PROJECT

ADOPT

Advanced Decision-support System for Ship Design, Operation and Training

Funding: European (6th RTD Framework Programme)
Duration: Apr 2005 - Sep 2008
Status: Complete with results
Total project cost: €2,953,771
EU contribution: €1,899,999

Call for proposal: FP6-2003-TRANSPORT-3
CORDIS RCN: 75816

Background & policy context:

Modern ship types are developing rapidly. Consequently, the experience gained by a crew on a certain ship does not necessarily apply to another vessel, even to vessels of the same ship type.

Situations have been reported where vessels have entered dangerous situations without any warning. With today's modern ship types, the captain and his crew can be faced with 'new' phenomena like parametric excitation and pure loss of stability. Generally, guidance on how to identify such problems and resonance is not available or appropriate, mainly due to the highly non-linear roll motion and lack of development (i.e. the means to use the theoretical knowledge for practical application). Also phenomena like slamming and excessive vertical accelerations at the bow are not simple to detect on large modern ships.

Recent data proves that commercial losses and loss of life can potentially be reduced by introducing this kind of decision support system. Losses pertinent to the motion of ships in heavy seas recorded from April 2005 until March 2006 are 43 lives and an estimated € 100 million. (Source: www.janmaat.de).

Objectives:

The objective was to create a risk-based system that will assist the captain in deciding safe and efficient ship handling with respect to the motions of an intact ship in severe seas, based on the risks arising from:

- the identified hazards and their formulation of limit states;
- the actual sensed environmental situation;
- the ship's condition;
- the ship's behaviour;
- the expected sea state on all possible courses;
- the prediction of ship motions on all these courses caused by the prevailing conditions, etc.

Methodology:

The work under the Project included:

- Development of a toolbox for sensing 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 the developed toolbox with existing systems.
- Integration of the predicted ship response with on-board monitoring devices and enabling these combined systems to predict the ship’s response accurately.
- Presentation of relevant information on predicted sea-keeping behaviour and risk control options to the captain in real-time.
- Development of interfaces for operational use, use in design and approval, and use in training.
- Development of a user display, which is actually able to communicate the relevant parameters and their real 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.
- Validation of the developed DSS using full-scale measurements.

**Parent Programmes:**
**FP6-SUSTDEV-3 - Global Change and Ecosystems**

**Institute type:** Public institution
**Institute name:** European Commission
**Funding type:** Public (EU)

**Lead Organisation:**

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<th>Flensburger Schiffbau-Gesellschaft Mbh &amp; Co Kg</th>
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<tr>
<td><strong>Address:</strong> Batteriestrasse 52 24939 Flensburg Germany</td>
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<td><strong>Organisation Website:</strong> <a href="http://www.fsg-ship.de">http://www.fsg-ship.de</a></td>
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<td><strong>EU Contribution:</strong> €0</td>
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**Partner Organisations:**

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<td><strong>Address:</strong> Munstermannskamp 1 Lüneburg Germany</td>
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<td><strong>Organisation Website:</strong> <a href="http://www.oceanwaves.de">http://www.oceanwaves.de</a></td>
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<th>Technical University Of Denmark</th>
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ADOPT has provided a process of DSS creation with the three major process elements:

- mode 3; design
- mode 2; training
- mode 1; operation

Decision support for mode 1 starts in mode 3. Mode 2 is required to convey the information generated in mode 3 to mode 1. Operation of a ship in mode 1 will be improved by mode 2 even without a specific computerised mode 1 DSS. A computerised mode 1 DSS will further improve the operation in mode 1 by given real time support, that might capture scenarios beyond the experience or capabilities of the crew.

It has been reflected in Mode 3; Design that DSS shall be modular, risk-based, ship-specific, reliable, shall take into account the relevant uncertainties from all sources, shall provide quality control regarding the reliability of the displayed information, shall display information of limitations in the displayed content, shall be able to perform a self-assessment and shall resolve internal contradictions and provide consistent decisions support.

The general approach in the Mode 2; Training is not only the familiarisation with the system itself but
also to give advice on the background of phenomena (like parametric rolling), as the purpose of the DSS only can be captured when the theoretical foundation is available. Through this approach, the training not only customises the user with the system but also contributes to an improved situational awareness of the risks in specific sea states.

The training concept consists of two modules with two sessions each, starting with general ship theory. Since the ADOPT-DSS is ship specific, the theory will afterwards be consolidated by exercises in the simulator demonstrating the vulnerability of the specific ship in particular seas. In the next session, the crew will be familiarised with using the DSS. This again starts with the theoretical description how the DSS works, what are its limitations, what are its modules, and in which situations it can help. Afterwards, in the final module, the user will be customised in a simulator environment to get experience in using the system and improve his behaviour in critical situations.

Mode 1: Operation has satisfied the following requirements for DSS:

- to be modular;
- to support realtime decision making;
- supported by a DSS, the master shall improve his decision making under uncertainty;
- decision support shall have a time range of about one watch; to operate on a ship whi

**Technical Implications**

A risk-based, ship specific decision support system regarding the assessment of ship responses is by today’s knowledge feasible. The feasibility of such DSS depends however on:

- wave sensors able to identify multi-peak seaways, e.g. swell and wind-sea,
- a calibrated database of ship data,
- a calibrated set of limit states and respective threshold values,
- advanced state-of-the-art motion modeling tools onboard, and
- a HMI embedded in typical bridge equipment as the conning display and designed from experts for users, not from experts for experts.

Independently, the DSS needs to be embedded within a rational procedure that:

- makes the implementation ship specific,
- ensures correctness of numerical models,
- limits uncertainties or at least quantifies them,
- strictly distinguishes between safety risks and economic risks,
- accounts for the identified requirements, and
- unambiguously identifies the limits of the support that can be expected.

Documents:

- Publishable executive summary (Other project deliverable)

**STRIA Roadmaps:** Vehicle design and manufacturing

- Water transport (sea & inland)

**Transport modes:** Passenger transport, Freight transport

- Decarbonisation, Societal/Economic issues,

**Transport policies:** Digitalisation

**Geo-spatial type:** Other