Adaptive and smart materials and structures for more efficient vessels

ADAM4EVE

Project introduction

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Short introduction

The collaborative project ADAM4EVE is funded by the European Union within the Seventh Framework Programme (FP7).

The project commenced in January 2013 with 22 partner for a duration of 36 months.

Center of Maritime Technologies e. V. – Coordinator (Germany)
Uljanik Brodogradiliste DD – Shipyard (Croatia)
RINA Services SPA – Classification society (Italy)
Flensburger Schiffbau-Gesellschaft mbH & Co KG – Shipyard (Germany)
Fraunhofer-Gesellschaft e. V. – Research organisation (Germany)
VTT – Research organisation and towing tank operator (Finland)
Lloyd's Register EMEA – Classification society (United Kingdom)
SP – Research organisation (Sweden)
Alveus l.l.c. – Design office (Croatia)
University of Southampton – Research organisation (United Kingdom)
Ship Design Group SRL – Design office (Romania)
Universitatea Dunarea De Jos Din Galati – Research organisation (Romania)
STX France SA – Shipyard (France)
Compania Transmediterranea SA – Ship operator (Spain)
ACCIONA Infraestructuras S.A. – Industry company and material expert (Spain)
HSVA GmbH – Research organisation and towing tank operator (Germany)
Carnival PLC – Ship operator (United Kingdom)
SC NAVROM Reparatii SRL – Shipyard (Romania)
MEC Insenerilahendused – Design office (Estonia)
SAARE PAAT AS – Yacht builder (Estonia)
PAULSTRA – Industry company and material expert (France)
Rhebergen Composites BV – Material expert (Netherlands)

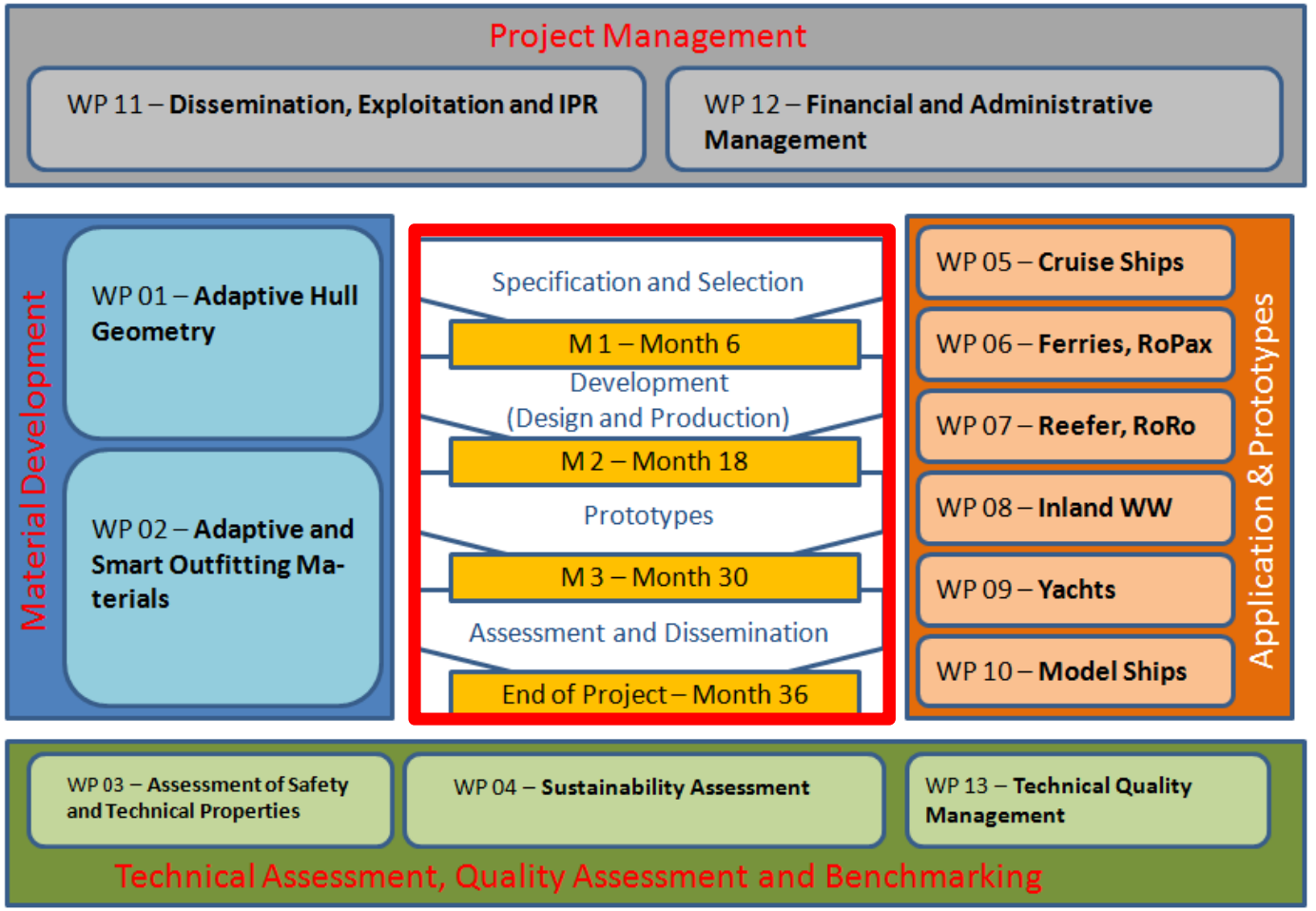
Workplan overview

Three important sections:

- **Material development**
- **Assessment**
- **Application**

Project is broken down into

four phases



Scope I

The main idea:

- To ***explore the potentials of adaptive and smart materials and structures*** in ships and pave the way for industrial application.
- These materials and structures will allow ships to ***react more flexibly to the changing operational and environmental conditions*** and thus to provide a ***more efficient and environmentally friendly operation*** while at least maintaining the current safety level.
- Moreover, the use of smart and intelligent materials will allow offering ***new functionalities, making ships more attractive*** to operators and passengers.
- The **"lightweight-effect" is not achieved by light materials**
- The **scale of structures**, outfitting and machinery can be **decreased by using adaptive solutions** with improved functionality.

Scope II

Problems

- **varying** operational and environmental **conditions**.
- ship designs **optimised for specific** operational and environmental **conditions**
- Structures and materials usually have **constant properties**

Aims

- improve ship performance and safety by making **materials and structures modifiable during operation**;
- modifications can be **passiv** (smart materials) **or activ** (sensors and actuators);
- provide **inexpensive solutions** using recent developments of nanotechnologies and material sciences

Challenges

- **complexity** of ships and ship systems
- extreme **loads and environments**
- **safety** recommendations
- **cost efficiency** constraints in a one-of-a-kind industry

Objectives

- **Material and Component Development** to
  - take up relevant knowledge from **other industries and research**
  - develop suitable adaptive multi-material **components, actuators** and **control mechanisms**
  - develop modules, interfaces and **manufacturing processes for the marine sector**

- **Assessment of Safety and Sustainability** to
  - identify and rank potential **risks** and applicable **risk control options**
  - identify KPIs for **LC efficiency, environmental impact**
  - perform **assessment** of safety, technical functionality and life cycle impact.

- **Validation and Development of Realistic Application Cases** to
  - apply the innovative solutions in **realistic design studies for specific products**
  - validate the components' **functionality and producibility**
  - identify problems and **research needs** for **extended maritime application** of adaptive materials.

Applications/Solutions

Several application areas were selected accounting for:

- Cruise vessels
- RoRo/RoPax vessels
- Reefer vessels & train ferries
- Inland navigation vessels
- Sailing yachts

Lightweight and innovative materials are investigated:

- Reinforced rubber
- Electrochromic & thermochromic coatings and foils
- Coatings with adaptive fire-safety properties
- Magnetorheological elastomers
- Etc…

And applied in adaptive solutions:

- Adaptive Stern-Flap
- Adaptive Bulbous Bow
- Phase changing insulations for thermal energy storage
- Electrochromic laminated windows
- Etc…

				Impact	Feasibility (3=high, 2=medium, 1=low)	
				After the project	Within the project	After the project
	No	tec Idea No.	Ap Area No.	Weight factor: Individual	34%	33%	33%
				Weight factor: Total	34%	66%	
Potential Solutions	1	2	5	Adaptive window (Thermochromic) APPLIED FOR Windows with adaptable transparency	1.85	2.05	2.50
	2	3	5	Adaptive window (Electrochromic) APPLIED FOR Windows with adaptable transparency	2.00	1.90	2.00
	3	3	17	Adaptive window (Electrochromic) APPLIED FOR Windows with adaptable transparency	2.10	2.05	1.75
	4	6	4	SPD foil APPLIED FOR Finishing touch	1.60	1.80	1.75
	5	6	22	SPD foil APPLIED FOR Climate control of the ceiling of the uppermost deck	1.80	1.65	1.38
	6	6	23	SPD foil APPLIED FOR Emergency guidance inside the corridors	1.85	1.65	1.63
	7	7	4	thermochromic paint APPLIED FOR Finishing touch	1.95	2.30	2.50
	8	7	22	thermochromic paint APPLIED FOR Climate	2.00	1.05	2.00

ADAM4EVE –Examples

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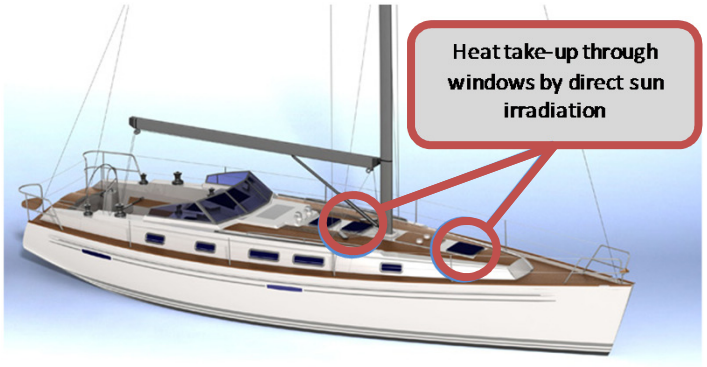

approximately **10-15 % less** energy consumption for heating, ventilation and air conditioning

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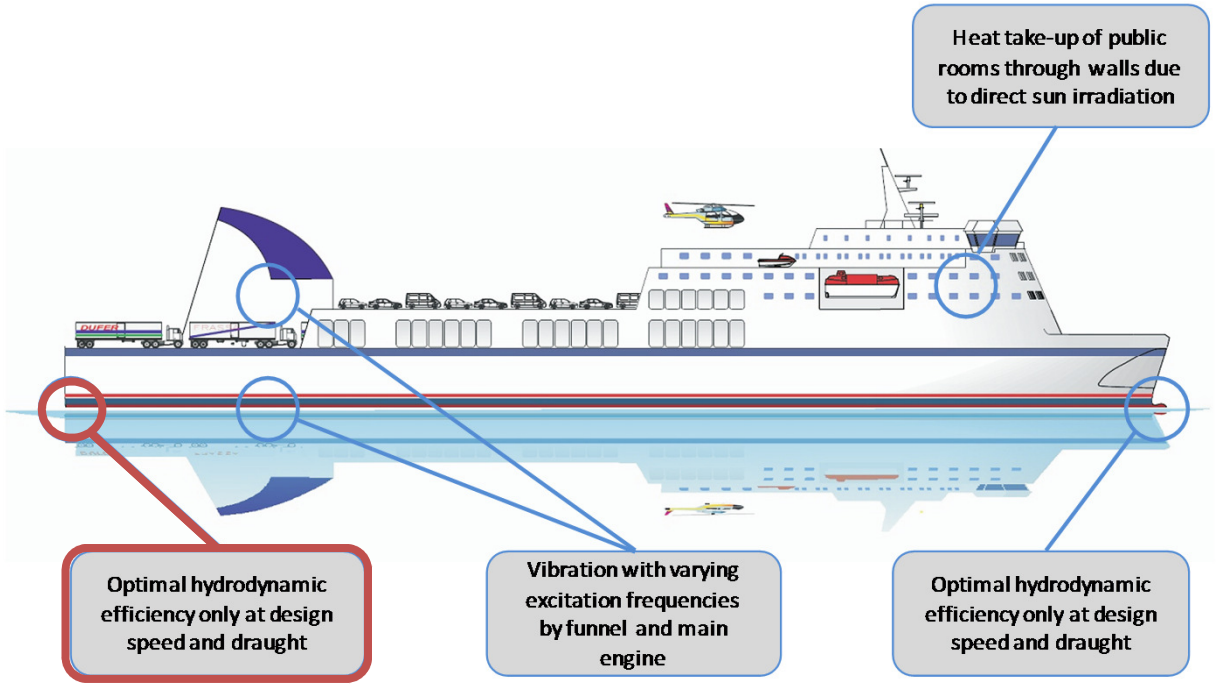

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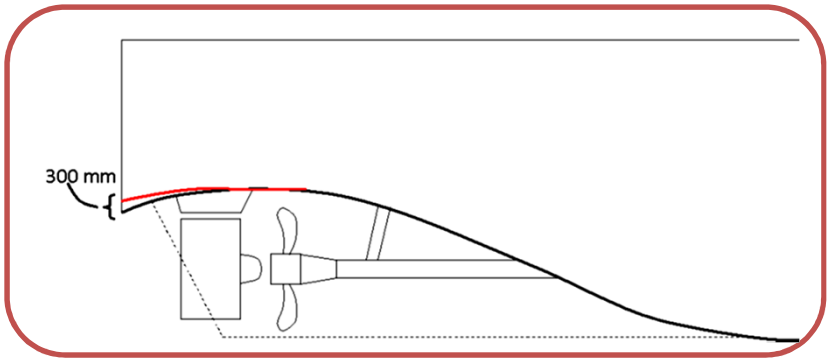

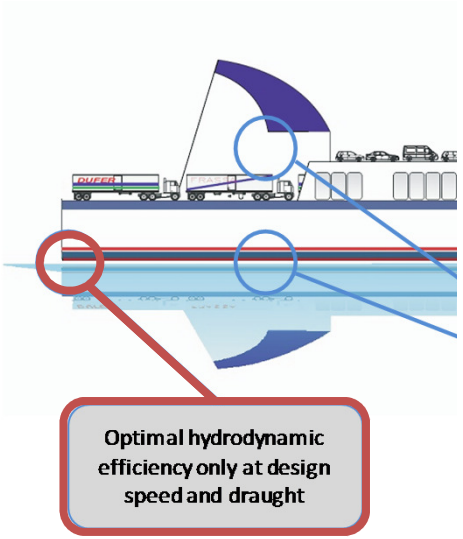

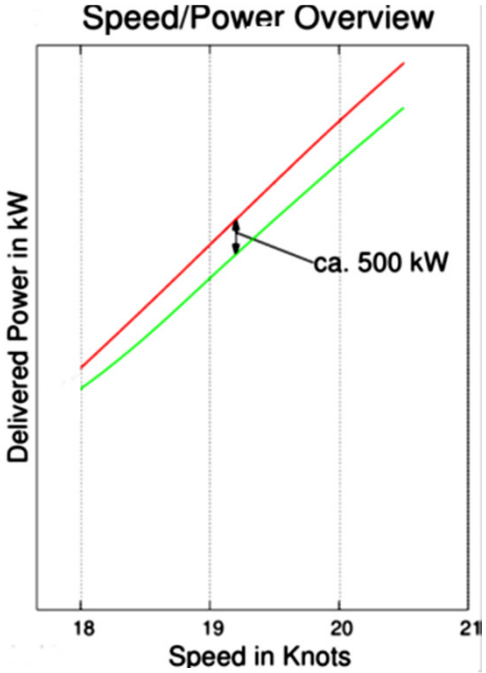

approximately **10 % less delivered power** needed in comparison to the conventional design

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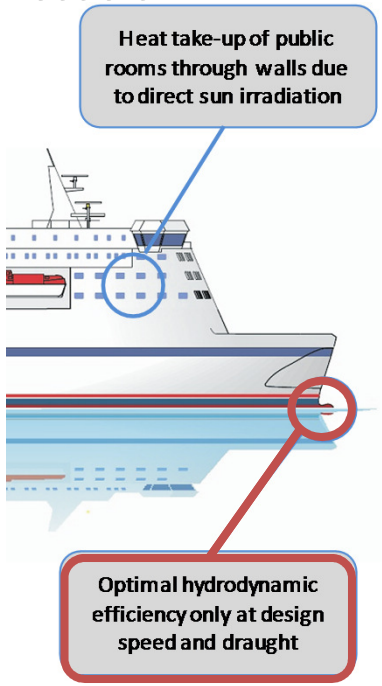

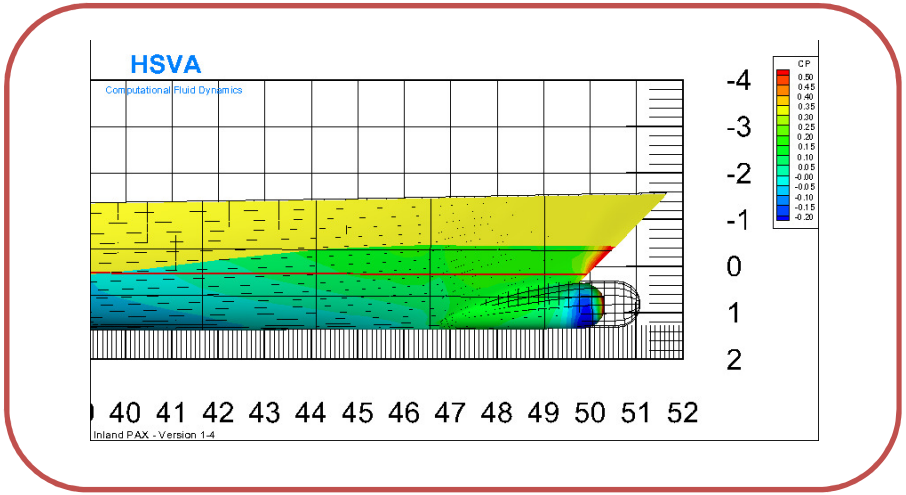

approximately **10 % less resistance** by varying the **length of about 700 mm**

ADAM4EVE – Conclusions

- Adam4Eve is the **first project** with adaptive and smart materials in the maritime sector
- The project will demonstrate the **feasibility for applying materials and structures** from other industries for marine applications
- The **demonstrators** built in the project will show the **ecological and economic potential** as well as the **safe handling** of adaptive materials in **production, operation and scrapping**.

Thank you for your attention!

For more information please visit the project's homepage

www.adam4eve-project.eu

or contact:

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