3D maritim

AUGMENTED SHIPBUILDING

A position paper by
the **3D maritim**
competence network

THE FUTURE WITH AUGMENTED SHIPBUILDING

The shipyard employee is looking at the engine to be supplemented by an exhaust gas treatment module. The ship owner made some last minute changes and decided that the ship being constructed should observe the future, stricter environmental regulations now already. Therefore, a reactor for the after-treatment of emissions must be built into the exhaust tract. Directly in front of it, an additional nozzle is placed to supply the reducing agent. It converts the nitrogen oxides to harmless nitrogen and steam. However, this changes the geometry of the exhaust pipe. It becomes shorter and is supplied with a connection for the nozzle.

The employee activates the AR glasses on his helmet, cross-fades the 3D CAD model over the already constructed exhaust tract and retrieves the measurements. Considering the dimensions, the modification should be feasible. But for a decision, the colleagues from design, prefabrication and the classification society should be consulted. He therefore convenes them for a web conference for which they jointly schedule a time slot at short notice.

By means of the camera on the helmet, the operator records the current exhaust tract and explains to his colleagues connected from their offices at the other end of the shipyard where the reactor and the nozzle must be installed. He also shows them the models of both components the supplier has conveyed to him in the meantime.

As a result, the designer modifies the pipe concerned with only a few steps online and presents it, virtually connected with the new components, to the conference participants. The operator overlays the adjusted pipe to the current installation situation. It fits. Then the classification society is able to give the green light immediately based on the updated model data. Last but not least the prefabricator announces that he is able to supply the component via Rapid Manufacturing within a few hours already.

The implementation of these short-term modifications did not even take a day and only slightly interrupted the construction process.

THE PERSPECTIVE OF THE EUROPEAN SHIPYARDS: INTEGRATIVE PROCESSES

It is not the container ships built in series which are the main driver of sales in the German shipbuilding industry nowadays. This is where the low-cost suppliers from the Far East are leading the market. But for special ships of all kinds, the location still offers global benefits and opportunities. Nowhere else do shipyards offer such a high level of production technology, and it is rare to find better project management in shipbuilding.

For many components, German suppliers are global market leaders. Their proximity to the shipyard and close cooperation are additional benefits for the German special shipbuilding sector.

The shipyards which are successful today have long been geared towards the design and construction of special ships. But for the future of a fourth industrial revolution, even their methods are not efficient enough anymore today. Special ships of the future are intelligent and networked. Without intelligently linked processes, methods and tools in design and construction, they cannot be realized.

In order to explore, design and test new processes, methods and tools in projects within the context of the requirements of special shipbuilding, research institutions, specialized IT providers and shipbuilding companies have joined forces in the 3D maritim network.

〉〉〉 **3D MARITIM** NETWORK

The **3D maritim** *network is a unique pool of specialized IT companies, research institutions and users driving the application of 3D in the maritime industry. The complementary specialist expertise of the network members covers all issues required for various application scenarios: 3D reconstruction, semantic enrichment of 3D data, Virtual and Augmented Reality, man-machine communication or computer vision.*
www.3dmaritim.de/en

In the process, one focus has already emerged: the use of 3D models and computer graphics to ensure an agility and productivity even in highly complex projects as is required by the market today. Computer models and data mix with already built parts in real time to form an environment in which decisions can be made quickly and safely.

Complex products themselves are networked and equipped with a special kind of intelligence via electronics and software today. In the same way special shipbuilding in particular needs the close connection of sensors with a flexible, autonomous control, allowing a seamless interaction of man and production machines. This new generation of systems is called Cyber-Physical Systems (CPS).

〉〉〉 WHAT ARE CYBER-PHYSICAL SYSTEMS?

Software-intensive, embedded systems are increasingly networked among each other, but also with data and services online. This is how intelligent solutions are created, connecting, by means of sensors and actors, processes of the physical world with the virtual software world and interpret, monitor and control in interaction with people. The central feature of Cyber-Physical Systems is the so-called X-Awareness: "[...] the correct perception and interpretation of situation and context (Situation Awareness, Context Awareness), the recognition of the state as well as the quality of CPS services and components and, last but not least, of the state, the goals and intentions of the users (Human Awareness)."

Source: German Academy of Technical Sciences acatech (www.acatech.de)

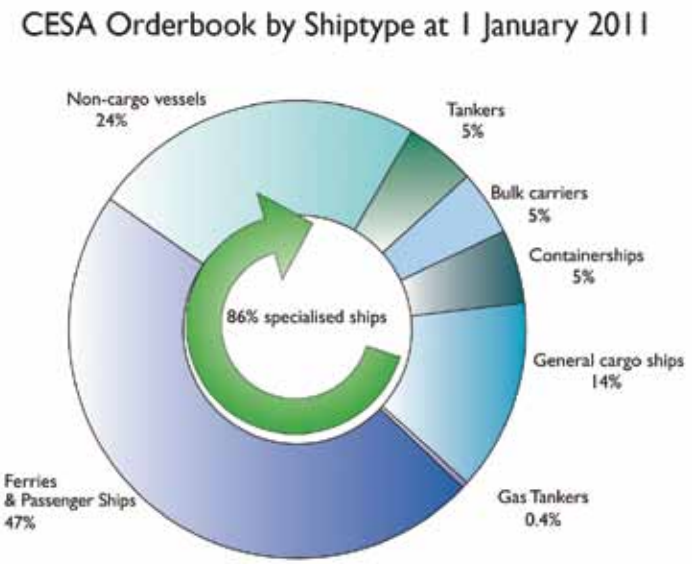
SPECIAL REQUIREMENTS IN SHIPBUILDING

It is the special features of the unique vessels and limited editions in special shipbuilding which are also imposing special requirements on the processes, tools and methods. These requirements cannot be met merely by solutions in the marketplace for mechanical engineering or the automotive industry.

››› EUROPE IS BUILDING SPECIAL SHIPS

Following a phase in which particularly German shipyards had primarily filled their order books with container ships, special ships are dominant today. This is proven by the figures published by the European industry association CESA.

Source: Community of European Shipyards Associations, (www.cesa-shipbuilding.org)



THE SHIP IS CREATED IN SIMULTANEOUS PROCESSES

Even before the construction is completed in every detail, the building and welding of the shell must be initiated. Construction and production - at the shipyard, this is a very complex interplay of planning and changing on the spot. Design and building unfold in the form of many overlapping and, for the most part, parallel process steps. Here is the decisive approach of the network's research program: Engineering and production must be so closely knit as if they were one single process.

The consistency of the data between design and building, between PLM (Product Lifecycle Management) and ERP (Enterprise Resource Planning) therefore has a high priority. All data must be available everywhere at the earliest possible stage. And it should be easy for the production experts to use them. Just as the findings from production or maintenance must be fed into modification construction without delay.

For modifications the data situation is especially dramatic. For a ship to be overhauled after 20 years, there are technical drawings at most. Never 3D models. And even for a new ship leaving the shipyard, there are often no correct 3D models availa-

ble. Here, the status quo must be captured quickly with camera and scanner and transferred to 3D models. So that whatever is being built will fit to the millimeter to what is already there.

THE SHIP IS BIG

Cars and planes, which usually serve as examples for complex products, are relatively simple compared to ships. For a ship, a multiple must be added in the number of components and parts installed. The large extent is reflected in a corresponding data volume of 3D geometry, calculation and simulation models as well as the related commercial and technical data from an ERP system.

But the extent is also expressed in the long stretches to be covered at the shipyard, for instance from the design workplace to the hull at the construction site. Here, tools are missing to shorten or avoid the way. In order to fetch or view documents from the respectively other site or to check whether what is developed will fit, the technologies of mobile computing and the state-of-the-art, wireless telecommunications can render valuable services for the quick access to the required data.

ACCOMPLISHING WHAT IS TECHNICALLY FEASIBLE

Unique vessels and limited editions present a special problem to all parties involved: for design and construction of the innovative special ships, there is a lack of experience. The ships are created by means of complex mathematical calculations and nowadays include systems from high-tech components for propulsion, navigation, security and equipment. Here, the early-stage analysis on the computer can help simulate something before it is built, and explore the limits of what is technically feasible. Design studies and construction model in 3D - that is already state of the art at many shipyards. But a consistency from the early stage via design and simulation, production up to the training in the after-sales area as well as the application in the ship operation - that is a vision of the future yet to be explored.

Be it dynamic flow computation for the shell of a ship; be it ergonomics examinations on the submarine for the reachability of a device or for the visibility of an instrument display - each field has special requirements, needs a different data structure and works with special IT tools. These models can be provided with a common basis and be easily used even for other areas in different contexts, by means of software. And it brings just the time advantage and the process security required by shipyards for the global market in the future.

ALREADY CRUCIAL TECHNOLOGY TODAY: MIXED REALITY

3D models represent the results of the design phase. In production, on the other hand, everything is real and analogue. Mixed Reality forms the bridge. Construction states which are scanned or recorded by photo or video camera can be overlaid and mixed directly and in real time by virtual data. Therefore, Mixed Reality will play a key role in the closely meshed network of design and production.

These topics are currently being developed by the **3D maritim** network and will be available shortly:

REVIEWING SECURITY CONCEPTS

The evacuation of a ship is the emergency to be focused on in the design phase. For this purpose, there are simulation programs showing how the passengers and crew members move about. In the process, points on a level are illustrated. In their stead, human models can be moved about integrated in the software platform. And the viewer himself may feel like one of the human models and see whatever can still be seen in the emergency lighting in an aisle below deck - or what happens if the ship is in a sloping position.

››› TECHNOLOGY TREND MIXED REALITY

Mixed Reality is the generic term covering the entire spectrum between Virtual Reality and Augmented Reality. Virtual Reality is the illustration of 3D model data in a form that seems like a real object to the human eye. The user thus plunges into a completely virtual world and can experience and evaluate a ship which previously only existed inside the computer.

Augmented Reality complements the view on real objects or their pictorial representation (for example in photo or video) by overlaying with virtual models. Particularly attractive are mobile applications in which the position of the user is captured and additional information is inserted in the right position in the camera image of a smartphone.

EVALUATION FOR PROCESS PLANNING

A digital human model provides the possibility to realistically simulate the performance of an installation inside the ship or even the operation of an assembly unit. What does the person see? How does he or she need to move in order to grab or mount something? Can he or she do it alone? Or does the job require two people?

ELECTRONIC CONSTRUCTION STATUS COVERAGE

To cover the actual status of the construction measures, the currently installed components and their physical layout, partners from **3D maritim** have joined forces in the project Electronic Construction Status Coverage. The goal is a device that will make the data acquisition as easy as taking photos of the construction site. A mobile tablet PC is therefore equipped with a camera and additional sensors and thus captures the current spatial geometry.

DESIGN BASED ON THE REAL DATA

How can the CAD models of pipes be adapted within the digital production to the existing construction situation, to the already installed pipelines? Here, the interplay of image processing and visualization ensures that scanned reality and virtual reality match up. Taking over measurements from the scan in CAD models results in construction data guaranteeing a high quality in the assembly.

AUGMENTED SHIPBUILDING – RESEARCH IN DEMAND

THE SCENARIO IN THE BEGINNING OF THIS BOOKLET IS STILL A VISION

For the realization of this vision in a reliable, industrial-suited approach, new tools and methods are required. New information ties, new networking techniques for the shipyard in order to satisfy the perceived requirements in a process to be newly created. The key focus Cyber-Physical Systems aims at the data-driven connection of engineering and production which will decide the future for the German shipbuilding industry.

The network is working on the definition of research priorities by means of which the visions of the partners can be converted into practical solutions in the years to come.

- Product Lifecycle Management (PLM) for special shipbuilding – central management of the data and processes throughout the entire lifecycle
- Intellectual Property Protection in shipbuilding – know-how protection with role-based system of secure access rights
- The mobile worker – with highly precise data acquisition and Mixed-Reality support in steel environments
- The virtual Meeting Room – for the cooperation of all employees of an ›expanded shipyard‹ via web and video conferences
- Data flows between virtuality and reality: capturing the current production states as a geometry model all the way to the implementation of planned geometry by means of Rapid Prototyping
- Holography and Cyber-Physical Systems in shipbuilding – intelligent design and production processes for the shipyard
- Training: Which skills do engineers and workers need in the future in order to practice Augmented Shipbuilding?

Numerous innovations in the processes and IT tools are required if the German special shipbuilding industry is to maintain and expand on its market-leading position and development. It is worth investing in targeted research.

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