Danaos Research Centre

Operation Research in Ships Management

Projects overview
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**About:** Danaos research Centre (Dr.C) is activated covering the whole spectrum of a ship management and operation processes looking forward and beyond to *quest the best*. We are working towards to be ‘*better than you instead of me too*’. We also strongly believe that dominance and leadership require innovative thinking, teamwork spirit, extroversion and continuous awareness. So we extrapolate our memories in the future and we generate creative solutions. In this direction we cooperate with organizations, academia and institutes.

Next to success of previous years Dr.C has been formalized in 2004 when the FPS SEAROUTES project was successfully completed. The homonym spin-off company established financed from General Secretariat of Research and Technology (GSRT). The same year Dr.C participated in the EU coordination action for efficient and environmentally friendly waterborne transport named INMARE. As result Dr.C elected as major participant in EU IP Research Project named FLAGSHIP with a total budget of 1,5 M€ and gained a fund of 700K€ corresponding to 82 man-months.

Dr.C has been awarded with the most prestigious awards for its innovative activities. In 2007 was nominated for *EU ICT (Information and communication) award*. In 2010 was awarded for innovation as national representative from EBA (European Business Awards). In 2011 gained the *applied research award in «Greece innovates»* PanHellenic competition. In 2012 Dr.C won the highest worldwide distinction, the *«Nobel»* in Operation Research and management The *Franz Edelman award* among with INTEL, HP and TNT from Institute of Operation Research and Management (INFORMS).

We strongly believe in cooperation and we apply the golden rule «*total is greater than the sum of parts*» Dr.C cooperates with the leading research institutes such as BMT, MARINTEK and MARIN and universities such as Technical University of Athens, University of Strathclyde, University of Piraeus as well as the main stakeholders in maritime industry including Lloyds, GL, Ficantiery, CONSAR, ECSA and others

"To be or not to be..." is the opening phrase of a soliloquy in the "Nunnery Scene" of William Shakespeare's plays Hamlet.

Our mission and answer in this dilemma is «to be better».

More than 30 published papers are included in our portfolio. Dr.C researchers provide a numerous of presentations and lectures in international conferences and universities. The awarded Operation research in ships management toolkit (ORISMA) is offered to academia as a tool kit for further applied research activities.

In this direction of continuous improvement and betterment we share our knowledge and expertise and we invite Experts from science and professional communities to join our forces.

Dr.C investing in applied research implements creative solutions to improve ships management efficiency. As example the innovative Risk@ssessor dominating in the market is utilized by hundreds of vessels with a ROI of several M€

One of our most important core values is the extroversion. Our applied research results would be used as models in other thematic areas.
So far we share our creativities questionings, pursuits, solutions, innovations, failures and successes as lessons to be learned.

We are focused on applied research. In this direction we are working in realization of bona fide developments in favor of business management and operation continuous cost/benefit improvement.

**FLAGSHIP: [www.flagship.be](http://www.flagship.be)**
European framework for safe, efficient and environmentally friendly ship operations (2007-2012 Completed)

FLAGSHIP was a 53 month, EU-funded project, focusing on improvement of safety, environmental friendliness and competitiveness of European maritime transport. The project will contribute to a further increase in the capacity and reliability of freight and passenger services and to a reduction of negative impact from accidents and emissions.

The emphasis of the project is on on-board systems and procedures, ship management systems on shore, impact of new technology on present ship-owner and operator organizations, effective and efficient communication interfaces and impact of standards and regulations.

Project has been successfully completed on May 2012 and Danaos acted as major participant with a total budget of 1,415,120€ and gained a fund of 690,500€ corresponding to 82 man-months.

Within the scope of the project we focused to create a ship compliance advisor for local and international rules and legislation. The primary aim is to create an electronics regulation database that allows users to easily find regulations that are known to apply to them.

The system can also help the user by suggesting regulations that may apply to them, and whether they are breaking them.

**Projects in progress**

Projects financed from EU and GSRT (General Secretariat of Research and technology)

Thanks to The wide publicity and the recognition of Danaos research Centre dominance in applied research as award winner in «Greece innovates!» Competition in 2011 we were invited from strong consortia to participate in the same year with proposals in the national call from General Secretariat of
Research and technology named «Synergistic 2011» action. 

581 proposals have been submitted and initially 85 of them were selected for funding. The first and among the top-ten of them are the two proposals in which Danaos Management participated. Finally additional 65 proposals were approved for funding and the submitted proposal Ecomarine, where Danaos Peripherals was participated, with the highest budget in the action, was approved.

MARIBRAIN PROJECT

http://maribrain.prismaelectronics.eu

The project is focused in research and implementation of an integrated data acquisition system over a wireless sensors network and knowledge administration analyzing remotely the vessel’s operational status and monitoring the efficiency. Maribrain achieved the highest grade (3.85/4) in the «ΣΥΝΕΡΓΑΣΙΑ 2011» national research call among 585 proposals and at the same time the highest budget of 1.870.000, 00 €

The full project title is: "Ship's Health Condition, Operational Status and Performance Remote Monitoring based on wireless sensor network and technical experience management system". The project’s R&D effort will lead to a product / platform aimed to be used by maritime companies that own, manage and operate any type of ships. The goal of the project will be to develop a smart wireless sensor network platform that can be used to monitor a ship status on a 24-7 basis, to apply conditional based maintenance models and services to a maritime company and to allow a maritime company to operate in an environmental friendly way. Condition Monitoring (CM) creates a mechanism for objective feedback on the quality of any work which has been carried out. Focusing only on what needs to be maintained helps create minimal disruption to operations and fewer unnecessary tasks, in turn delivering a more effective maintenance process, improved reliability and business value. The potential benefits of using CM within a condition-based maintenance culture include: improved safety and reliability, optimized scheduling and maintenance costs, fewer unnecessary spares, strips downs and maintenance-induced failures, reduced uninsured risk. The platform to be developed will combine hardware and software that will allow a smart and easy way of monitoring of critical ship parameters in order to evaluate their operational status and their efficiency. The adaptability to any type of vessels, the easily expansion, the distributed intelligence, the high ROI and the low installation cost and time are the basic advantages that make our approach unique to the global market. In the scopes of the project are: • The developing of new optical sensors for measuring critical parameters for monitoring the efficiency of the ship, like fuel type indicators, exhausts analyzer and torque meter. A wireless sensor network is designed based on new intelligent multi-sensing devices and fully adoptable to the ships’ environment. The developing of a sophisticated experience management system to handle the collected data and lead to automated diagnosis and prognosis software tools.
ECOMARINE project
www.eco-marine.gr

The project is approved for funding from GSRT within the scope of «SYNERGASIA 2011» action with the highest budget of 2.464.226 €

Objectives of this project are:

Maximize electricity production from waste heat recovery (WHR) and Improve electric power quality, through a supplementary static energy recovery unit.

The heat of the exhaust gases can be directly converted to electrical energy with the use of a thermoelectric generator (TEG). Fuel consumption as well as emissions will be decreased, improving the efficiency of the marine power system. Super capacitor-based energy storage systems, as an intermediate energy bank for the TEG modules generation. The final system will be tested in lab and in situ to assess its applicability in retrofitting and new shipbuilding operations.

Detailed objectives are:

Energy conversion efficiency, with the application of the most effective and robust MPPT algorithms: Power density / Unit mass (objective around 3 kW / kg including filtering and cooling volume) : Power quality improvement: Sustainability: Low maintenance demand : Technologies will minimize the emission of ‘greenhouse’ gasses such as CO2.

As well as Human security aspects shall be part of the analysis : High capacity rapid charge & discharge capacitor storage technology: Modular standardized bidirectional control power interface modules: Adaptation of a modular and scalable approach: Closed control loop embedded software and ruggedized electronic controls: Interfaces to major vessel data buses and repositories and to authorized vessel staff: Analysis of the system sustainability and eco-efficiency: On-board assessment and validation

AMINESS Project
www.aminess.eu

Analysis of marine information for environmentally safe shipping

Project is one of the top ten projects that has been selected for funding from GSRT within one of the highest budget of 1.280.000 €

The goal of the AMINESS project is to contribute in the safety, management and monitoring of the sea environment and the Aegean Sea in particular.

Reducing the possibility of ship accidents in the Aegean Sea is important to all economic, environmental, and cultural sectors of Greece. Oil spill cleanups can cost over 1 billion Euros, whereas accidents involving water soluble cargos would result in irrevocable changes to the Aegean ecosystem. Despite an increase in traffic, there are no national-level monitoring policies and ships formulate routes according to their best judgment. However, to reduce their own financial risk, shipping companies would directly
benefit from a system that can reduce the possibility of an accident involving their own ship. The project objective is the development of a web portal offering access to ship owners, policy makers and the scientific community. The portal will be used to (a) suggest vessel and environmentally optimal safe route planning (b) deliver real-time alerts for ships and (c) support policy recommendations. The portal will be based on historical and real-time maritime data, including real-time information for ship position and speed, weather and sea forecasting and land and sea location. Through this web-portal, the project aims directly to reduce the risk of a ship accident and consequently to contribute in the protection of the Aegean Sea. At the same time, the web-portal aims to bring profit to the enterprise partners of the project, mainly by proposing accident risk reducing services to ship owners. The research partners will be given a unique opportunity to advance their methodologies for handling and analysis of huge quantities of heterogeneous spatiotemporal streaming data to assess risk in real time. Any lessons learned from the analysis of the high risk ship traffic of the Aegean Sea are likely to have direct and immediate relevance to policy makers and stakeholders globally.
EU Research Projects

Further to successful completion of the integrated project FLAGSHIP Danaos was invited by strong consortia to participate in several EU FP7 calls. The results are impressive. Seven (7) proposals were approved with extremely high scores for funding from EU. **Emar, Mosaic, Ecompliance, Seahorse, Shopera, INCASS and MESA** are the names of approved projects covering all the spectrum of ships management activities.

Danaos holds one of the top ten of the national research programs of the European Union and one of the first three positions in the thematic area of shipping.

No doubt the rewards acclaimed success of Dr. C center in applied research are copyrighted to the research team. Although the staffing of the center comparatively few in numbers it victorious competes in international level research institutes and universities.

Proposals have been submitted or are in preparation stage to the last EU Horizon 2020 calls and we estimate to benefit a substantial I fund for the next three years.

The Seahorse Project

**www.seahorseproject.eu**

Safety Enhancement in transport by achieving human oriented resilient shipping environment

Within the aeronautical industry it is critical to have safe and reliable operations in order to prevent accidents and mistakes which can potentially cause a huge loss of life and destruction. In this respect, the aeronautical industry has led the way in terms of understanding and implementing tools, methodologies and systems to combat human error within a system. One such principle which has been highlighted as being particularly successful is the integration and adoption of resilience engineering principles. Resilience engineering within the aeronautical industry has been very useful onboard aircraft where the number of accidents and incidents has been shown to decrease through the utilization of resilience engineering.

In order to achieve successful transfer and implementation of the proven resilience engineering concepts and tools from the aeronautical industry to marine transport, a systematic approach needs to be adopted. Therefore, within the SEAHORSE project it is our aim to TRANSFER the effective and successful safety concepts utilized in the aeronautical industry, adapting and tailoring them to the unique needs of marine transport in the following manner.
Firstly, the best practices in aeronautical industry with regard to managing errors and non-standard practices will be identified. Then, the current practices in marine transport will be assessed and gap analysis in order to identify any potential gaps that may affect the successful implementation of safety management will be conducted. Finally, a ‘Multi-level Resilient Marine Transport Framework’ will be developed through the adaptation of the identified resilience engineering principles of the aeronautical industry to the unique needs of marine transport.

ECompliance Project
www.e-compliance-project-eu

E-Compliance will build upon strengths created across numerous EU projects in order to facilitate tighter integration and co-operation in the fragmented field of regulatory compliance in the maritime domain. Regulations are created by numerous different bodies, with little co-operation between them. As such, there is a significant lack of cohesion between the vast array of regulations and the possibility of conflicting regulations is very real. By creating a model for managing regulations digitally and creating services for all the different stakeholders, can harmonize these regulations and allow for co-operation between the different stakeholder groups. Not only will this improve the quality of regulations, but it will also reduce the burden for those having to enforce the regulations as well as those who must comply, resulting in a regulatory regime that is more effectively implemented.

The maritime sector is heavily regulated. The interaction between the national, European and international institutions is a complex subject area. This situation creates inefficiencies in regulation enforcement. On the other hand differing interpretations of regulations creates difficulties for shipping companies to manage compliance at each port of call. The EU e-
Maritime initiative is aimed at making maritime transport safer, more secure, more environmentally friendly and more competitive by improving knowledge, facilitating networking and dealing with externalities. A key priority for e-Maritime is supporting authorities and shipping operators to collaborate electronically in regulatory information, management and to address the challenges outlined above.

Activities will include:

- Establishment of a cooperation model between regulation setting and enforcement authorities, both for port state control and IMO regulations, for modelling and interpreting regulations, ensuring harmonization across national and organizational boundaries.

Demonstration of automated compliance management by:

- Modelling and delivery of regulations in electronic format
- Harmonized e-Services for more effective and coordinated enforcement controls and inspections.
- E-services in support of the class requirements, particularly on surveys and for ship risk management in upgraded e-Maritime applications.

The INCASS project

www.incass.eu

Inspection Capabilities for Enhanced Ship Safety

The INCASS project is a multifaceted project bringing together a range of experienced and dedicated partners in order to tackle the issue of ship inspection, identification of high-risk and sub-standard ships, providing access to information related to ship surveys independent of the ship flag state and inspection regime and moreover incorporate enhanced and harmonized cooperation of maritime stakeholders in order to avoid ship accidents, promote maritime safety and protect the environment (EC 2012). The INCASS consortium aims to bring an innovative solution to the integration of monitoring, inspection, data gathering (including real-time information), risk analysis and management and Decision Support for ship structures, machinery and equipment in an efficient and collaborative manner through the introduction of the following innovative concepts:

- Enhanced inspection of ship structures based on robotic platforms
- Providing ship structures and machinery monitoring with real time information
- Incorporate Structural and Machinery Risk Analysis Advanced/Condition Based inspection tools and methodologies, Reliability and Criticality based Maintenance founded on Condition Based approaches, Enhanced Central Database
The Mosaic Project

www.mosaicships.com

The Project aims to investigate two novel ideas concerning ship structures. First the introduction of High Strength Low Alloyed Steels (HSLA) in specific structural details in order to deal with the major issue of crack initiation and propagation in critical areas of ships and second the replacement of specific structural parts of the ship with composite materials.

Regarding the use of HSLA steels, it has been well documented that today’s merchant ships are prone to crack initiation and propagation in stress concentration areas mostly due to fatigue loads.

In this respect it is envisaged to replace Grade A or AH steels by HSLA steels with high toughness properties in specific areas of the ship structure, thereby reducing the risk of cracks developing in stress concentration areas. Concerning the use of composite materials, it is envisaged that they could replace parts of the steel structure, such as superstructures, piping and other non-critical parts. Composite materials can replace steel in certain parts of the ship thereby reducing weight and corrosion effects, without sacrificing structural integrity.
The SHOPERA project

www.shopera.org
Energy Efficient safe ship operation

Efficiency Design Index (EEDI) for new ships (MEPC.212 (63)) represent a major step forward in implementing the REGULATIONS ON ENERGY EFFICIENCY OF SHIPS (resolution MEPC.203 (62)). There are, however, serious concerns regarding the sufficiency of propulsion power and of steering devices to maintain the maneuverability of ships in adverse conditions, hence the safety of ships. This gave reason for additional considerations and studies at IMO (MEPC 64/4/13). Furthermore, whereas present EEDI regulations concern the limitation of toxic gas emissions by ship operation, what is a new constraint in ship design and operation, it necessary to look holistically into this and find the right balance between efficiency, economy, safety and greenness. The aim of the proposed research project is to address the above by: further development and refinement of high fidelity, hydrodynamic simulation software tools for the efficient analysis of the maneuvering performance and safety of ships in complex environmental conditions; Performing sea keeping/ maneuvering model tests in combined seaway/wind environment for different ship types, to provide the required basis for the validation of results obtained by numerical simulations, whereas full scale measurements available to the consortium will be exploited; Integrating validated software tools into a ship design software platform and set-up of a multi-objective optimization procedure; Investigating the impact of the proposed new guidelines on the design and operational characteristics of various ship types; investigating in parallel the impact on EEDI by the developed integrated/holistic optimization procedure in a series of case studies; development of new guidelines for the required minimum propulsion power and steering performance to maintain maneuverability in adverse conditions; preparing and submitting to IMO a summary of results and recommendations for further consideration.
The eMar project

www.emarproject.eu

E-maritime strategic framework and simulation based validation

The e-Mar project aims to empower the European maritime sector in offering efficient quality shipping services fully integrated in the overall European transport system over an upgraded information management infrastructure.

eMar approach will facilitate extensive participation of the European maritime public, business and research community in a knowledge development process leading to the specification of the e-Maritime Strategic Framework.

The development of the e-Maritime Strategic Framework will include the following key aspects:

- A number of market surveys to be conducted by a leading company in this field to identify business drivers and requirement priorities of different stakeholder groups.
- Stakeholder needs analysis, using knowledge of technology and architectural capabilities from related research projects such as MarNIS, Freight Wise, EFFORTS, Flagship, and SKEMA etc. to identify new processes and functionalities.
- Identification of implications for standardization and standardization strategies for areas that cannot be relied upon being developed in other places.
- Measures to address legal and organizational inconsistencies at national and regional levels, human factors and change management issues.
The MESA project
www.waterborne-tp.org/index.php/esa
Maritime Europe Strategic Action

Maritime Europe Strategy Action (MESA – FOSTER WATERBORNE), main strategic objective (in line with WATERBORNETP) is to strengthen the effectiveness of the research and innovation capacities of the European maritime industry, by:

- Optimization of the European maritime RDI strategies

- Improvement of the stakeholders network, of the dissemination, of the use of the research results, and increasing the visibility of the R&I findings

- Fostering the definition of the maritime R&I transport policies

MESA, is

Providing support to the WATERBORNE TP work, enlarging and maintaining it,

- Identifying 4 major themes (implemented via Thematic Technology Groups on Energy Efficiency, Safety, Production, E-Maritime) performing an in depth analysis and assessment of the achievements at EU and National level, to foster future strategic lines in research and innovation,

- Updating the strategic research agenda and creating an innovation agenda contributing to close the gaps between research and market uptake,

- Enhancing a network for the exchange of ideas and priorities, (S) acting as major player for dissemination raising waterborne value chain profile and visibility in Europe.

- Foresight activity will provide market, societal and regulatory trends studies, contributing to transport RDI policies. A Integration Group will issue Strategic documents for the waterborne sector: VISIONS2030, Strategic Research Agenda, Innovation Agenda, Implementation Plan, homogenizing findings of the Thematic Technology Groups and the Foresight. A comprehensive communication strategy will be implemented including coverage of the TRA2014, 2016, Technology Workshops, Major Conferences, Newsletter, Brokerage Events, Show Cases of successful projects, TRIP liaison, etc.

MESA involves 28 partners, (industrial, research, education, associations) ensuring the widest possible participation accustomed to work together since many years, in the majority of EU projects and in the WATERBORNE-TP
Collaborative Projects

Dr.C is realizing the ORISMA initiative of application of operation research methodologies and models in ships management. By extension of the two coordinates, the number of vessels from one to whole fleet and the time horizon from couple of weeks to several months we increase the problem complexity and the utilization and development of operation research models is imperative. The maximizing fleet revenue with voyage planning optimization has been completed in 2012 and utilized from Danaos Shipping and other ship management companies with impressive results. New optimization models for vessel inspection, bunkering plan are in development phase. The crew planning is the system that has been alive from the beginning of this year welcoming with satisfaction from the market.

Operation research in Ships Manning

System is the unique long term maritime crew planning and assignment optimization that Danaos Corporation envisaged, Danaos Management has implemented and Danaos Shipping deployed as an enrichment of its ORISMA (Operation Research in Ship Management) toolkit. The major novelty in this system is the extension of the two coordinates, the number of vessels from one to whole fleet and the time horizon from couple of weeks to several months. Another initiative is the addition of a third dimension the teamwork index of the vessels’ management team. As assignment optimization problem the definition of an objective assignment function that should be optimized is required. We analyzed the problem and found out the formulas and the variables that are needed for the calculation of coefficients in the identified individual objectives that are combined in a weighted multi-objective assignment penalty function. The extension of coordinates and the team-working dimension increases the problem complexity and is hard to achieve optimal solution with conventional heuristics. So we combine operation research genetic and multi-index axial integer models, efficient assignment algorithms and, new developed ones into one model adjusted to specific problem requirements.

System also supports strategic decisions regarding the depth determination of the availability officers’ pool, the entries’ attributes such as rank, performance, availability and nationality avoiding in one hand unfeasible
solutions and keeping on the other the safety pool level as less as possible. Furthermore an alert mechanism generates the appropriate triggers for actions whenever safety levels are reached and suggests mitigation plan. From design point of view the most important novelty of the ORISMA approach is the usage of ship officers’ quadruplet as the monitoring entity instead of the individual ship officer.
Dr.C Committee

Dr.C is staffed with business experts and distinguished researchers with expertise in management science, Operation research, naval architecture, information and coms science, mechanical engineering and maritime management.  
The Dr.C is supervised by a research committee. The committee currently is coordinated by Takis Varelas and Sofia Archontaki.

Takis Varelas (TV)

Is acting as Danaos Research Centre director since 2004. TV is majored in chemistry (University of Athens), in DataMetrics and in Management Science (University of South Africa). He spent more than thirty years in managerial positions in maritime and information worldwide dominant enterprises. He spent also 10+ years as Professor in Technical University of Crete.

Sofia Archontaki (SA)

She directs Dr.C projects since 2000. She is majored in management science, operation research and journalism. She spent 20+ years in maritime managerial positions. Author of several papers has been honored with the highest distinction in Operation Research the Franz Edelman award from Institute of Operation Research and Management Science as well as with Applied Research Award of «Greece Innovates!» 2012 competition.