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Development Paper

IdealShip

Design and development of AutoSet, a high fidelity integrated ship management system incorporating several tools and processes, using non-vendor and open access solutions, for accurate and efficient analysis of safety and performance sensitive hydrodynamic problems in complex and extreme sea operational conditions, taking into consideration intact stability performance and added resistance; and at the same time ensuring efficient propulsion and minimum emissions of pollutants.

List of participants

No	Name	Acronym	Country	Country Code
1	Centre for Factories of Future (Maritime Division)	C4FF	United Kingdom	UK
2	Lloyd's Register	LR	United Kingdom	UK
3	Piri Reis University	PRU	Turkey	TR
4	Southampton University	SU	United Kingdom	UK
5	Satakunta University of Applied Science	SUAS	Finland	FI
6	Polytechnic University of Catalonia	UPC	Spain	ES
7	ADIK Shipyard	ADIK	Turkey	TR
8	Consorzio Armatori per la Ricerca	CONSAR	Italy	IT
9	Kaptanoglu Shipping	KAPT	Turkey	TR
10	SE.MA2	SE.MA2	Italy	IT
11	The Royal Institutions of Naval Architects	RINA	United Kingdom	UK
12	Maritime University of Szczecin	MUS	Poland	PO

PROJECT SUMMARY

The aim of this research is to investigate the key design and operating factors affecting the safety of ship operations and develop methodologies to optimise navigation and engine control systems for safe operations and efficient performance in view of the introduction of new International Maritime Organisation (IMO) standards related to energy efficiency, in particular the EEDI (Energy Efficiency Design Index). The proposal starts with a review of the new IMO regulations and intends to focus on the development of appropriate methods, tools and procedures to facilitate and support the safe design and operation of several different types of ships in compromised situations. Such situations might include severe and restricted seaways such as the Dover, Bosphorous and Gibraltar Straits, and Rauma Fairway, manoeuvring and accounting for interaction with other vessels, maritime structures and the environment. Furthermore, the project includes the necessary safety requirements of two main types of vessels (one tug and the other an offshore service vessel) currently not covered by the EEDI, in anticipation of future energy efficiency requirements for these categories of vessels. The activities will include the development of high fidelity tools and processes for the accurate and efficient analysis of safety and performance-sensitive hydrodynamic problems in complex and/or extreme sea operational conditions, including intact stability performance (surfing/broaching, rolling, extreme motions) and added resistance. This will take advantage of recently completed EU funded projects M'aider (www.maider.pro) and SURPASS (www.surpass.pro) which has a comprehensive database of previous accidents. Three of the partners in this consortium were promoters of these two projects; they will provide their support to allow the IdealShip consortium to use their project results.

The proposal will extend and validate hydrodynamic analysis for ships' manoeuvring performance in safety-sensitive environments, such as confined waterways, including particular aspects of shallow water hydrodynamics and slow speed behaviour, and including interaction with other vessels and stationary structures in diverse environments and weather conditions.

The project work will concern the adaptation of multi-objective optimisation and integrated design environments for holistic operational performance and minimum powering requirement predictions; this will ensure safe application of the design rules guaranteeing, at the same time, the right balance between safety, economic efficiency and environmental performance. The project is expected to contribute to improving the safety of vessels in compromised situations, while respecting regulatory environmental constraints. The project will also contribute to the strengthening of technical knowledge as inputs to negotiations in/with IMO and also in/with EMSA so that ship performance is not compromised in view of EEDI introduction.

The main product of the project is an AutoSet system similar to an aircraft autopilot but designed to monitor sea conditions and hydrodynamic parameters for minimum resistance to ship motion, with the intention of regulating the navigational equipment and engine performance parameters for minimum fuel consumption and exhaust emissions, also ensuring no intentional risk of power reduction to satisfy EEDI requirements.

Recent developments

A review of recent publications (Lloyd's Register, Life Matters, June 2012) and the IMO's own reports (Marine Environmental Protection Committee (MEPC), 64 session, Agenda item 4, 29th June 2012) and similar reports by learnt societies and classification societies and maritime organisations, for instance, German Lloyd Academy (GL, EEDI in practice, 2012) which give a clear view of the roadmap for reducing the marine engine emissions in particular in the near future. The whole of Central and North America coastal areas are now almost an ECA (Emission Control Area) and it is expected that coasts of Mexico, Alaska and the Great lakes, Singapore, Hong Kong, Korea, Australia, Black Sea, Mediterranean Sea and Tokyo bay are currently considering becoming ECAs. What is significant is that these constitute 90% of shipping routes so the implications are serious.

The Lloyd's report (Life Matters, June 2012) contains a set of guidance notes to provide advice to owners, operators and shipyards who are perhaps looking to adopt the EEDI early on a voluntary basis, or prepare themselves for its future mandatory implementation. The guidance reflects the current status of the IMO regulations as well as providing information on what options are currently available for ensuring compliance. It is stated that the purpose of the EEDI is to provide a design index, primarily applicable to new ships, that has been developed by the International Maritime Organisation (IMO) and is to be used as a tool for control of CO_2 emissions from ships. The IMO aims to improve the energy efficiency of ships via (future) mandatory implementation of the EEDI.

The IMO, as the main regulatory body for shipping, has, in recent years, devoted significant time and effort in order to regulate shipping energy efficiency and thereby control the marine emissions. For this purpose, the IMO has developed a number of technical and operational measures that include:

- The Energy Efficiency Design Index (EEDI);
- The Energy Efficiency Operational Index (EEOI);
- The Ship Energy Efficiency Management Plan (SEEMP).

The IMO has also been working on a number of Market-Based Measures (MBMs) for the marine industry. The MBMs' development is still ongoing. It should be noted that the EEDI represents one of the major technical regulations for marine CO_2 reduction and the IMO, under the banner of the Marine Environmental Protection Committee (MEPC) and its associated Energy Efficiency working group, has been finalising the regulations and guidelines for the EEDI, with input from each of the various flag states and other industry bodies.

Latest legislation regarding marine emissions controls

The Regulations on Energy Efficiency relating to the EEDI and SEEMP will enter into force on 1st January 2013 within a new Chapter 4 of MARPOL Annex VI. Within the regulations, there remains the option for administrations to adopt a waiver up to 4 years from the entry-into-force criteria.

At MEPC 63 in March 2012, the IMO Guidelines relating to these Regulations were adopted under the following resolutions:

- Resolution MEPC.212(63) – 2012 Guidelines on the Method of Calculation of the Attained Energy Efficiency Design Index (EEDI) for New Ships;
- Resolution MEPC.213(63) – 2012 Guidelines for the Development of a Ship Energy Efficiency Management Plan (SEEMP);
- Resolution MEPC.214(63) – 2012 Guidelines on Survey and Certification of the Energy Efficiency Design Index (EEDI);
- Resolution MEPC.215(63) –Guidelines for Calculation of Reference Lines for use with the Energy Efficiency Design Index (EEDI);

The EEDI will only affect new ships above 400 gross tonnes* and will be applicable to the following ship types:

- Bulk carriers;
- Gas carriers;
- Tankers;
- Container ships;
- General cargo ships;
- Refrigerated cargo ships;
- Combination carriers;
- Passenger ships**;
- Ro-Ro cargo ships** (including vehicle carriers); and
- Ro-Ro passenger ships**

*Excludes ships with steam turbine, diesel-electric and hybrid propulsion.

** Not initially subject to regulatory limits.

Each ship will require its own EEDI which will be verified by a recognised organisation (RO) as described further on in this document. Following verification, an International Energy Efficiency Certificate (IEEC) covering both EEDI and SEEMP will be issued by the RO on behalf of the Flag State and will be required to be maintained onboard the ship throughout its life.

The certificate is valid for the life of the ship unless the ship undergoes major conversion, is withdrawn from service or transfers flag.

The EEDI

The EEDI equation calculates the CO2 produced as a function of a ship's transport work performed. In other words, the equation provides a measure of the ship's 'benefit to society' by establishing how much CO2 is produced per transport work done which equates to g CO2 / tonne.nm. The equation is highly complex and is made up of several expressions for:

- Main engine(s)
- Auxiliary engine(s)
- Energy saving technologies (auxiliary power)
- Energy saving technologies (main power) Transport work

The top line of the EEDI equation is characterised by four key terms, whereby the energy saving technologies terms may include, for example, waste heat recovery systems, use of wind or solar power. The CO2 produced is based on the product of the power, specific fuel consumption and carbon factor for a particular type of fuel used. The bottom line of the equation relates to the total CO2 generated by each of the four terms, to ship capacity and speed. In addition, there are a series of correction factors that moderate the equation. These account for:

- Ship design factors (e.g. Ice-Class and shuttle tankers)
- Weather factor for decrease in speed in representative conditions
- Voluntary structural enhancement
- Ships built to Common Structural Rules (CSR)
- Capacity correction for chemical tankers and LNG ships

The calculation of the EEDI is detailed within the recently adopted 2012 Guidelines on the Method of Calculation of the Attained EEDI for New Ships (IMO Resolution MEPC.212(63). Verification of the EEDI is comprehensive and will be in two stages:

- Pre-verification which commences at the design stage and
- Final verification upon completion of the sea trials and commissioning.

Details of the verification methodology are given in IMO resolution MEPC.214 (63) and the process.

Full details of recent agreements regarding EEDI are given in the Marine Environmental Protection Committee, 64 session, Agenda item 4, 29th June 2012. It is worth noting that the report to the Committee was submitted by IACS, BIMCO, INTERTANKO, INTERGARGO and OCIMF. This Agenda item primarily reviewed the arrangements for EEDI as outlined in the above paragraphs and addressed one outstanding issue from 61 Session viz.: a ship's manoeuvrability in adverse conditions. Some delegates had argued that, in order to reduce installed power, a ship's designers may choose to lower a ship's design speed to achieve the required EEDI. To avoid negative impact, such as having under-powered ships, a provision was added to regulation 21 in the Chapter of MARPOL Annex VI, stating, in effect, that the propulsion power shall not be less than the propulsion power needed to maintain manoeuvrability of ship under adverse conditions, as defined in the guidelines to be developed by the organisation. What is significant is that pre-assessment will ensure that a ship has sufficient installed power to achieve the minimum required advance speed in head waves and wind conditions, defined to facilitate course-keeping in all wave and wind conditions. All guidelines are comprehensive and well documented. The only issue is how all these will be enforced. Although there clear verification processes and procedure, it is still unclear how ship builders and ship designers will respond.

The intention of this project is not only to support IMO's EEDI application or any other related initiatives such as the 'Resolution MEPC 213(63) – 2012 Guidelines for the Development of a Ship Energy Efficiency Management Plan (SEEMP)', but also to review the existing arrangement for navigation on board vessels and consider the possibility of integrating the outputs of all navigation equipment with all the outputs from engine controls. The ultimate aim is to develop an intelligent management system which helps to reduce energy consumption and engine emissions to a minimum, whilst simultaneously considering the hydrodynamic characteristics and above all safety of the ship and its crew. We also intend to develop a means of monitoring the emissions at ports by novel means as demonstrated by Figure 1 below.

Example: Technology

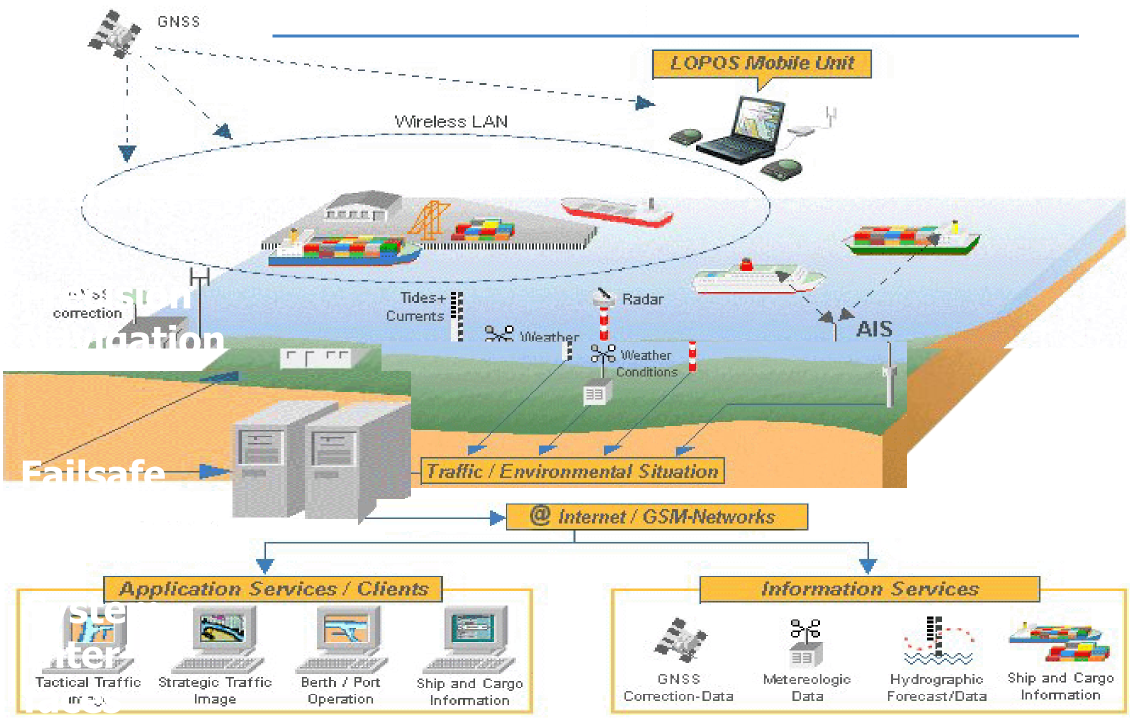

Figure 1. Ports as Controlled Zones Monitoring Arrival of EEDI and Non-EEDI Vessels

It is assumed that ship designers/builders will have to abide by the EEDI requirements and hence, as part of this project, the EEDI will be used as one of the core equations for integration and fusion of data from various navigation and engine controls. It is also acknowledged that slow steaming has helped considerably with fuel saving and has resulted in a substantial reduction of emissions such as CO2. The advantages of slow steaming is documented in a report by Maersk Group, showing a reduction of bunker fuel use in 2007, dropping from 13.8 million tonnes to 10.7 million in 2010, which is reported to have saved 2 million tomes of CO2 and brought about a significant reduction of NOX and SOX levels. Slow steaming has already proven its merits worldwide, so much so that COSCO, K-Line, Yang Ming and Hanjin are already applying slow steaming throughout their fleets with the result of considerable energy savings and reduced emissions. The latest report from Maersk is that emissions reduced by 36.44% in 2007, 38% in 2008 and 42.67% in 2009 as a result of applying slow steaming, although the details of what these figures really mean and where the base lines lie are not yet clear as there is no mention of losses due to slowing down the engines and increasing journey times.

However, considering a surplus of ships, due to the current economic crisis, the decision to slow down the ships may not be a major issue now but will be an issue in the future when business is expected to pick up. It is also true that slow steaming can mean a drive to cutting energy consumption through optimal hull designs, waste heat recovery systems, use of wind power wherever and whenever feasible or solar power. Recent research by Ziarati

(2010) using high pressure fuel injection systems, reduced engine heat losses, lighter engines and engine components has shown a considerable reduction in CO_2. Ziarati (2002) also argues that better management of energy on board vessels is an important consideration in reducing fuel consumptions with lower engine emissions. One significant area is an improved matching of turbochargers with the engines. While his engine designs are used worldwide, and his lab in Bath University is reported to have been supported by almost all oil majors and engine and engine component manufacturers, he believes there is a long way to go to make diesel engines consume less oil and produce reduced amount of pollutants. He is also of the view that fuel types make a difference and that lower Sulphur fuels often produce lesser CO_2, NOX and of course, SOX.

As a result of a project with Lloyd's Register, funded through an EU non-nuclear initiative, Ziarati (1994) produced the UK's first revolutionary hybrid engine for cars and trucks using dual power systems. The work led to development of engine 'finger printing' that would be an easier means of monitoring a ship's engine efficiency and exhaust emissions. The findings from these pieces of research will be built into the intended set of tools, which are expected to be developed as result of this proposed programme of research and development. The two papers by Ziarati (1992 and 2009) will be sent if requested.

The project with support from C4FF, LR and CONSAR will consider the work not covered by EEDI such as tugs, offshore service vessels and stationary structures. For these types of vessels it would be of interest to define an energy efficiency measure appropriate to the type, because energy consumption/tonne miles is not meaningful as these vessels do not transport goods; therefore the denominator needs to account for the work that these vessels perform. This will be investigated for the particular ship types chosen in detail.

For a dive support vessel, for example, this would mean finding an expression for the Service provision at station under DP conditions and safe provision of the dive services, accounting simultaneously for the efficient travel from station to station.

Concept & Motivation

There is no dispute that an intelligent integration of ship navigation and engine controls for accurate and efficient analysis of safety and performance sensitive hydrodynamic problems in complex and/or extreme sea operational conditions, including intact stability performance (surfing/broaching, rolling, extreme motions) would help realise the ultimate aim of **improving the efficiency of waterborne transports** by the reduction of ship emissions through energy systems' integration. The intention is continuous assessment and minimisation of the risks. Risk awareness and management will play a major role in developing the intended tools and system measurements and their integration. The project will further strengthen the competitiveness by focusing on innovative vessel designs and automatic manufacturing techniques. The research will also contribute to cross-thematic marine and maritime research ("The Ocean of Tomorrow 2013") and the Commission's

'Marine Knowledge 2020.' The results of the project will contribute to enhancing the safety of vessels in compromised situations, while respecting regulatory environmental constraints. The results will also contribute to the strengthening of technical knowledge as inputs to negotiations at IMO committee meetings.

Based on these facts, the IdealShip consortium proposes the conception of a collaborative platform with semantic capabilities (by means of ontology modelling) that implements a radically new methodology for the adoption of systematic situational processes, in high fidelity tool development, for safe and efficient shipping. The platform will support shipping companies in managing and implementing the complex instrumentation and control systems and processes that arise in a networked environment, taking into account their internal and external links, by enabling open, multi-agent focused situational processes (i.e. interaction among ship builder/owner/operator/crew/port authority, etc.). The aim of the IdealShip methodology is to create a high fidelity tool that would propose navigational as well as engine commands, and provide the most optimum bearing and related manoeuvring environment, combined with optimum engine power and speed for given sea conditions, planned routes or passages. This would be highly detailed, and more knowledge-based and suggestive than data from sensors from various parts of a ship. Two of the ships will have additional load cells and composite sensors in specific locations, and the engine controls will use the latest Engine management software system developed by C4FF using 'finger printing' techniques. The partnership is also supported by a specialised ship builder (ADIK) with experience of high technology material ship-building so that hull stress on new materials could be estimated.

The methodology implemented in the platform will be based on the newest management trends in Software and Product Development (*such as Extreme Programming, SCRUM, Feature-driven Development, Lean Development, DSDM, Crystal or Flexible Product Development*), merged with the most useful practices of traditional Situational Methodologies (*such as Brainstorming - BS, Brain Writing - BW, Heuristic Redefinition Process - HRP, Transformation of Ideal Solution Elements with Associations and Commonalities – TILMAG or Theory of Inventive Problem Solving - TRIZ*). Terms such as brainstorming and brain writing may appear to be inappropriate, but the proposed high fidelity tool will be supported by latest neural network technologies, including expert systems as was the case when developing knowledge acquisition of the aeroplane autopilot system.

This methodology will provide guidelines for operational decisions in various sea conditions and sea environments, taking into account the technical and human risks that may be relevant. As mentioned, these concepts enclosed in the *IdealShip* methodology will be put into practice in an intelligent, collaborative platform based on an ontology that will model the relationships of the actors in a ship operation process, and including semantic capabilities for enabling intelligent knowledge enrichment and sharing. The platform, built upon a Service-Oriented-Architecture, will also provide a set of knowledge-based services that will assist users in the different activities of the ship operation process.

What's the reason for inventing a new platform and methodology for the systematic implementation of ship manoeuvring in globally acting ship operations and practices? What's new in this solution?

Safety is a critical success factor for shipping companies that want to survive; this means that, whatever benefits a new tool brings, safety should not be compromised. The second factor is the IMO and its requirements. These have to be respected, even if some requirements have not been fully tested. The IMO's recently introduced new standards related to energy efficiency in particular the EEDI is not as clearly understood as it first appears. A careful review of the EEDI clearly shows that the formula used to arrive at the Index is more rigid than first appears. The formula itself has not been fully tested, but EEDI signals the introduction of emission controls at sea and there are more regulations to come. The mid-eighties brought the beginning of the end for many engine designers as the EU started discussing future emissions levels for several pollutants such as CO2, NOX and so forth, yet failed to limit the unacceptable levels of particulates from combustion of diesel fuels responsible for many cancer cases. Nevertheless, the imposition of emission levels brought new ways of designing and producing cars and this process is continuing. The same is expected for the shipping industry. If the shipping industry fails to regulate itself, EU or USA and some others will take the lead. This is already happening with the introduction of the North America Emission control Area (NCA).

With regard to the high fidelity tool itself, the present methodology proposes the use of Agile Methodologies to systemise the operational processes and accelerate the adoption (or adaptation) of the situational-based options (simulation first, validation and then action), offering a multi-agent-centred approach rather than a procedure-centred one and facilitating the creation of a tailor-made methodology for a given situation in line with its own specific characteristics. Furthermore, IdealShip proposes the creation of a radically new platform to help ship crews to successfully implement the optimum navigational course and engine power for given navigational manoeuvring situations and sea conditions.

IdealShip involves a high number of well-known ship science centres, and companies with leading edge technologies in propulsion and navigation systems; one of the companies (C4FF, UK) has one of the largest accident data-bases with substantial experience of data and engineering system modelling. Partners represent Europe from the North (Finland) to Central Europe (Poland) to South of Europe (Turkey) and West to East, are represented by Spain and Italy. Finland, Poland and Turkey work with two ship builders and operators who build and operate a wide range of ships. Italy will support the prototype and Spain will support validation (through TR). The methodology and platform designed under the scope of IdealShip will be validated in 3 ship builder/operator companies (ADIK, K and STX), each working on a particular type/group of vessels and each focusing on specific operating conditions. These companies will participate in the definition of the methodology and platform and in the verification during the design and development process; they will also participate in the validation of the integrated solution. Each shipping company will present a set of situational cases focusing on specific areas of ship operation, targeting different objectives as outlined in the work packages. The IdealShip integrated tool will be called AutoSet.

Aircraft Autopilot systems – not dissimilar to ship bridge

Figure 2. Ship Autopilot System Proposed Will Not Be Dissimilar with Aeroplane Autopilot System.

Ship AutoSet Systems

Figure 3. Proposed Ship AutoSet System Is Based on Current Practice – Innovation Is in Integration

Key Questions and Objectives

The project objectives were decided after posing several questions. The outline of the questions posed and subsequent responses are given below:

What shall be the big deliverable from this project and who will benefit? In what manner will they benefit?
The main deliverable is an integrated tool named AutoSet. AutoSet will be composed of a series of high fidelity tools configured for accurate and efficient analysis of safety and performance sensitive hydrodynamic problems in complex and/or extreme sea operational conditions, with a view to optimising fuel consumption (but not sacrificing stability) through intelligent use of navigation systems and engine management.

Will our work benefit the ship owners in safe operations?
The project results will benefit both ship operators and ship builders. The application of EEDI has design implications so all concerned with ship design and production/building should also benefit. Regarding environmental impact, all concerned should be the beneficiaries in one way or another.

If so, can we quantify the gain in terms of enhanced safety?
One expectation is to quantify fuel efficiency and emissions, as well as options for safer operations in extreme conditions.

Will it benefit shipyards, perhaps in enabling them to get better set of competences?
Shipyards will benefit as explained above, but more importantly they will become safety and EEDI conscious as well as becoming familiar with the latest, new International Maritime Organisation (IMO) standards relating to energy efficiency. AutoSet would also help them to make more efficient and less pollutant ships.

Or for that matter, will the equipment suppliers be better placed to offer correct products to the yards and owners?
Application of EEDI alone would have design implications for ship builders as well as equipment suppliers. It is believed that the intention of integrating navigation and engine management systems in safe and fuel efficient operations in the project, would place equipment suppliers to offer correct products to yards. No vendors are included in the project consortium; this is to minimise canvassing, but the Steering Committee includes representatives from navigation equipment producers (such as Kevin Hughes), engine manufacturers (such as Wartsila), a large passenger ship builder (STX), and representatives from ports (such as ports of Rauma and Istanbul) to ensure the products and processes are appropriate and that they are exploited when they become available. FI, IT, ES and TR partners have the backing of their major maritime organisations. The Turkish Chamber of Shipping has offered full support to the project.

How will this work enable better regulatory frameworks?
The introduction of the North American Emission Control Area (ECA) is an advance notice and the start of the regulatory regime. EU is also considering emission controls. The situation is not dissimilar to what happened to the automotive industry in early 1980s.

Data fusion from internal sources

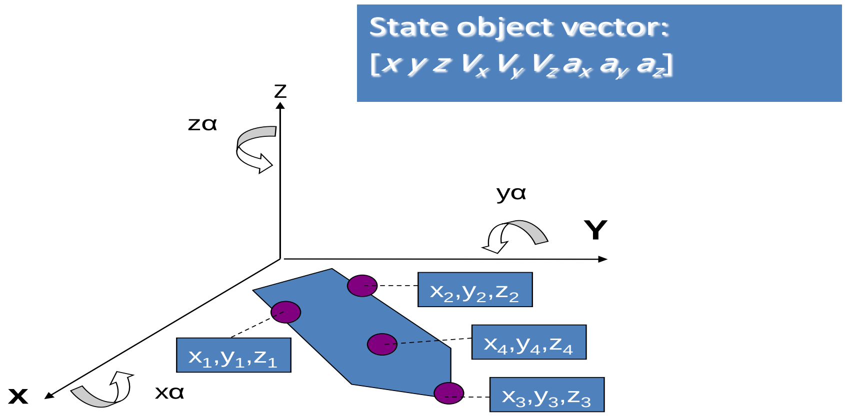

Figure 4 Application of Data Fusion for integrated solutions to navigation

Description of the Solution

The solution is twofold. One concerns the development of data/knowledge sets regarding ship operations and their integration, and the other is the information and communications technology aspects of the project. The intention is to develop five tools as well as a main tool here referred to as **AutoSet**. A diagrammatical of current practice based 'Previous Knowledge' and those on 'Current Developments', as against the proposed AutoSet solution, are presented in the following **Figures 5, 6 and 7.**

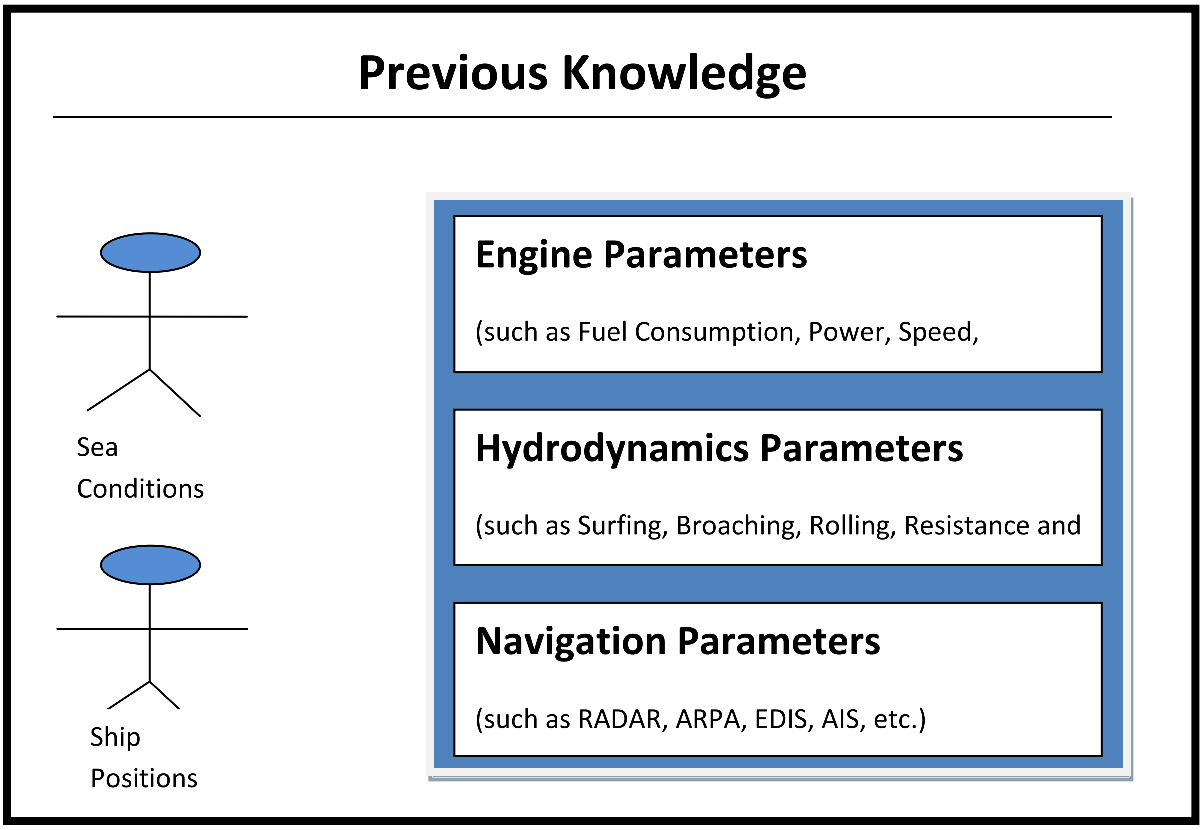

Figure 5: Previous Knowledge

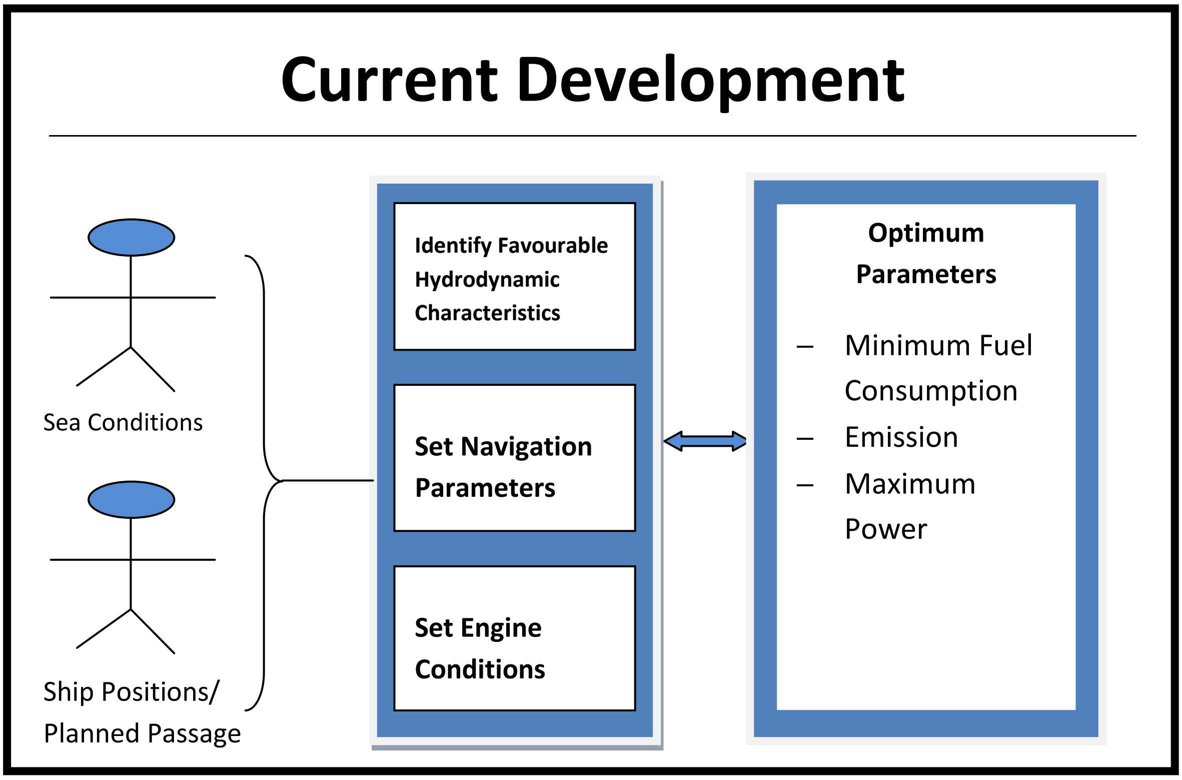

Figure 6 Current Development

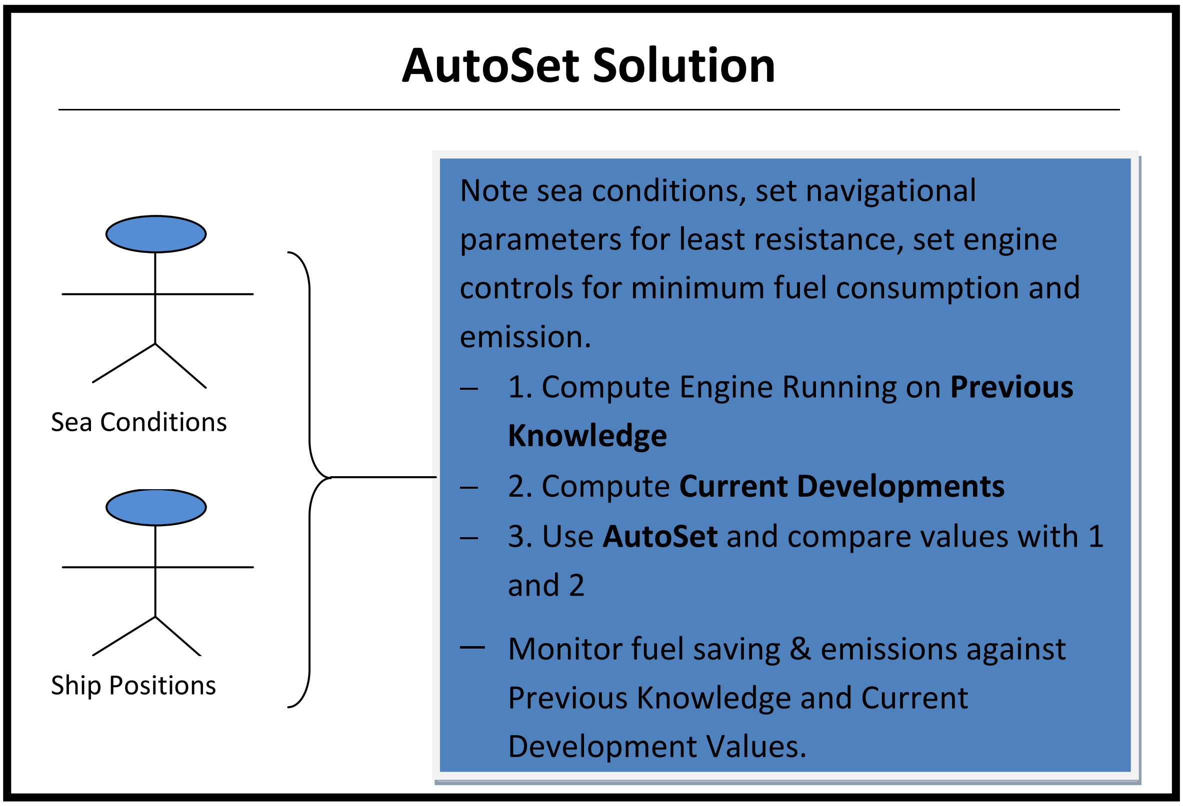

Figure 7 AutoSet Solution

One way of offering a description of the solution is to visualise the ideal solution based on the content of the Call and what has been stated so far. The solution visualises series' of developed or adapted tools, for tools 1 to 5 (see section 1.1.2 and 1.2), and a new integrated intelligent main tool, here referred to as AutoSet, to transform the data from the five tools into knowledge that can help the crew to make decisions in navigating complex sea conditions. Also of importance is minimising fuel consumption and reducing emissions of harmful pollutants from the diesel engine, without resorting to intentional reduction of the engine power and avoiding the risk of installing or setting an engine power which may compromise the safety of the vessel, to satisfy EEDI. The crews in partner ship operators will undergo training using the adapted/developed tools including on the AutoSet. There will be a great deal of emphasis on dissemination of technical input, which is expected to lead to several technical and professional papers and articles with at least one position paper to the Commission based on the project results. This is with a view to support, when requested, the activities of EU services within the IMO and EMSA framework. Research will clearly identify the ship type(s) as well as the nature/condition of operation concerned, referred to hereafter as **Situational Case -** a particular situation a ship finds itself in, in a given sea condition**.** The **Situational Process** is the process needed for a change in Situational Case, which in IdealShip dictates a situational change for reducing fuel consumption and lowering engine exhaust emissions.

The project will also learn from naval architects coming from companies like Det Norske Veritas, Daewoo, Germanischer Lloyd, Hyundai, Lloyd's Register, Samsung, Technip, and the American Bureau of Shipping, using the engineering simulation (CFD) to answer several design and operational questions; for example, new ways to:

- Modify bilge keels to prevent excessive vessel rolling
- Optimise thruster positioning
- Get accurate hull drag predictions for transportation of a semi-submersible
- Understand wave slam loads and enhancements before going to the tank

The recent work by researchers, such as Prof. Dr. Peric's, regarding the latest applications of flow, thermal and stress simulation, and how they are impacting on the development of today's maritime vehicles and structures, will be explored to ensure the novel use of CFD in the intended design processes. The research will also explore other methods for using CFD to design marine systems and the impact of these on ship performance, fuel consumption and engine exhaust emissions. Some of these experiments are planned to take place in test tanks, with one set in icy water conditions.

The intention is to ensure the AutoSet is linked to port computer network facilities, as demonstrated in Figure 1, Section 1 (Ports as Controlled Zones Monitoring Arrival of EEDI and Non-EEDI Vessels), and hence enabling ports to monitor EEDI of approaching ships to ensure compliance with the requirements for particular ship size and type as set by the IMO.

Implementation of the Solution & Architecture

The ship operation aspects of the IdealShip project are described in previous sections. The development of the ICT aspects will make use of existing Service Oriented Architecture Implementation Frameworks (e.g. by adapting exiting frameworks such as Spring Framework or others that will be studied during the project). These frameworks implement all the necessary components in a service architecture, such as the Enterprise Service Bus paradigm (ESB, communication channel for enterprise and external applications), Service Oriented Integration (SOI, to guarantee interoperability inter and intra applications), standard services for security (LDAP, TLS), service connectivity (J2EE, .Net, WebServices), communication through Java or .net Messaging System (JMS, .netMS) and others. It will be analysed based on how to create and integrate into the framework a service/component to search, raise and make available the knowledge bases, including the IdealShip ontology. The ontology could be modelled on/with RDF/OWL notation with the tool Protégé.

Regarding the ship crews, the accepted standards will be used, though the consortium will make an effort to implement software artefacts to ensure the validity of the portal in a near future.

The full project details have been sent to the European funding under FP7 programme.