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Project No. 031488

CREATE3S

Innovative Concepts REalized by Advanced design & production to improve Total Efficiency of new generation Short Sea Shipping

Specific Targeted Research Project
Sustainable Surface Transport Theme

Publishable Final Activity Report

Period covered	from Nov. '06 to April '10	**Date of preparation**	July 2010
Start date of the project	November 2006	**Duration**	42 months

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Project coordinator organisation name	SAMSKIP B.V.	

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	2.0 Final	February 2011

TABLE OF CONTENT

1 PROJECT EXECUTION

1.1 Summary description of objectives

CREATE3S goal is to initiate a new impulse in European Short Sea Shipping and Shipbuilding innovation by realising a new advanced concept in Short Sea Ship design, manufacturing and operating. The potential impact of the concept addresses the **competitiveness** of Short Sea Shipping as crucial transport mode in a growing EU economy and the **competitiveness** of the Shipbuilding industry as primary provider of advanced, safe, clean and economically efficient short sea ships. The principal project objectives are:

1 A modular Short Sea ship concept composed of a basic ship hull module upon which various cargo-containing modules can be mounted.
2 Correspondingly, a logistic concept based on the modular ship concept for the waterborne transport leg that outpaces current concepts in terms of logistic and economic performance, and possesses at least equal ecologic performance.
3 Correspondingly, an advanced manufacturing concept based on the modular ship concept that outpaces current manufacturing concepts in terms of production cost and lead time.

The practical project outcome is:

- A novel logistic concept with a better turn around performance and better linking with inland waterways transportation. The logistic concept goes along with:
  - A new ship concept capable of carrying independent cargo modules
  - Cargo modules for different cargo types occurred
  - The ship-shore interface layout with cargo loading/unloading systems
  - Methodologies for analysing logistic chain operations
- An advanced manufacturing concept having also a generic added value since it can also be used for ship concepts outside the project.

1.2 Contractors involved

To realise the new concept a European consortium was formed which includes top-of-the line enterprises from the logistic chain, the manufacturing and service industry, and the research community. The project coordinator is Rotterdam-based Samskip Multimodal Container Logistics, the largest container transport companies in Europe.

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Other contractors are:

Partner no.	Partner name	Country
6	Damen Shipyards Group	The Netherlands
8	Estaleiros Navais de Viana do Castelo	Portugal
10	Imtech Marine & Offshore	The Netherlands
12	TTS Ships Equipment AB	Sweden
13	LogIT	Norway
14	Center of Maritime Technologies	Germany
15	Norwegian Maritime Technology Research Institute	Norway
16	Maritime Research Institute Netherlands	The Netherlands
17	Delft University of Technology	The Netherlands
18	University of Newcastle upon Tyne	United Kingdom
20	Bureau Veritas	France
24	Centrum Techniki Okretowej S.A	Poland

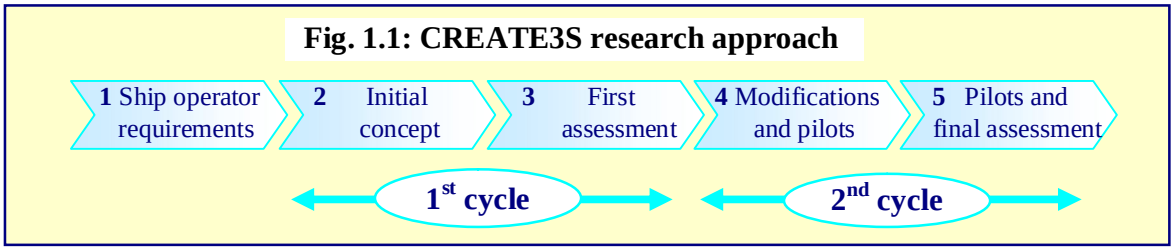
Public information on CREATE3S can be found on the project website
http://keilir.samskip.is/create3s/

1.3 Work Performed

1.3.1 Approaches and methodologies

CREATE3S work programme followed an end-user driven, problem solving approach.
The project's starting point was the "cargo movement" along the logistic chain in accordance with the logistic operator's requirements. In the same way, required capabilities on cargo carrying at sea and cargo handling in port formed the starting point for the development of the new ship concepts. In both occasions the logistic operator identified and quantified the economic/operational and technical parameters hereby ensuring hat the resulting ship concepts are competitive, safe and clean "transport vehicles'. The problem solving process proceeded in two sequential iteration cycles of analysis-synthesis-evaluation steps.

Fig. 1.1: CREATE3S research approach

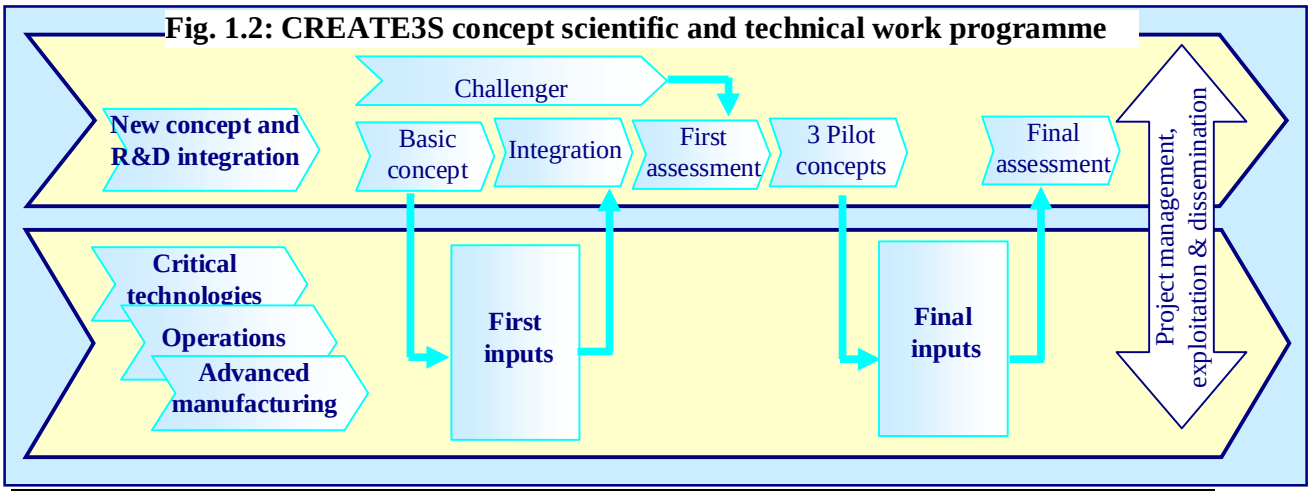


The five-step sequence forms the work plan "back-bone" or main R&D flow, a structured process where the new modular concept is being developed and where inputs from different disciplines are integrated. These disciplines are:

- Critical technologies : Hydromechanics and structures
- Operations : Logistics, economy, ecology
- Advanced manufacturing : Distributed production, advanced techniques

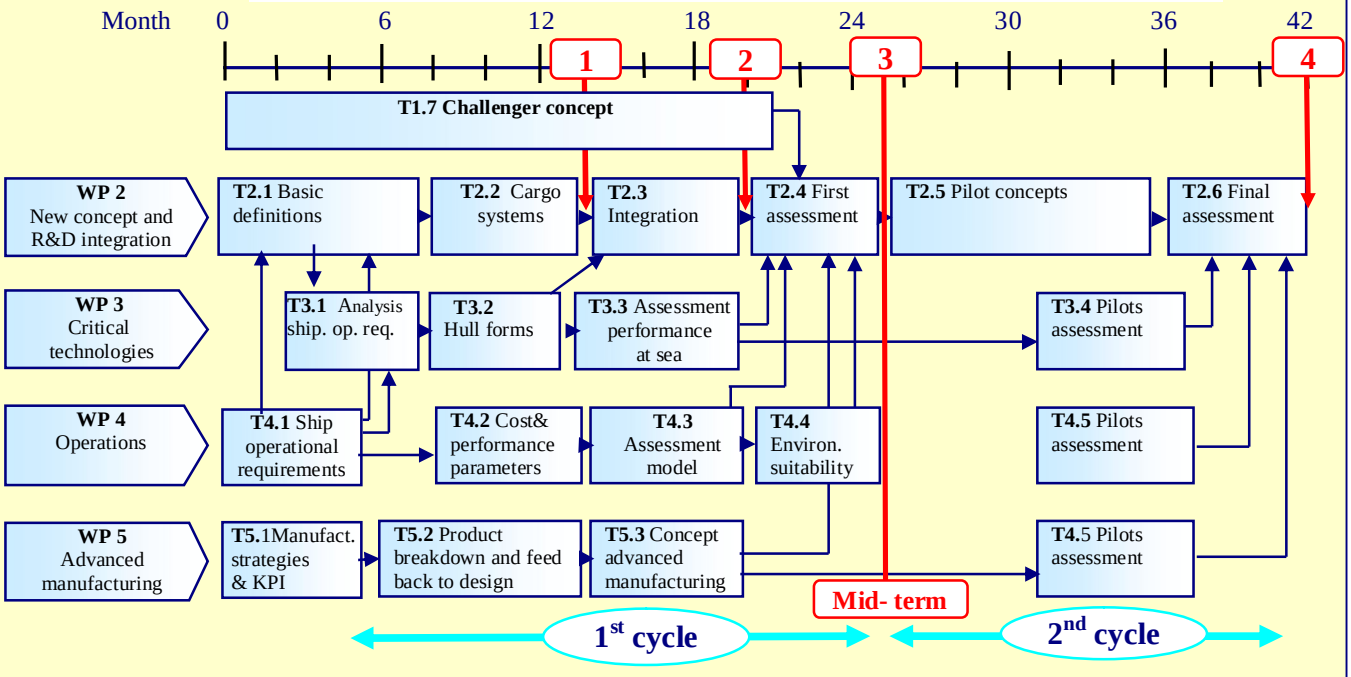
The corresponding conceptual scientific and technical Work Programme is illustrated below.
To this structured approach an additional element was introduced, the so-called "Challenger": a parallel track with access to all project information sources but following its own course with the aim to drive, push and stimulate discussion on the evolving concept using external expertise and generated knowledge/output of the main R&D flow but without interfering with it.

Fig. 1.2: CREATE3S concept scientific and technical work programme



The concept scientific and technical Work Programme was further detailed into an activity network containing 1 management and 4 technical Work Packages, each containing a number of tasks. The main R&D flow contains 4 assessment moments (mile stones):

Fig. 1.3: CREATE3S scientific and technical work programme concept



1 **Immediately after establishing the basic concept:**
An outline of basic ship concepts adapted to the end-user (operator) requirements for various relevant trades, containing the basic definition of: cargo-containing modules, basic ship platform modules and the outline of cargo handling systems for intermodal loading units.

2 **Immediately after integrated the first inputs from the various disciplines:**
A first integrated modular concept based on contributions from all the disciplines and including all design, operation and manufacturing aspects from the 1st cycle:
   a. New short sea ship concepts consisting of basic ship platform and cargo-containing modules variants
   b. Operational profile in the form of turn-around voyage description
   c. Cargo loading/unloading facilities onboard and onshore
   d. Advanced manufacturing issues

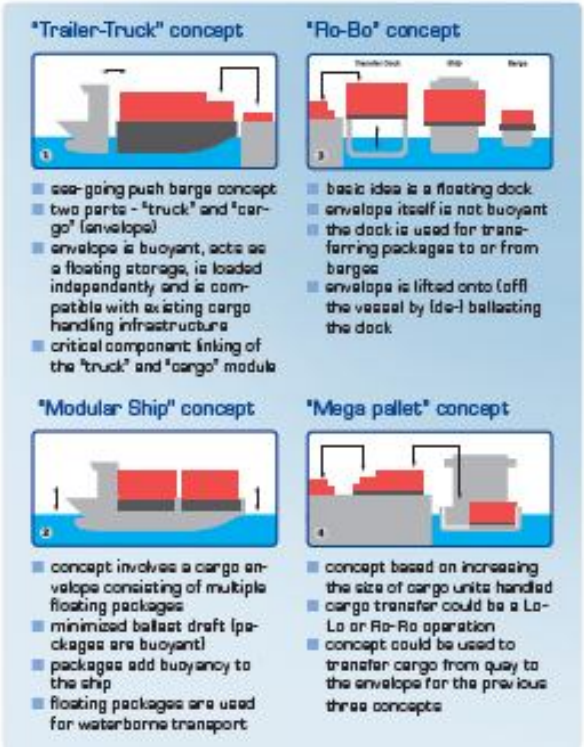
3 At mid-term, when assessing the complete concept: go-no go decision. The assessment addressed the technical, economic and ecologic performance of the modular concept and provided recommendations for concept improvements that will be used for the pilot development.

4 **At the end of the project, the final assessment:**
A consolidated answer to the modular concept feasibility on the basis of the 3 pilots assessment results is provided.

1.3.2 Work performed

The flow diagram in Fig. 1.4 shows the execution of the CREATE3S scientific and technical work programme. Each step in the diagram contains one or more tasks and mentions the corresponding deliverable. The main flow (left side) steps are:

- **STEP A**: Outlining the ship operator requirements (task T4.1) and the reflection on the CREATE3S modular concept (task T3.1). Task T4.1 dealt with the container logistic operational aspects which form the basis for the CREATE3S concept, also addressing the synergy of the concept with the liquid bulk market. The logistic aspects and operational requirements were presented in deliverable D4.1. Task T3.1 deals with conceptual solutions for hull geometry and structures in conjunction with task T2.1 yielding the internal report IR3.1.



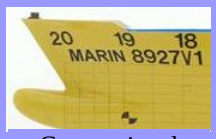
- **STEP B**: Developing 4 alternative concepts each with a dedicated cargo concept (tasks T2.1 and T2.2). The four concepts logistic merits were evaluated leading to the choice of the modular ship as the basis for the further research and development work. The modular ship main particulars are a dock ship concept carrying standard cargo barges (cargo packages) loaded with containers. The barges are loaded/unloaded by ballasting the dock ship and loading/unloading the barges. The results are included in deliverables D2.1-D2.2.

Modular ship concept:
Dock ship ballasted to on/off load position, cargo barges are towed away

- **STEP C**: The CREATE3S modular ship concept is further detailed yielding three different classes, respectively 2 500 (class I), 5 000 (class II) and 7 500 (class III) TDW dock ships. Choosing class III as the basis for further development a detailed design is prepared within task T2.3, already integrating more advanced hydrodynamic and structural developments. The outcome is included in deliverable D2.3

- **STEP D**: Class III technological viability reaches the advanced design stage which includes;
  - Structural concept FEM-calculations. A particular issue regarding the hull structure is the investigation regarding the Advanced Double Hull (ADH) and the steel-composite hybrid structural concepts.
  - Extensive powering and sea keeping model tests for investigating resistance, sea keeping properties and safety according to IMO rules for open top container ships which are applicable to CREATE3S dock ship classes. A particular issue regarding resistance and sea keeping is the comparison between two hull bow geometries: a bulbous bow and a reverse bow.

  This work is done in task T3.3 and the results are displayed in deliverable D3.2



Conventional bow

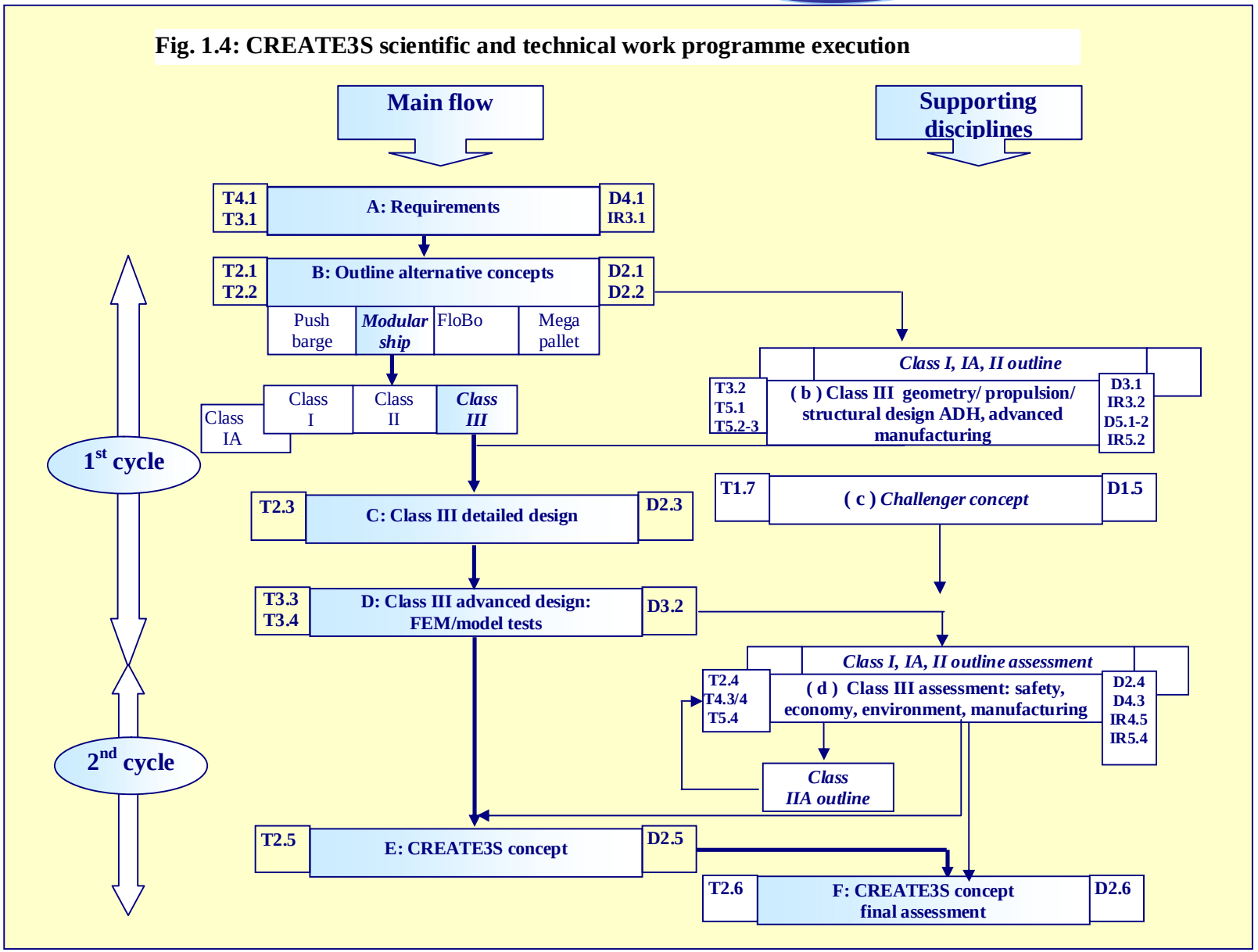
Reversed bow

- **STEP E:** This step deals with three pilot concepts, these are elaborated CREATE3S ship classes to technology and safety validity levels. Step E integrates the results of earlier performed work in steps C and D. The work is carried out within task T2.5, the results are presented in deliverable D2.5.
- **STEP F:** In this step the final outcome of the CREATE3S project is assessed with respect to the initial defined objectives, advances beyond the state of the art and innovations. The work is carried out within task T2.6, the results are presented in deliverable D2.6

The right side of the flow diagram in Fig. 1.4 shows the work carried out within the supporting disciplines in parallel with the main flow:

- **Step (b):** deals with the Class III dock ship geometry and ADH structural design concept in support of **STEP C** (Class III detailed design). The work is carried out within tasks T3.2, T5.1, T5.2 and T5.3, the results are presented in deliverables D3.1, D5.1, D5.2 and Internal Reports IR3.2 and IR5.2.
- **Step (c):** deals with the Challenger concept (see par. 1.3.1) within task T1.7, the results are presented in deliverable D1.5.
- **Step (d):** deals with the intermediate assessment of the CREATE3S concept (task T2.4 and deliverable D2.4) and with the supporting work with respect to the CREATE3S Class III and other pilot concepts Classes I and II and their variants on matters such as safety, economy, impact on the environment and manufacturing (tasks T4.3, T4.4 and T5.4, deliverables D4.3 and Internal Reports IR 4.5 and IR5.4).

Fig. 1.4: CREATE3S scientific and technical work programme execution



1.4 Results

The results achieved are listed below in terms of meeting the project objectives, advancing beyond the state of the art and achieved innovations.

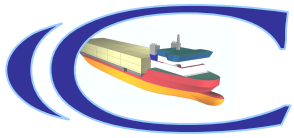
1.4.1 Meeting the project objectives:

CREATE3S objectives	CREATE3S achievements
A modular Short Sea ship concept composed of a basic ship hull module (hereafter ship hull module) upon which various cargo-containing modules (hereafter cargo module) can be mounted.	The CREATE3S modular concept meets this objective. The cargo carrying modules (packages) are capable to carry containers and liquid bulk cargo
Correspondingly, a logistic concept based on the modular ship concept for the waterborne transport leg that outpaces current concepts in terms of logistic and economic performance, and possesses at least equal ecologic performance.	Simulation studies show that the CREATE3S concept can move larger cargo volumes than current concepts and achieve better economic and environmental performance under specific market conditions and different cargo modal split. Although for the investigated business cases a 10% improvement was not demonstrated, the simulation work shows that the concept is competitive. Possibilities for penetrating the liquid bulk market were also identified.
Correspondingly, an advanced manufacturing concept based on the modular ship concept that outpaces current manufacturing concepts in terms of production cost and lead time.	The advanced manufacturing concept can benefit both conventional and CREATE3S concepts, and a 10% improvement in production has been identified. This achievement also represents a possibility for the European shipbuilding industry to strengthen its competitiveness.

1.4.2 CREATE3S; advances beyond the State-of-the-Art

Intended advance beyond the state of the art	Achieved advance beyond the state of the art
Ship concepts	
Cargo unit (module) size: the aim is to contain the entire cargo carrying capacity into one cargo unit.	The cargo concept was finally based on standardised cargo packages (barges), hereby enhancing operational flexibility and better integration with inland waterway transport.
Cargo unit function: the unit does not possesses enough buoyant capability for sea-sailing and is loaded/unloaded directly to/from the land-side	Cargo unit (i.e. the package), do possess enough buoyancy and is able to directly penetrate inland waterways.
The interface between ship hull and cargo modules (standardisation in dimensions and securing systems) and the systems to load and unload the cargo	There is no mechanical link between cargo packages and dock ship. Loading and unloading is done by ballasting/de-ballasting the dock ship. Both items are well proven technology.
Hydromechanic performance	
Consolidated ship hull forms for a number of ship classes (families), offering enhanced hydromechanic performance.	Five ship classes were developed with similar hull forms. Bow geometry (bulb versus reversed) were investigated by numeric and model investigation at the MARIN facilities in Wageningen.
Ship structures	
Lighter and cheaper modular ship hull structures families that can be produced in an industrialised manner	• Conventional and Advanced Double Hull (ADH) concepts were investigated. ADH gains in production cost were annulled by the higher material cost. The conventional structure proved to be more competitive.. • A partial study regarding hybrid steel-composite structure for the upper part of the ship was carried out. Large weight savings were obtained but no cost benefits.
Large cargo modules fitting the ship platform modules	Achieved by the standardised packages.

Shipping operations	
Less time spent in ports	Time spent in port was reduced by 75 %, resulting in significantly more cargo handled compared to existing operation.
More flexibility in short sea shipping operations	More flexibility can be achieved by better linking with inland waterborne transportation, increased integration with D2D transport operations, mixing cargo (containers/liquid bulk), and introducing a so-called “metro-system”.
Ship Production	
Reduced overall consumption of man-hours in the entire process chain, by developing specialized skills and efficiently using leading edge equipment and processes	Saving up to 10 % were achieved for the overall production of the vessel, compared to current practice.
Reduced lead time and flexibility to cope with customer requirements by composing tailor-made products from standard components	Lead time reduced and one ship can be produced in approximately 41 weeks. The design has several sections that are standardised and the manufacturing strategy is expected to handle variations in customer requirements for the other sections.
Improved working conditions through transfer of outfitting and assembly works to the workshop	Distributed production does include outfitting in the various workshops, but effect on working conditions needs to be further investigated.
Improved product quality through pre-tested standard components	Standardised production is expected to improve quality of vessel and equipment.
Reduced operational cost through modular products which can easily be adopted to short term changes in the market	The manufacturing strategy developed reduces the operational cost for each shipyard as production is more standardised, yet how this materialise during market fluctuations are not known.
Reduced maintenance cost by the use of standard components	Have not been fully investigated by the project, thus few conclusions on this can be made

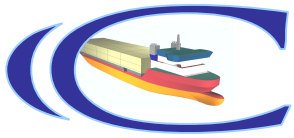


1.4.3 Create3S Innovations

The CREATE3S Description of Work contains a set of innovation related activities that are classified by work package and innovation type. Regarding the innovation type OECD, Technological Innovation is as defined in the Oslo Manual from 1995[1]. The + symbol indicate achievement of innovation, while the ☐ indicate innovation not achieved.

Innovation type	WP2: New concept	WP3: Critical technologies	WP4: Operations	WP5: Advanced manufacturing
Product	Modular ship concepts of cargo and cargo modules +	• Better hull form + • Lighter structures ☐	• Short turn-around cycle in ports + • More flexibility +	• Shorter lead times + • Reduced risk ☐
Process			• Faster cargo delivery method +	• Modular approach in production + • Distributed process +
Marketing	• More flexible concept + • Redu • ced time in port +			
Organisational			New logistic process +	New production organisation model +
Business model			Different way to capture value through distributed process +	Different way to capture value through distributed process +
OECD	Modular ship concepts of cargo and cargo modules +	• Better hull form + • Lighter structures ☐		• Distributed production + • Modular concept +

[1] "Technological product and process (TPP) innovations comprise implemented technologically new products and processes and significant technological improvements in products and processes. A TPP innovation has been implemented if it has been introduced on the market (product innovation) or used within a production process (process innovation). TPP innovations involve a series of scientific, technological, organisational, financial and commercial activities".



1.5 Impact of the project

The envisaged potential impact of the CREATE3S project addresses two issues:

1. The **competitiveness** of Short Sea Shipping as crucial transport mode in a growing EU economy
2. The **competitiveness** of the Shipbuilding industry as primary provider of advanced, safe, clean and economically efficient short sea ships.

The competitiveness of Short Sea Shipping centres around the ability to ensure efficient door-to-door supply chains with the following key issues:

a. Efficient linking of the motorways of the sea with coastal and inland routes
b. Swift manoeuvring and entry into ports
c. Efficient ship-shore interfaces facilitating the integration with other surface transport modes.

The CREATE3S dock ship/cargo barges (packages) solution provides this ability by matching all three key issues: it reduced time in port by ca. 75 % (b), it handles its cargo load efficiently without requiring shore-based facilities at the time of loading/unloading (c), it allows (after off-floating) to directly link with inland waterways transportation without necessitating cargo handling from sea ship to inland ship (a). The additional ability to transport liquid bulk cargo and mix this with containers provides a degree of flexibility which is not available in current unitised cargo (container) operation.

The competitiveness of the Shipbuilding industry centres around the capability:

a. To conceive novel ship concepts in diverse variants which are safe, clean and cost efficient
b. To incorporate herein ship architectural concepts based on modularisation and standardisation for advanced manufacturing and reduced lead time
c. To incorporate herein advanced materials to improve payload-to-weight ratios

The CREATE3S dock ship and cargo barges (packages) architectural configuration provides this capability by matching all three mentioned issues: the CREATE3S ship classes have a common architectural concept (a) based on modularisation and standardisation principles fostering advanced manufacturing strategies and reduced lead time (b). The investigated concepts of advanced steel-composite hybrid structure improves significantly payload-to-weight ratio's (c), the Advanced Double Hull concept satisfies the conditions of (a) and (b) but does not improve payload-to-weight ratio's.

2 DISSEMINATION AND USE

In general CREATE3S results were disseminated by publications and presentations as coThe CREATE3S consortium abstains from publishing results with the exception of result 09 LCA (Life Cycle Assessment) by Bureau Veritas (see below).

09 LCA	Life Cycle Assessment
Result description (product(s) envisaged, functional description, main advantages, innovations)	

Environmental Improvement Made Easy – Marine (EIME V5.0 Marine): Life Cycle Assessment and Ecodesign software for vessels.

EIME v5.0 is used by industrials to realize hundreds of life cycle assessment and product environmental labelling. Thanks to Bureau Veritas CODDE participation to European lead project on Marine fields, EIME v5.0 benefits from Marine sectorial specificities. Its specific Marine database and interface are adapted to simplify LCA of ships and their equipment. EIME v5.0 marine is compliant with ISO 14040 and ISO 14044 international standard principles and rules of application , as well as ILCD (International Life Cycle Data system) format.

Bureau Veritas CODDE experts regularly and frequently develop and implement on EIME Life Cycle Inventory (LCI) data, issued from diversified and professional sources. Its database content has been developed and implemented to ensure complex vessels environmental assessments. Since 2010 our database integrates the European database ELCD as well as materials and processes that are used in marine industries:

- Inventories of steels, aluminium, titanium or any metal or semi-metal used in shiphull structures or light work
- Inventories of electric and electronic components, textiles, chemicals, mechanical sub-systems such as windows or floors, insulations, paints and coatings, anti-fouling and anti-corrosion paints
- Inventories of processes using different techniques, such as cutting (laser-cutting, metal shearing, oxygen cutting etc), welding (metal inert gas welding, spot, electric, MAG arc welding etc), sand blasting etc.
- Inventories of end of life treatment applicable to waste generated during construction, operations and end of life, including hazardous waste treatments such as asbestos, PCB paints, bilge oil, ballast water treatments etc.

EIME v5.0 marine interface has been developed for ensuring user comfort and easiness. For each life cycle phase Marine interface is proposing to the user a selected range of LCI's and is guiding the user to model the ship life cycle:

- Construction of a ship with specific developments for building yard operations (workshops, pre-fitting and building of hull sections, testing etc), transport on site and for supplying materials, waste management.
- Operations, including consumables (materials, water etc), inspection and maintenance, supply to ship and waste management and specific navigation to model ship energy consumption.
- End of life with specific dismantling procedure based on the IMO guidelines for ship recycling, transport of equipment on yard and waste management.
- Specific Marine output resulting from life cycle modelling such as Green passport draft and calculations of a set of environmental indicators, reflecting marine challenges and impacts of regulations.

EIME v5.0 functionalities facilitate ship design for environment, integrating environmental criteria (recommendations, hazardous substance tracking, graphics for comparing environmental performances of several options, eco-radar etc)

Possible market applications (sectors, type of use) or how they might be used in further research (including expected timings)	
	Assessment of ship End of Life fully completed. Completed LCA of ships and complex vessel structures by December 2010
Stage of development (laboratory prototype, demonstrator, industrial product etc):	
	Industrial product. Is being further developed with EU POSE2IDON for ship full life cycle assessment
Collaboration sought or offered (manufacturing agreement, financial support or investment, information exchange, training, consultancy, other)	
	Internal developments
Collaborator details (type of partner sought and task to be performed)	
	Not applicable
Intellectual property rights granted or published	
	Tool fully owned by BV. Specific terms and conditions for sale and use of licences currently being used.
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