	ADVANCED DECISION SUPPORT SYSTEM FOR SHIP DESIGN, OPERATION AND TRAINING (ADOPT)

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Summary:

- Publishable executive summary

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36 MONTHS PUBLISHABLE EXECUTIVE SUMMARY

CONTRACT N°:   **TST4-CT-516359**

ACRONYM: ADOPT

TITLE: Advanced Decision Support System For Ship Design, Operation And Training

PROJECT COORDINATOR: Flensburger Schiffbau Gesellschaft mbH & Co. KG (technical)
                          Uniresearch B.V. (administrative)

CONTRACTORS: GKSS-Research Centre,Institute for Coastal Research
                          OceanWaveS GmbH
                          Force Technology
                          Technical University of Denmark
                          DFDS A/S
                          Technical University of Hamburg-Harburg
                          National Technical University of Athens
                          SAM Electronics GmbH

REPORTING PERIOD: FROM April 1st, 2007 TO March 31st, 2008

PROJECT START DATE: April 1st, 2005

CONTENT

0   EXECUTIVE SUMMARY

0.1 STRATEGIC OBJECTIVES ADDRESSED

This Specific Targeted Research Project fits in the research domain 4.12 "Developing technologies to sense and predict natural and infrastructure conditions affecting safety and efficiency of transport operations". The project aims at creating a blueprint of a reliable system for the bridge that joins the available information, senses real-time environmental data, takes into account 'new' phenomena (e.g. parametric rolling) and calculates the risk arising from the motions of an intact ship in a seaway. Based on this, decision support will be provided to the captain if the present risk is not acceptable. The developed blueprint definition will be validated in a simulated bridge environment.

0.2 PROJECT OBJECTIVES

Ships should always be prepared to expect all kinds of weather during a trip, even those that test the limits of its structure and stability. Captain and crew are trained to recognize dangerous situations and take (counter) measures. Decisions are based on experience and on the specific information available. This information is always limited. It mostly deals only with the past and present situation and seldom predicts. Even with information presented on various displays, the crew needs to predict the consequences on experience.

Modern ships develop rapidly, and are far too complex to rely on experience alone. Experience gained by a crew on a certain ship often not applies to another, even not the same ship type. With the need for reduced times for transportation, deadlines becoming more relevant, rising insurance policies, marine pollution becoming a major issue, crew numbers reduced to an utmost minimum, and systems becoming more complex, this results in too few people, who need to decide fast and often under huge pressure. All knowing the consequences of taking a decision that will mean delay (or worse).

The ADOPT DSS will provide information and guidance by offering an evaluation of consequences; giving insight in the uncertainty related to the information.

This will be done by identifying and defining: 1) Criteria for safety, 2) Sea keeping safety, and 3) Describing criteria for ship design, classification & operation.
This will result in increased knowledge on ship motions and their prediction.

Expected results are commercial advantage for shipping companies, more safety of crew and cargo, pollution prevention, training of crews.
Regulatory bodies will be supported with a set of criteria – both qualifying and quantifying – describing minimum requirements on decision support systems. This is of particular relevance, as at IMO the Code on Intact Stability is under review, as well as the MSC/Circ. 707 on guidance to the master.

The ADOPT project focuses on increasing safety and performance in operation, training and design by development of a system that senses the environment for ACTUAL situation data, and predicting the ship motions accordingly, thereby ensuring optimal operational performance, relying on computer based decision support tool creating an interface to be used in ship operation, training and design.

0.3 CONTRACTORS INVOLVED

Flensburger Schiffbau Gesellschaft mbH & Co. KG (Project Coordinator)

FSG is world market leader of freight RoRo newbuildings. FSG was established in 1872. Recently built vessels have been a series of six RoRo-vessels for the Mediterranean. The hull number 713 UND EGE of this series was awarded for the "Outstanding RoRo-concept 2001" by Ship Pax Information. MV "Tor Magnolia", FSG hull number 721,

was awarded "Ship of the year 2003" by Hansa, International Maritime Journal.

Contact Person: Mr. Thomas Gosch

GKSS-Research Centre
GKSS Forschungszentrum Geesthacht GmbH (GKSS) is one of 16 national research facilities belonging to the Hermann von Helmholtz Association (HGF). GKSS has two sites at Geesthacht near Hamburg and Teltow near Berlin with a total staff of approximately 750 employees.

Contact Person: Mr. Heinz Guenther

OceanWaveS GmbH
OceanWaveS GmbH is a spin-off company from the German research centre GKSS, and currently employs 8 people. The company is an SME owned by Konstanze Reichert and Jürgen Dittmer and was set up in 1996 with the aim to produce and market the Wave Monitoring System WaMoS II.

Contact Person: Mrs. Konstanze Reichert

Force Technology
FORCE Technology is a non-profit knowledge and technology-based service provider which offers development, consultancy and other services in the areas of: Optimisation of production and processes; Materials utilization, protection and analysis; Maritime technology; Integrity management; Inspection, testing, calibration, verification and certification; Sensor technology development and application; Management systems optimisation and development;

Contact Person: Mr. John Koch Nielsen

Technical University of Denmark
The Technical University of Denmark (DTU) is among the largest educational establishments for the engineering sciences in Northern Europe and has approximately 6000 students and about 1700 researchers. It is the task of DTU to create, sustain and develop environments for education and research of an international standard in the fields of engineering sciences and related disciplines. DTU has identified twelve focus areas for research. One of these focus areas is shipbuilding and marine technology. Research and education within this area is mainly carried out by the Department of Naval Architecture and Offshore Engineering. This Department has a scientific staff of around 26 of which half are PhD students.

Contact Person: Mr. Peter Friis Hansen

DFDS A/S
The shipping company **DFDS** A/S Copenhagen was formed in 1866 and has since owned and operated about 450 ships, including passenger ships, Ro-Ro passenger ships, cargo ships and Ro-Ro cargo ships. DFDS A/S is now the parent company of DFDS Seaways A/S and DFDS Tor Line A/S. The present fleet of DFDS Tor Line include 22 Ro-Ro ships and the fleet of DFDS Seaways include eight Ro-Ro passenger ships, all fully owned and operated by the mentioned companies.

Contact Person: Mr. Arne Blåberg

Technical University of Hamburg-Harburg
The TUHH is one of the youngest universities in Germany as well as one of the most successful. Research work started in 1980 and in 1982/83 lecturing followed. Today around 100 senior lecturers/professors and 1.150 members of staff (450 scientists, including externally funded researchers) work at the TUHH. With an average of 5.000 students the TUHH offers a uniquely high ratio of staff to students.

Two departments of the TUHH are participating in the ADOPT project:
- The department of Ship Design and Information Technology of TUHH (SDIT), which focuses on the development and introduction of 1st principle based methods in ship design. The application of these methods in ship design enables the designer to develop competitive ships, which is the focus of education.
- The Institute of Ship Operation, Sea Transport and Simulation (ISSUS), which has become a department of the TUHH in 2004. The overall objective of ISSUS is to provide a complete picture of waterborne transport as part of the whole intermodal chain.

Contact Person SDIT: Mr. Stefan Krüger
Contact Person ISSUS: Mr. Jens Froese

National Technical University of Athens
The National Technical University of Athens is the oldest and largest Technical University in Greece and it shows a most distinguished record of achievements, going back to its foundation in 1836. NTUA was for long the only Technical University in the country, thus engineering education and research in Greece has always been linked to NTUA as the prime source of every major technological development.
NTUA is participating in the ADOPT project through the Ship Design Laboratory of the School of Naval Architecture and Marine Engineering.

Contact Person: Mr. A. Papanikolaou

SAM Electronics GmbH.
SAM Electronics is a leading electronic system supplier for shipping and marine with a total staff of about 645. The headquarter is in Hamburg, Germany. The company is specialised in the design, implementation and marketing of maritime electric and electronic systems. The relevant product range comprises communication and navigation equipment, positioning and control systems, ship automation, power generation and distribution and electrical propulsion.

Contact Person: Mr. Karl-Christian Ehrke

Uniresearch B.V
Uniresearch was set up in 1994 and is a fully independent company (SME), who's profession is to offer advise, project management and consultancy services in the field of national and European research projects and innovation activities. Uniresearch has a team of qualified consultants, bringing together a mix of technical, scientific and business administration backgrounds. Over the years, the consultants have acquired strong management skills, a profound knowledge of international partnerships, and a sound experience in managing European RTD-projects.

Contact Person: Mr. Jaap Struijk

0.4 RESULTS ACHIEVED SO FAR

As a major result of WP3, two parallel implementations for the assessment of ship motions and probability calculations are realized. One suitable for up to moderate ship motions and therefore used for the evaluation of economic risks, one suitable for the assessment of extreme motions, being suitable for the evaluation of safety risks.

WP6 has integrated the results from WP2, 3, 4 and 5.
WP6 and WP7 are in progress.

0.5 EXPECTED END RESULTS

Main objective:

Creating a blueprint-definition for a reliable system that will assist the captain in deciding safe and efficient ship handling, based on the sum of the actual sensed environmental situation, the ship's condition, the ship's behaviour, the expected sea state on all alternative courses, the prediction of ship motions on all these courses caused by the prevailing conditions, etc.

In other words: sensing the environment, predicting the ship's responsive motions and supplying the captain with information on suitable Risk Control Options.

This system will be designed for use in operation and in training, but also in design, supporting the naval architect with information on how the ship will perform in real life. In crew training simulating the different expected conditions and training the crew to take decisions based on actual data, will help them to better understand the ship' behaviour even without the DSS and to take the appropriate actions.

Scientific and Technological Objectives are:

- Development of a "blue-print" definition for risk-based tactical DSS with respect to content, quality, reliability and functionality;

- Identification of relevant data and criteria for decision-making under uncertainty, as wave processes are probabilistic and consequently ship responses as well. Many other input data are uncertain, e.g. tank fillings, cargo mass, distribution and centre of gravity, etc.;
- Identification/development of procedures for decision-making and risk control options;
- Generation of knowledge and criteria with respect to operational performance/safety for use in design evaluation;
- Sensing of the environment for real-time use in tactical decision making based on predicted ship response;
- Improving the accuracy of sensing the actual wave spectrum, representing the actual environmental conditions. The actual wave spectrum data will be used for predicting the ship's present and near future situations (up to 5 - 10 minutes ahead in time). The XBAND radar, utilized for sensing the environment, ranges abt 6nm. Methods will be developed, to match this range and the time horizon to the ship speed of about 20 knots;
- Development of a methodology for utilizing real-time wave data to predict the corresponding short term ship response with sufficient quality. This feature is especially relevant for adequate decision-making in dangerous situations;
- Real time prediction of ship motions and motion induced phenomena for the actual or planned loading condition according to environmental information (sensed seastate, wind, weather forecast) including parametric roll, roll resonance in general, pure loss of stability, vertical and horizontal accelerations, slamming, bending moments, *etc.*;
- Development of calculation/simulation strategies to evaluate the "blue-print" criteria with sufficient accuracy;
- Development of calculation / simulation / interpolation methodologies and data models for real-time prediction in on-board use (where there is no ship motion specialist available);
- Identification of relevant ship data, quantification of the respective quality for the real-time prediction of ship responses, and development of according methodologies;

- Reliability control of basic ship data and estimation of resulting uncertainties in the assessment;

Based on the risk-based blueprint definition,
- Development of a toolbox for sensing of the environment, prediction of ship response, and support for decision-making and selection of appropriate Risk Control Options;
- Development of interfaces for the interaction of developed toolbox with existing systems;
- The integration of the predicted ship response with on-board monitoring devices and enabling these combined systems to accurately predict the ship's response;
- Presenting relevant information on predicted sea keeping behaviour and Risk Control Options to the captain in real-time (note: this is now only possible for naval architects in the office, if at all);
- Development of interfaces for operational use, use in design and approval, use in training;
- Development of an user display, which actually is able to communicate the relevant parameters and their actual meaning to the crew especially in extreme conditions;
- Interfacing with available systems on the bridge (GPS, radar, ECDIS, *etc.*);
- Validation of the usability of the system in (simulated) extreme conditions in a full mission simulator to evaluate and improve usability also in extreme conditions;
- Validation of the developed DSS using full-scale measurements.

Based on the above, it is expected that this will increase the efficiency in shipping operations by 15% due to improved reliability of this mode of transport (in terms of safety of the vessel, danger for the cargo, environmental protection, reliability of this transport mode as such).

0.6 INTENTIONS FOR USE AND IMPACT

It is intended to make use of the DSS in FSGs newbuildings, as soon as a demonstrator/prototype is available. This will generate first experience, which will feedback into the developments. Additionally, this industry demand establishes the fundamental motivation for all parties involved in ADOPT, and will demonstrate the utility of having a DSS on board.

Prior to this, available results of ADOPT will be immediately used in the design department of FSG. For example, the hind cast study (WP2) will be used to evaluate the reliability of the time schedule of a ship sailing in the area covered by the study.
For DFDS, it is of strategic importance to maintain schedule, minimise operating costs and to keep up their reputation as reliable shipping company.
OWS expects that the project will show that the use of wave monitoring systems supports the master in many situations hence makes the navigation safer. Thus the acceptance of the WaMoS II will increase and so its commercial success.
Force Technology expects that the results of ADOPT will significantly improve the quality of the decision support system "SeaSense" and improve the efficiency in generating data for the system.
SAM Electronics, which is a major worldwide supplier of Integrated Bridges for cruises ships, RoPax and RoRo ferries, tankers and bulkers, expects to improve its performance in terms of functionalities.
GKSS, DTU, TUHH and NTUA-SDL's interest in the ADOPT project is to contribute to the development of the decision support system for design, training and simulation purposes. This will be done by disposing their expertise in, among others, the development of design and applied hydrodynamics software tools (in particular of ship motion simulation codes) (NTUA) and bringing in knowledge on recent developments in the evaluation of ships in rough weather by direct calculation of capsizing frequencies (TUHH).
By participating in a project as ADOPT with its international maritime partners, they will also be expanding their European network.

NTUA will also consider the in-house developed ship motion simulation codes, like NEWDRIFT (3D-6DOF frequency domain panel code: ship motions and wave induced structural loads) and CAPSIM (3D-6DOF non-linear time domain code: simulation of ship capsize in waves) for implementation in the ADOPT DSS. Also they expect to be involved in the exploitation of expected product (DSS) for training purposes.

0.7 PLAN FOR USING AND DISSEMINATING THE KNOWLEDGE

Use of generated knowledge will be made immediately at the involved universities, consultants and yard.

Core element of dissemination of the knowledge is the involvement of Flag State Authorities by means of an Advisory Panel.
The German Flag State was already involved by participation in the HAZID workshop. For the future, contributions to IMO-MSC/SLF are foreseen.

A paper partly resulting from the ADOPT project was presented at the 8th International Workshop on Stability and Operational Safety of Ships, Istanbul, October 6/7, 2005 by NTUA. A 2nd related paper of NTUA has been presented at the 9th International Conference on Stability of Ships and Ocean Vehicles (STAB2006), Rio de Janeiro, September 25/29, 2006. This paper has been peer reviewed and selected for re-publication at the Journal International Shipbuilding Progress (Vol. 54, 2007).
On the EU Status Seminar in December 2006 SAM Electronics has given a presentation of the ADOPT project.
On the 6th OSAKA Colloquium on Sea keeping and Stability of Ships (Japan, March 26-28,2008) a paper, titled "Risk-Based On-board Guidance to the Master for Avoiding Dangerous Seaways", resulting from the ADOPT project was presented by NTUA.

In April 2008 the project has a whole session at the 7th International Conference on Computer Applications and Information

Technology in the Maritime Industries 2008 conference. Five papers were presented at this opportunity:

<u>Jan Tellkamp et al.</u>
- *ADOPT - Advanced Decision Support System for Ship Design, Operation and Training*

<u>Heinz Günther et al.</u>
- *ADOPT DSS – Ocean Environment Modeling for Use in Decision Making Support*

<u>Stefan Krüger,</u> Florian Kluwe, Hendrik Vorhölter
- *Decision Support for Large Amplitude Roll Motions based on Nonlinear Time-Domain Simulations*

<u>Dimitris Spanos</u>, Apostolos Papanikolaou, George Papatzanakis, Jan Tellkamp
- *Onboard Assessment of Sea keeping for Risk-Based Decision Support to the Master*

<u>Dirk Wittkuhn ,</u> Karl-Christian Ehrke, John Koch Nielsen
- *ADOPT – Man-Machine Interface and Training*

With this dissemination ADOPT has redefined the state of the art for onboard decision support systems.

A "passive" means of dissemination is the ADOPT-website, available under:
http://adopt.rtdproject.net

Finally a meeting with regulatory bodies – German and Danish Flag State, DNV – has been held in January 2008. One day of the final ADOPT meeting is reserved for invited parties, and the members of the advisory board.