic for ease of transcending complexity and sustainable for ease of gaining wider acceptance and support, thus nurturing safety culture and providing a mechanism for continuous improvement.

Such requirements demonstrate the challenges facing the maritime profession. This is particularly true for knowledge-intensive and safety-critical ships, where the need for innovation creates unprecedented safety challenges. The Design for Safety philosophy and the ensuing formalised methodology Risk-Based Design developed and introduced to the maritime industry through the SAFER EURORO Thematic Network that culminated to SAFEDOR and the introduction to IMO of the Safety Level and Goal-Based Standards were meant to ensure that rendering safety a design driver would incentivise the maritime industry to seek cost-effective safety solutions, in response to rising societal expectations for safety.

The impact of these developments on maritime safety has been colossal and is still being delivered but new challenges are emerging that require another step change, namely developing, utilising, measuring and accounting for all measures of risk avoidance/reduction/mitigation/control in ship design and operation (including emergencies) to enable and facilitate focus on all types and ages of ships through a fit for purpose regulatory framework that will be developed, implemented and demonstrated with the aim of being taken again to IMO to facilitate, guide and support our strife towards zero-risk-tolerance shipping.

6.8. Technology arena 8: virtual vessel demonstrator

Vessels and maritime assets at large are increasingly complex products that have to comply with multiple constraints like energy efficiency, environmental-friendliness, a high level of safety, use of innovative materials, enhanced production means and processes and including safer waterborne transport. These challenges will be addressed in relevant R&DI projects requesting improved and powerful simulation and computation tools to develop and test physical and/or virtual prototypes from the design phase to the dismantling one including the operational phase of the vessel. Therefore a vessel modelling infrastructure will be developed integrating RDI projects results and stemming knowledge to assess the operational performance over the life cycle of the vessel. The so called pan European Vessel demonstrator infrastructure will provide a holistic approach encompassing a large scope of technological areas from Virtual product to Virtual Life Cycle Assessment including Engineering and Testing facilities as well as operative deployment simulation.

7. Proposed structure

There are two types of Public-Private Partnerships under Horizon 2020: contractual Public-Private Partnerships (cPPPs) and Joint Technology Initiatives (JTIs). cPPPs follow the Horizon 2020 rules and procedures, with industry providing key advice on research priorities. JTIs are run as Joint Undertakings. Both JTI and cPPPs have a legal basis in Article 25 of the Horizon 2020 programme. The contractual arrangement forming the basis for each cPPP is signed by the European Commission and representatives of the respective industry grouping. It specifies the partnership’s objectives, commitments, key performance indicators and expected outputs. Each contractual arrangement mentions an indicative budget, although formalisation is only done through the Horizon 2020 work programmes, European Commission (2014).

The Vessels for the Research Association aims to establish a contractual Public-Private Partnership with the European Union. The following elements characterize the foreseen cPPP.

- The industry proposes a multi-annual RDI roadmap outlining research topics and consulting with the EU Commission on the future Horizon 2020 Work Programmes’ contents.
- The EU Commission manages the Horizon 2020 Work Programmes and publishes calls.

- The Horizon 2020 framework programme rules for participation are applied.
- An indicative budget is reserved for the implementation of the RDI roadmap.
- The Industry commitment is secured through a Partnership Agreement.

8. Conclusions

This paper has shown the need for and resources available for a maritime contractual Public-Private Partnership. Vessels for the Future has the potential to be every bit as successful as the four Public-Private Partnerships already established in Factories of the Future, Energy-efficient Buildings, Green Cars and Sustainable Process Industries.

References

European Commission, 2014. "Contractual public-private partnerships in Horizon 2020" Pub EC ISBN: 978-92-79-40106-0.