Developing Smart Technologies for Productivity Improvement of European Small and Medium Sized Shipyards
SMALL AND MEDIUM SIZED COMPANIES are an essential part of the European maritime economy. They provide a large number of jobs in maritime regions and beyond and successfully serve specific markets in the new build and repair sector.

The entire maritime sector is facing increasingly tough global competition as well as new challenges with regard to product performance and reduced environmental impact. Unlike larger yards, which have successfully specialized in high-value added niche markets and corresponding production processes, small shipyards need to react flexibly and quickly to varying market opportunities. Due to lacking financial and personal resources, limited access to information, expertise and technologies, and other factors, production processes in small and medium sized shipyards often bear significant improvement potentials. To exploit those potentials, small and medium sized shipyards need technical solutions, skills and business models, which fit their specific needs.

THE SMARTYards PROJECT aimed to improve the productivity of European small and medium sized shipyards and their partners in the process chain by

- including them and their regional maritime clusters in a Europe wide network, which facilitates information exchange, access to specific technologies and expertise, and encourages cooperation with researchers and experts from other small and large shipyards;
- Developing and demonstrating smart solutions, which are not necessary high-end technology, but which are tailored to the specific needs and requirements of small and medium sized companies.

SMART SOLUTIONS in the understanding of the project consortium need to be simple, flexible, affordable and robust. They need to be integrated into specific shipyard processes in an optimal way, ensuring the largest possible impact for the user. Smart solutions require technologies and equipment, but also corresponding skills and adapted business models, such as cooperation to increase economies of scale. The SMARTYards solutions catalogue presents some of those solutions for typical shipbuilding processes.

SMARTYards PROTOTYPES were developed specifically for and with end-user companies. After being tested and validated on site, they are presented in this brochure with the aim to attract more end-users and uptake of the project results by additional small and medium sized companies.

In addition, the brochure encourages shipyards, technology and service providers to JOIN THE NETWORK which was established during the project and which will remain active in the future.

In this sense: ENJOY READING, GET INSPIRED and CONTACT US to become member of the growing SMARTYards Network.

Michael Hübler
SMARTYards Project Coordinator

Dr. Frank ROLAND
Managing Director

CENTER OF MARITIME TECHNOLOGIES e.V.
SMARTYards

Project and Objectives

The project “Developing Smart Technologies for Productivity Improvement of European Small and Medium Sized Shipyards (SMARTYards)” was performed in a consortium of 17 partners from nine European countries in the period October 2013 – September 2016.

While the permanent improvement of shipyard business processes, skills and technologies is a challenge for the entire European shipbuilding industry, small and medium sized (SME) shipyards face specific challenges. Limited financial capabilities and resources reduce their possibilities to invest in new technologies and production facilities. The comparably small scale of financial as well as production turnover reduces the economic feasibility of single purpose automation. Limited personnel resources and lack of skills reduce the ability to use innovative technologies and to participate in research and development activities. Finally small and medium sized shipyards often lack the access to information and cooperation networks, which are available to the large shipyards. For these reasons, SMARTYards aimed at improving the productivity of the production processes of small and medium sized European shipyards and related subcontractors working with them.

To achieve this objective SMARTYards has:

- Developed, tested and validated six prototypes selected from a pool of 25 technical ideas proposed in 7 different technology areas.
- Investigated the productivity of each prototype, its impact on Environment, Health and Safety and its opportunities for the shipyards production processes.
- Prepared and tested training material for the prototypes.
- Developed a concept for a sustainable Research Development and Innovation Network for SME Shipyards involving European Maritime Cluster Organisations and the SMARTYards Consortium.

SMARTYards Technology Areas and Prototypes

The shipyard’s production process includes all processes from design through engineering (production preparation) to manufacturing, assembly and outfitting. Even though design processes are not part of the core field of work of small and medium sized shipyards, these have been included in the project as they are mostly carried out by SME companies and due to their importance for the whole building process. Maintenance, repair and retrofitting processes are incorporated, being an important business area for smaller shipyards.

SMARTYards identified seven Technology Areas (TA) that characterize the design, production and delivery processes of a shipyard. For each area design studies were made to identify technological ideas for improvements for shipyards’ business processes and their savings potential. The results were documented in the SMARTYards Solution Catalogue and used to define the six prototypes that have successfully been developed:

- Work Content Estimator
- Distributed Design Processes
- Simulation
- Micro Panel Line
- Portable Container Workshop
- Composite Service Deck

SMARTYards Technology Areas and their coverage of design and production flow

<table>
<thead>
<tr>
<th>Design</th>
<th>Production Preparation</th>
<th>Production</th>
<th>Operation</th>
</tr>
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<tbody>
<tr>
<td>20%</td>
<td>20%</td>
<td>77%</td>
<td>5%</td>
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</tbody>
</table>

- **Basic**: 75%
- **Detail**: 15%
- **Planning**: 5%
- **Design Engineering**: 10%
- **Part Preparation**: 15%
- **Preparation**: 20%
- **Dock Assembly**: 15%
- **Outfitting**: 10%

*SMRC* - Ship Maintenance, Repair and Conversion

- **TA-1**: Design Methods and Tools
- **TA-2**: Production Preparation and Planning
- **TA-3**: Accuracy Control and Shaping
- **TA-4**: Welding and Assembly
- **TA-5**: Coating Materials and Processes
- **TA-6**: Outfitting and SMRC Techniques
- **TA-7**: Innovative Materials and their Assembly
A comprehensive Technology Catalogue for the seven Technology Areas was developed. This SMARTYards Solution Catalogue proposes smart solutions (equipment, design for production and process organization) to improve productivity in small and medium shipyards. Additionally, in order to sustain this catalogue’s usage after the end of the SMARTYards project, a methodology to collect, assess, select, adapt and validate optimized and holistic solutions for small and medium sized yards was prepared. In conjunction, a WIKI platform was set up as a possible tool, being an online platform wherein the elaborations of design studies can be maintained online by the users.

### SMARTYards Technology Ideas

#### TA-1 Design Methods and Tools
- **a** Resource Planning and Monitoring Tool for Design Processes
  - Conceptual
- **b** Work Content and Weight Estimation Tool in Early Planning
  - Prototype
- **c** Product and Work Breakdown Tool in Early Design
  - Conceptual
- **d** Variato
  - Conceptual
- **e** Methods to Improve the Efficiency of Distributed Design Processes
  - Prototype
- **f** Generating FE-Model from 3D-CAD-Software
  - Conceptual

#### TA-2 Production Preparation and Planning
- **a** Advanced Planning in Shipyards using Simulation
  - Prototype
- **b** Model Generator for Simulation
  - Design Study
- **c** Production Management Data Base
  - Conceptual
- **d** Centralised Planning Services
  - Conceptual

#### TA-3 Accuracy Control and Shaping
- **a** Bending assisted by integrated measurement
  - Design Study
- **b** Induction Heating for Straightening
  - Design Study
- **c** Accuracy Management System for Small Yards
  - Design Study

#### TA-4 Welding and Assembly
- **a** Simple, mobile and flexible welding equipment
  - Prototype
- **b** Qualification of innovative welding processes
  - Design Study
- **c** Welding Parameter Database using statistical process models, Weld Manager
  - Conceptual
- **d** Macro Programming using digital cameras
  - Conceptual
- **e** Work Breakdown information for production
  - Conceptual

#### TA-5 Coating Materials and Processes
- **a** Coating Decision Support System
  - Conceptual
- **b** Overspray Containment System
  - Conceptual
- **c** Simple and flexible equipment for coating preparation and application
  - Design Study
- **d** Design for easy coating
  - Design Study

#### TA-6 Outfitting and SMRC Techniques
- **a** No heat input Joining Methods in Outfitting
  - Design Study
- **b** Repair and Retrofit Technologies and Planning
  - Conceptual
- **c** Logistics Planning and Materials Traceability - Best Practice
  - Design Study
- **d** Portable container workshop
  - Prototype

#### TA-7 Innovative Materials and their Assembly
- **a** Innovative Materials Catalogue and Joints Catalogue for dissimilar Materials
  - Prototype
- **b** Structural optimization and lightweight with conventional materials
  - Conceptual

### Training

Limited personnel resources and high time pressure often limit the skills and competences available in small and medium sized shipyards. As a result new technologies and more productive business processes are often difficult to implement. The focus of SMARTYards therefore was twofold: to elaborate specific training material for the introduction of the prototypes and to initiate new training schemes, which allow training on the job in everyday work.

The training material for each prototype includes tools of different typology (hardbooks, videos, etc.) to train the end users about its design, functionalities and operation. The training schemes are meant to improve and maintain the level of skills in the small and medium sized shipyards.
Design Methods and Tools

Work Content Estimator

**Problem**
The work content estimator is intended for use at shipyards not having their own design office and where the initial work content, weight, and cost price indication for a new ship is based on the input of many persons, each contributing from their own expertise.

**Achieved results**
The Work Content Estimator (WCE) is designed to extract geometric properties from a ship’s general arrangement plan drawn in AutoCAD into structured data in Microsoft Excel. This enables the shipyard to speed up the process of initial cost price estimation in the pre-contract phase. It further provides the shipyard with an initial weight and work content estimation. Due to a user-friendly Graphical User Interface, the process of data extraction can easily be controlled.

**Benefits for SME shipyards**
- Significant reduction in work activity for calculations
- Reduces errors and increases the reproducibility and quality of documentation
- User friendly as it prevents the need for complicated and integrated software tools
- Compatible with AutoCAD which is much used in the shipbuilding industry
- Secures knowledge that is now in the heads of shipyard’s employees

**Reduces errors and increases the reproducibility and quality of documentation**
### Problem
During the ship design process many specialists work together, each addressing a certain aspect of the ship’s design such as stability or construction. For this they use specialised 3D software tools. The challenge is to maintain consistency of data between these tools during the design process and the production (preparation) process at the shipyard.

### Achieved results
This SMARTyards prototype is designed for design data exchange between a 3D hull arrangement software package and a 3D ship stability software package. It is based on a “two way data exchange portal” ensuring consistency of data between these two packages. The communication is via internet without using central data storage. The applications use each other’s methods without having direct access to each other’s data structures and storage. The prototype can be used within the shipyard or as enabler for a distributed design process between the shipyard and strategic partners, like for instance a design office.

### Benefits for SME shipyards
- Large time savings during the design process
- Reduces the probability of errors
- Improves consistency of data
- Supports tasks performed on different locations
- Easier collaboration between SME shipyards and design offices
In order to be competitive, shipyards must optimise the use of available resources and decide on strategic partnerships. To achieve this, many different aspects must be taken into account, since the design, construction, outfitting and delivery of a new ship is a complex process. Simulation is one solution to tackle these challenges.

Achieved results
This SMARTYards prototype is designed to simulate the shipyard’s production processes. It enables the shipyard to identify scenarios to optimize the use of available resources. It further gives insight in the options to take up and manage a larger number of projects simultaneously. The core elements are the Shipyard Planning and Support Interface (SPSI) and the Shipyard Simulation Model. The SPSI is the shipyard’s planner interface which is used to handle data required for simulation. The simulation database is specifically developed for the needs of the shipyard where the simulation will be used.

Benefits for SME shipyards
• Optimization of the use of available resources
• Insight in consequences of various assembly sequences
• Structured gathering of historical data, thus improving the quality of future simulations
• Identification of new business opportunities
Welding and Assembly

Micro Panel Line

Problem
Where larger shipyards have automated their welding processes, SME shipyards often lack the financial resources for the purchase of this type of equipment and the knowledge to programme them. As a result welding work is done manually.

Achieved results
The SMARTYards Welding Robot is designed for the automation of the welding process for unified large flat panels (welding stiffeners on a flat plate with certain frame distances, or similar) and micro panels with more complex welding routes. It consists of a gantry on which the welding robot is positioned and a scanning system that provides the robot with the needed information. The system comes with pre-programmed welding scenarios, allowing the operator to select the required scenario after which the welding robot proceeds with its task autonomously. The welding robot is designed to be implemented in a micro panel line.

Benefits for SME shipyards
• Reduction of the amount of manual welding activities
• Automation of repetitive manual welding
• Runs on a simple gantry
• Can be operated during night shifts and/or parallel with manual welding tasks
• Robot can be shared between shipyards

Robot needs no programming
Outfitting and SMRC Techniques

Portable Container Workshop

Problem
Due to space limitations, lack of financial means or other factors shipyards not always have the possibility to optimise the layout of the shipyard in relation to the production process. This often results in a loss of productivity due to the fact that workers need to go to the main workshops for small tasks.

Achieved results
This SMARTYards prototype is designed to provide shipyard workers with a workshop containing preselected tools, machines, and materials at their work location. By providing this workshop shipyard workers can perform tasks without going to the main workshop, thus increasing their productivity. The workshop is a container and positioned on a floating pontoon. This pontoon is moved around the shipyard bay and moored alongside the ship where the work needs to be done or in close vicinity alongside a quay.

Brings workshop to the ship

Benefits for SME shipyards
- Increases productivity of workers
- Small tasks are performed at the working location
- Prevents disruption of serial activities in the workshops
- Can be used alongside ships or hoisted on their deck
- Pontoon can be used for transfer of goods
Innovative Materials and their Assembly

Composite Service Deck

Problem
As long as class rules remain the main problem to introduce new materials (mainly non-metallic materials and the specific joining between them), many SME shipyards avoid to demonstrate potential customers that these materials have many advantages compared to the use of traditional steel. As a result they have fallen behind in development, knowledge, skills and experience.

Achieved results
This SMARTYards prototype is designed to provide a shipyard with knowledge about the use of composites in shipbuilding and ship repair by means of a physical demonstrator and a best practice composite handbook for shipyards. The purpose of the demonstrator is to establish knowledge in shipyards working at present with steel only. By testing and demonstrating different structural forms and joining techniques for combinations of materials, the implementation of composite components in shipbuilding is shown. It is considered that the Composite Service Deck is the best solution to enable a shipyard to see, understand and explain the benefits of composite materials to its employees, customers and relevant third parties like class societies. The best practice composite handbook for shipyards is the other element of this prototype giving a short overview for non-experts into composite for maritime application.

Benefits for SME shipyards
• Enables shipyards to decide where composite applications are feasible under the current rules and regulations
• Provides knowledge to assess the impact of the use of composites on productivity, resources, activities etc.

Promotion of composite materials to shipyards, ship owners and suppliers
Productivity Assessment

When new technologies or methods are introduced into shipyards, it is important to estimate their potential before their introduction. For this reason SMARTYards conducted for each prototype a productivity assessment both qualitative and quantitative. The performed assessments show that every prototype has the potential to act as enabler for increasing a shipyard’s productivity. By applying all solutions developed in SMARTYards, at least 20% productivity improvement can be expected.

Business Model Development

Where SMARTYards prototypes provide technical solutions for productivity increase, optimising the shipyards business model creates additional opportunities. To provide SME shipyards with insight in these opportunities a generic business model for shipyards was defined and used to analyse the business models of larger and smaller shipyards. This analysis showed for example that many shipyards optimize their business model by outsourcing or sharing certain tasks or complete business processes. The model was finally used to define different implementation strategies and schemes for each SMARTYards Prototype.

Keyactivities

SmartYards prototypes to increase productivity

Outsourced

Generic Business canvas model for shipyards

Participation in R&D network to increase productivity

Outsourcing of tasks to key partners to increase productivity

Sharing tasks with key partners to increase productivity

10% 40% 70% 88%
Sustainable Research Development and Innovation Network for SME Shipyards

SMARTYards has paved the way for a Sustainable Research Development and Innovation Network for European SME Shipyards. The SMARTYards user group already has more than forty participating companies from all around Europe. Several European Maritime Cluster Organisations have signed a Memorandum of Understanding to shape this network. Finally a detailed proposal for the scope, design and organisation of this network has been delivered by SMARTYards including legal schemes for the disclosure of intellectual protected information.

The ultimate goal of this network is to provide small and medium sized shipyards and their suppliers a platform that operates throughout Europe, supported by regional and national maritime cluster organisations and focused on the improvement of the productivity of these shipyards. For this, the network will concentrate on:

- Identifying points of contacts throughout Europe for direct support
- The creation of an internet based platform connecting knowledge and technology seekers (e.g. shipyards) and knowledge and technology providers (e.g. EU RDI Projects)
- Providing accessing procedures for intellectual property rights protected information and related standard contracts and payment terms

You are invited to join the network

To ensure the sustainable success of this network in the future you are kindly invited to join via the SMARTYards website (www.smartyards-project.eu) or by email (smarty-usergroup@cmt-net.org).
Response of Maritime Cluster Organisations on Proposal for Sustainable RDI Network

<table>
<thead>
<tr>
<th>What should be the main topics and content of a RDI network for SME shipyards?</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Structured documentation related to RDI research for technologies in use by shipyards</td>
<td>7</td>
<td>88%</td>
</tr>
<tr>
<td>2. Structured information on products available for shipyards</td>
<td>5</td>
<td>63%</td>
</tr>
<tr>
<td>3. Structured information on upcoming events focused on RDI projects</td>
<td>5</td>
<td>63%</td>
</tr>
<tr>
<td>4. Structured information on upcoming demonstrations of products</td>
<td>5</td>
<td>63%</td>
</tr>
<tr>
<td>5. Structured information on upcoming events (workshops, seminars, webinars)</td>
<td>6</td>
<td>75%</td>
</tr>
<tr>
<td>6. Structured information on upcoming training related to shipyards technologies</td>
<td>7</td>
<td>88%</td>
</tr>
</tbody>
</table>

**CARDAMA Shipyard**

“The direct benefit of being involved in the “SMARTYards Project” is the direct access to results and conclusions of each idea, but maybe the most important thing here is the indirect attitude of the partnership itself: many and different European companies working together (ship designers, software developers, technology centres, universities, shipyards) and just breaking down barriers like distance and the habitual secrecy in our Maritime Industry.”

**ULJANIK Shipyard**

“We see the SMARTYards project as a way of finding new opportunities to improve our existing best practices and developed processes, as well as their innovation. Our goal is to ensure implementation of positive and proven results of the project in our core business and to strengthen intellectual capital of our company. From our perspective this is an essential question for any yard, therefore it is a great challenge for us.”

**Flensburger Schiffbau-Gesellschaft mbH & Co. KG**

“Due to continuous research and innovation Flensburg Shipyard has achieved a strong development in the area of production. Strengthening the results by aligning to other shipyards and improving the approaches by taking additional requirements into consideration were the main goals for Flensburg Shipyards in the project SMARTYards. Hence, flexibility in production is boosted enabling Flensburg Shipyard to meet the requirements of the future order book.”

**NAVROM SHIPYARD**

“The involvement of NAVROM SHIPYARD in the SMARTYards project is an open window for new ideas, technologies and connections and as part of this corresponding network, to bring us also the feeling to belong to a wide entity which is the shipbuilding industry. The technological and ideological contacts developed inside the project and continued after the end of the project period will only improve the quality of people and activity, a good way to be followed by all those involved in the shipbuilding industry.”
Contact
Project Coordinator:
Michael Hübler
CENTER OF MARITIME TECHNOLOGIES e.V.
Bramfelder Str. 164
D-22305 Hamburg • Germany
Tel.: +49 (40) 69 20 876-0
Fax: +49 (40) 69 20 876-66
Email: huebler@cmt-net.org