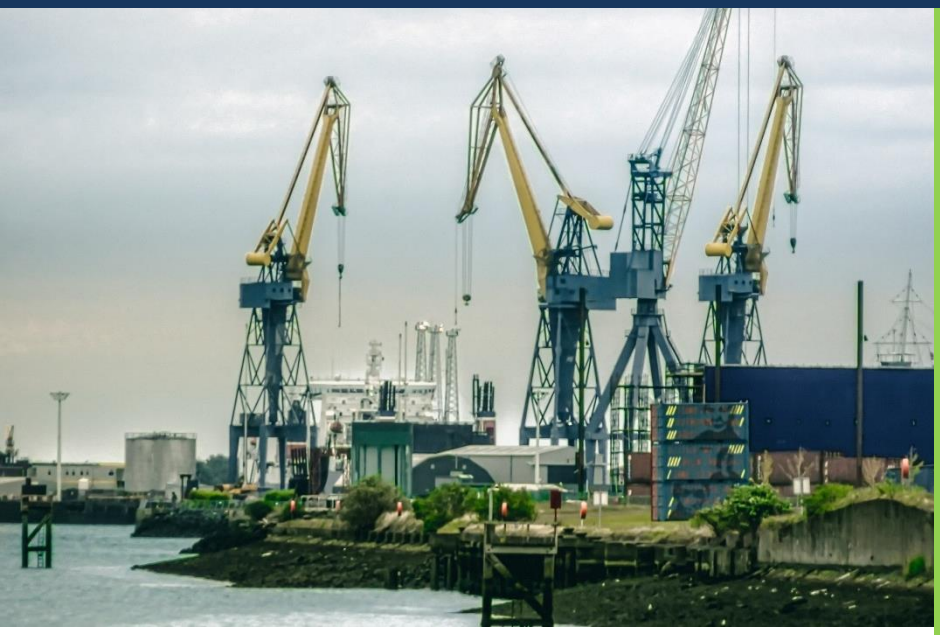
Providing piloting and training for shipyard ecosystems

Pilot training results



ECOPRODIGI

Interreg Baltic Sea Region

EUROPEAN UNION

EUROPEAN REGIONAL DEVELOPMENT FUND

Report by:
Machine Technology Center Turku Ltd.
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Background

ECOPRODIGI is an EU Interreg Baltic Sea Region Programme funded project which focuses on increasing eco-efficiency in the Baltic Sea region maritime sector by creating and piloting digital solutions in close cooperation between industry end-users and research organisations. Providing piloting and training for shipyard ecosystems is a continuation of the work done in the third technology case of the ECOPRODIGI project, optimisation of shipbuilding processes at shipyards. The training programme for shipyard ecosystems was piloted in Finland by Machine Technology Center Turku Ltd., and in Lithuania by Klaipeda Science and Technology Park. The piloting and trainings were designed for the project partners and associated partners but the sessions were also open to relevant supply chain companies. Machine Technology Center Turku Ltd. focused on competence development technologies in the shipyard environment with Meyer Turku shipyard. Klaipeda Science and Technology Park focused on utilising 3D scanning together with Machine Technology Center Turku Ltd. and Chalmers University in Gothenburg. 3D scanning focused on the shipyard to measuring the ship's hull blocks and the training 3D scanning data manipulation. Most of the 3D scanning results and findings are reported on external document. /1/ (see: Maritime industry processes in the Baltic Sea Region – research report)[1]

During training and piloting process, we tried to find answers to challenges such as:

- Finding best practices of eco-efficiency digital tools in yard process optimisation.
- How to use and share information gathered from digital performance systems?
- What are the best practices and lessons learned in terms of co-creating, piloting and implementing digital solutions in the shipyard ecosystem?
- What should be the new standard for in yard digital ecosystems?
- What are the best practices and lessons learned in terms of utilising 3D scanning?
- Besides the technological tools, what is needed in the yard's ecosystems?

Training for shipyard digital eco-efficiency ecosystems is the most important part of the technology implementation. If the individual workers and managers at shipyards who are the end-users of new technology do not see the value of it, know how to operate it or are not capable of redesigning work procedures in line with the possibilities the technology provides, the development of the technology as such is useless. Digital transformation of shipbuilding can only succeed if all parties involved (shipyards, suppliers, shipping companies and training institutes) understand the benefits and challenges of digitalisation. Most of the added value comes on understanding and sharing information. Companies in the industry are already

[1] ECOPRODIGI. Maritime industry processes in the Baltic Sea Region – Synthesis of eco-inefficiencies and the potential of digital technologies for solving them

deploying digital tools to engage their customers, suppliers and using digitalisation in their physical assets, e.g. equipment and systems.

As the use of digitalisation in shipbuilding expands and such technology becomes more complex, the industry is customising automation technology to optimise its use for shipyard operations. At the most fundamental level, global collaboration and technology transfer is a major trend for rapidly digitising shipyards. Shipbuilding companies are using advanced robotic systems around the world and applying the new technologies needed in modern shipbuilding processes and profession: automation, digitalisation, additive manufacturing, Internet of Things (IoT), Artificial Intelligence (AI), 3D Scanning etc. /2/ (see: Road to Shipyard 4.0)

The current COVID-19 pandemic has played a significant role in societies during the development of piloting and training for shipyard ecosystems. COVID-19 pandemic influenced the European maritime technology sector heavily. Production decreased due to health and safety concerns and in some cases production has stopped completely. The industry has announced temporary closures of plants due to collapsing demand, supply shortages, and government measures, and are facing cases of virus infections and quarantines among their employees. Situation has raised interest in the potential of digitalisation in existing practices but has made it significantly more difficult to develop completely new ways of doing things together with shipyards.

[2] ECOPRODIGI. Road to Shipyard 4.0: The state of play, a brief history of maritime developments, and a future roadmap.

Eco-efficiency training and piloting on process competence development technologies in the shipyard environment

Eco-efficiency as concept is very broad and can be difficult to define. Different people include different thigs under the topic based on their own experience and environmental views. Eco-efficiency concept can be outlined by dividing it into eight subcategories.

1. Reducing use of Energy
2. Reducing use of Chemicals
3. Recyclability
4. Longer product lifetime / Better durability of products
5. Reducing waste of materials / Reducing waste of time
6. Increasing Services / Increasing Transparency
7. Use of Recycled Raw Materials
8. Reducing use of Materials

Reducing use of energy in shipyard environment could include topics like minimising movement of material and works, making energy consumption transparent, proper scheduling of machine maintenance or changing the welding method to a more energy efficient method.

Reducing use of chemicals can be achieved by caching work methods or replace toxic chemical with more environmental safety solutions. The key issue is to have agreed instructions for handling chemicals; how to use them, how to protect yourself and how to dispose chemicals proper way. More transparency could be achieved on chemical usage example via sharing information how much hazardous waste is produced as kilograms per year.

Recyclability consists of topics such as sorting of side streams, utilising side streams and life cycle consideration. Recyclability will be emphasised in the future as circular economy business finds new profitable second and third step value chains for waist products. One example on shipyard environment could be reusing of welding fillers plastic reels. Sharing information on how many kilograms per year or how many percentages of total waste material is recycled, would help to evaluating how effective the current practices are.

Longer product lifetime and better durability are comparative to how good the final design is and what is the production quality of the product. There is an old disputed claim that “up to 80% of all environmental impacts are determined during the design phase of products” which is in some cases true and in some cases a little bit of an overstatement. The claim is originally probably based on Pareto 80/20 principle. What is true of the claim is that the design phase still has the most important role in terms of the environmental impact of the product. In shipyard environment for example, weld design and welding quality have an impact on welds fatigue life. Weld quality is also affected by how accurately the welder follows the welding procedure specification.

Reducing waste of materials and reducing waste of time can significantly increase production efficiency. The efficiency of time use can be improved by introducing Lean philosophy principles and flow production principles to production management and ways of working. Flow efficiency comes from things such as materials in the right place at the right time, people in the right place at the right time, pull control between work stages, reduction of the search for goods, and just in time supply delivery. In shipyard environment, waste can be reduced by effective warehousing of parts and subassemblies. Real-time part location and warehouse management could be the solution to achieve this new efficiency level. Digitally shared and easily accessible work instruction can be one way to speed up the production.

Increasing services and increasing transparency are tools that add more value to work. Transparency of things such as energy consumption and recycling efficiency create an effect of people trying to improve more and more. Given values provide immediate feedback to a worker on how well he or she has performed. When creating new services based on data it is good if data collection is automated and does not significantly increase the workload. Benefits for data collecting and sharing should also be clear to every worker. Digital eco-efficiency info screens could be one solution to show the level where we are today and what we should improve. This could be, for example, a real-life scenario in which someone notices that an air compressor uses quite a lot of energy during nights and weekends when no one is working, and then discovers leaking air pipe. There is also work culture cases where machinery is left on just to be sure it works next day or to allow for more waking up time on next morning.

The use of recycled raw materials should be supported as much as possible when it is the most eco-friendly option. An easy first step could be to pay attention to packaging materials. Little extra effort to consider packaging materials when purchasing new materials and directing supply chain to better choices would have a great impact. The percentage of recycled material use could also be a good number to share with workers to remind them that choices matter.

Reducing the use of materials can be achieved by changing work methods or selecting new materials with better case specific properties. An example of new, material-saving working methods is 3D-printing / additive manufacturing technology, in which products are produced by adding only the necessary material. This technology saves material significantly compared to old subtractive working methods and makes it possible to produce very complex lightweight hollow structures. In shipyard environment, new material solution is to use of aluminium, high strength steels and composites to make lighter constructions.

While everyone has their own opinion on eco-efficiency, they also have different opportunities to influence on industrial level based on their job descriptions. As shown in figure 1, production and production planning have possibilities to influence reductions in energy and chemical usage, as well as reduction of waste, and overall production quality. Most of the impact comes from focusing on new timesaving working methods and production quality. As mentioned earlier, designers have great impact on eco-efficiency. Designers should estimate their eco-efficiency impact and consider how to evaluate product design eco-efficiency. Designer choices can reduce the use of materials as well as increase the use of recycled materials. They can also reduce waste of time in their own work by using modern 3D modelling and collaboration tools. Workers on purchase and logistics departments can influence suppliers to select and use eco-friendly recycled materials and reduce material usage for example by

reducing unnecessary disposable packaging material. Upper management is responsible for selecting ecological corporate values. One example is using electricity which is produced by using only ecological energy production methods. They also have an important responsibility to make eco-efficiency transparent and to increase services that enable workers to perform more eco-efficiently.

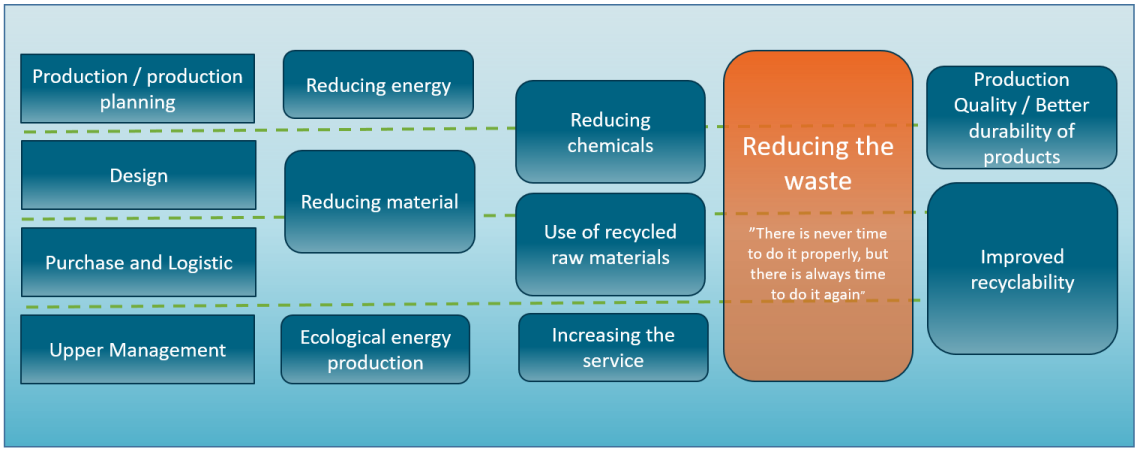

Figure 1. Workers in different positions have greater effect on different eco-efficiency subjects

To help lead workers on different job positions to think more broadly on all aspects of eco-efficiency we have created a model for finding eco-efficiency development subjects based on their own work. As shown in figure 2, the model for creating eco-efficiency value is based on eco-efficiency flash cards (figure 3) and a quiz. It is often thought that there is nothing concrete that an individual can do to make eco-efficient choices in their work. Eco-efficiency flash cards are developed for these kinds of situations and they can be further developed with profession specific examples to evoke ideas. Once the cards have been reviewed, a quick survey with short answers will be conducted. After that, the answers are pulled together and passed along among the respondents. This process leads to concrete development topics which are based for possible digital solutions. A solution could be, for example, a mobile instruction to harmonise or change practices.

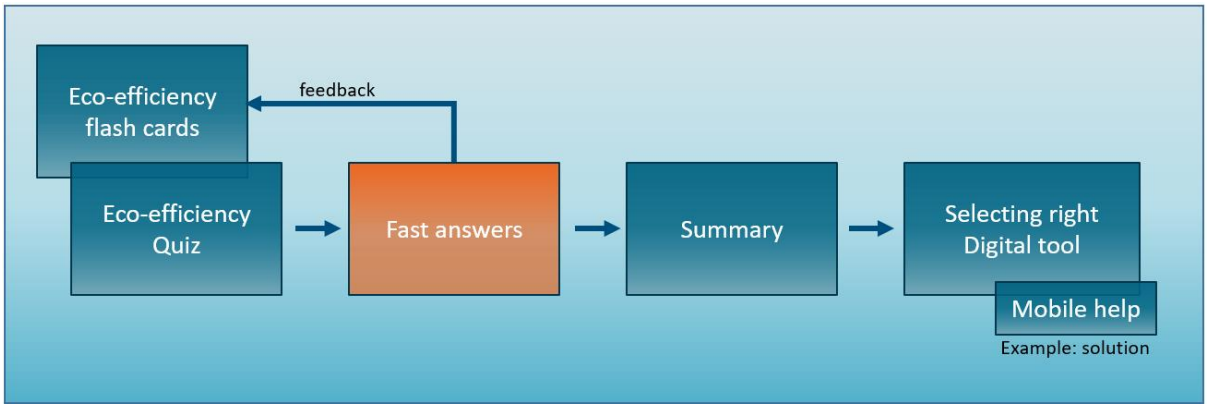

Figure 2. Model for creating eco-efficiency value

Figure 3 Eco-efficiency flash cards

One example of a digital solution that was created and developed by using a model for creating eco-efficiency value at a workshop session was a customer specific mobile welding procedure specification (WPS) guide for welders (Figure 4). A mobile guidance idea for welders came from the need to clarify the comprehensibility of the welding guidelines. Mobile instructions also made it possible to unify practices, clarify version control, speed up the upgrade process, use less paper instructions and, most importantly, improve the quality of welding work. A good mobile guide gives clear instructions, highlights images, minimises text and makes it easy to implement it in different language versions. The mobile guidance model can also be used widely in other themes on the shipyard environment to communicate with subcontractors and workers.

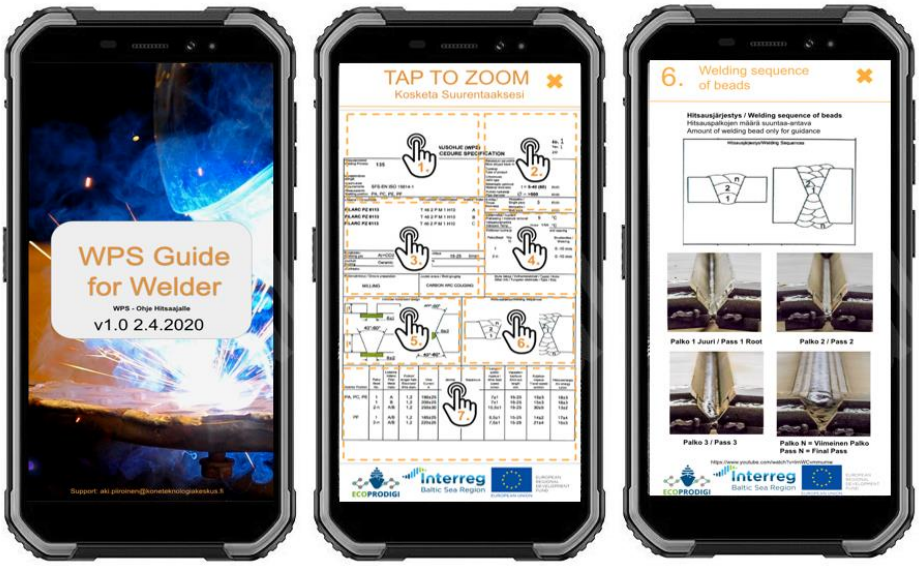

Figure 4 Mobile Welding Procedure Specification (WPS) guide for welder

A second case example solution for using eco-efficiency value at a workshop session was a model for creating new digital quality instructions based on reported quality issues (Figure 5). A workshop session was conduct with quality management workers. The model describes a process in which a quality issue leads to guidance production meeting involving designer, buyer, supplier, production management, quality management, production service provider / subcontractor as well as a person responsible for producing quality guideline instructions. Every participant has his/her own purpose in these meetings. A designer shares thoughts on the idea behind developed structure. A buyer shares the technical aspects which lead him on the purchase process. A supplier shares information on how their product is manufactured and what should be taken account in the installation process. Production management shares information on what are the installation conditions and scheduling constraints to the installation process.

Quality management determines what skills the installer needs to have and how quality is measured. Production service provider or subcontractor shares information on what experience they have according case structure installation and what kind of expertise they have. The person who is responsible for producing final quality guideline instructions is the most important participant although his/her existence is often completely underestimated. It is his/her duty to pull the discussion together and make a manuscript for the guidance that all participants get to comment. Based on the comments, he produces a final quality guideline. The meeting can also be in the form of a digital document process but on some level it should also involve open discussion. Good digital quality guideline platform makes it possible for everyone to comment instructions and even propose a revised version for approval.

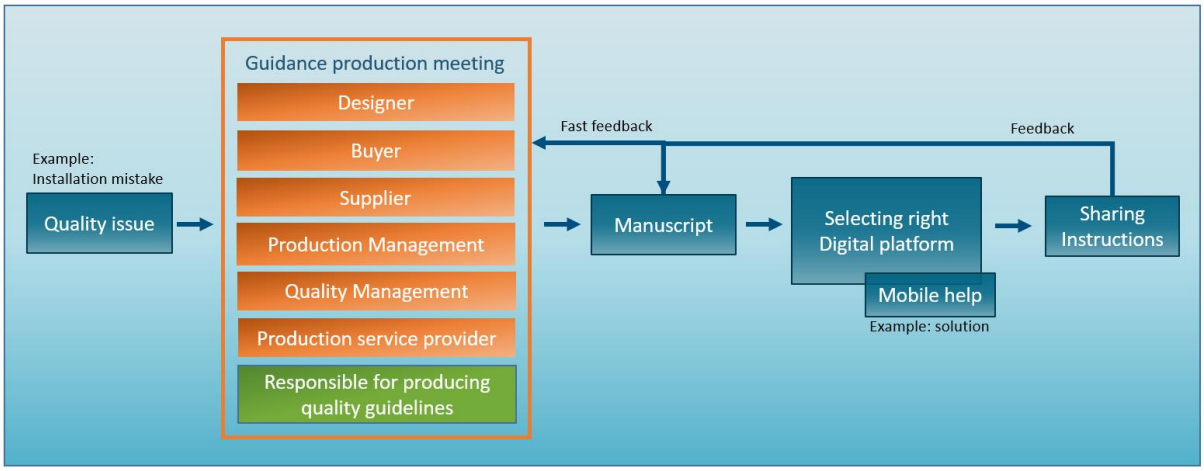

Figure 5. Model for creating digital quality instructions

Eco-efficiency and digitalisation in the shipyard ecosystem

We believe that an efficient use of new digital opportunities will bring in value by enabling our future business to become more eco-efficient. The goal of Meyer Turku shipyard is to manufacture the best and finest cruise ships in the world. Increasingly, customers are also demanding eco-efficiency, but it needs to be implemented cost-effectively.

The starting point for the development of eco-efficiency has been to find new operating models that provide not only eco-efficiency but also economic benefits. All eco-efficiency factors were considered from the point of view of the shipyard environment. In all the actions that were considered, more eco-efficient alternatives were found. The greatest opportunities for development were discovered in reducing waste.

The reduction of waste was widely viewed from the perspective of both materials and savings in time. The goal is to shorten the completion time and lower costs while achieving eco-efficiency. At shipyards, materials are lost and destroyed even before installation, goods are being searched from the large area of the shipyard for hours, materials are stored incorrectly, and, due to incorrect installations, work must be repaired and completely rebuilt. Here are some examples of the different challenges that were encountered in the dock environment. These cause losses to both the environment and productivity, which we set out to address in this project.

Case DIGI Welding Procedure Specification (WPS)

Shipbuilding includes a lot of welding work and most of this work is classified, i.e. welding procedure specifications (WPS) have been defined for them. Hundreds of welders work at Turku Shipyard and the turnover is high. There are many subcontracting companies and the challenge is to ensure the competence of the welders. The WPS application developed in the ECOPRODIGI project to meet this challenge is a good example of efficient digital data sharing.

With similar smartphone apps, even more instructions could be shared with everyone working in the dock area. Smartphones are now available to everyone and this advantage should be utilised. The idea has been to adopt the practice as Meyer Turku's quality management practice. Different quality requirements between the yard and subcontractors could be shared directly with employees / installers, reducing the potential for error, improving eco-efficiency, speeding up ship completion and achieving cost savings.

Case 3D scanning

Ship hull blocks are manufactured at various shipyards in the Baltic Sea region. The blocks are transported to Meyer Turku shipyard, where they are connected to each other by welding. Coordinating the blocks is a challenging process because they have shape and dimensional deviations. Deviations are currently only detected in the harbour basin when the blocks are connected, and the necessary alterations must be made in cramped spaces. The ECOPRODIGI project set out to find a solution in which the shape and dimensional errors of the blocks could be determined in advance and corrective measures could be taken before the blocks were lifted into the harbour basin. With 3D scanning technology, point cloud models are produced

from the surfaces of opposing blocks, which can be virtually connected to each other in advance. The necessary modifications to the blocks can be planned and implemented at the earliest possible stage.

The 3D scan did not meet the expectations in the original application, but its use may otherwise have been utilised in shipbuilding. Scanning technology shows the shapes and shape defects of large surfaces very accurately. New uses are being found all the time in various projects and the dock has acquired its own scanner.

3D scanning improves the eco-efficiency of shipbuilding and brings the desired improvements in manufacturing speed and cost-effectiveness. The results of the project in these respects are good. Staff 3D scanning training has been implemented during the project at Chalmers University in Gothenburg, Klaipeda Shipyard and Meyer Turku Shipyard. The know-how in scanning technology is now at a good level.

Different perspectives on eco-efficiency through digitalisation

Eco-efficiency through digitalisation can be utilised within the different sub-groups of shipbuilding industry based on the end-user perspective. From a technological perspective, there is no unambiguous definition, but it is often seen as a set of technology and knowledge that is capable of producing something meaningful. Digitalisation is also a very vague concept in people's minds that is easy to use but its definition depends on the context. Basically, people want to operate eco-efficiently and productively. We want to do the work well and right at the same time. Can eco-efficiency and productivity be improved by providing more information to authors? We believe so. The information should be as easily accessible as possible, but it is not obligatory to use it. The essential requirements of the contract between the customer and the supplier should be easy to find in order to achieve the desired result. When the installer / contractor is unsure about the agreed quality issues or the execution of the work, he or she would be able to find out quickly, for example with his or her smartphone. Opportunities for communication, information sharing, collection and production, and competence development are quite easy with current technology, even in shipyards' demanding working conditions. Smartphones are used by almost everyone and most people know how to use them. Their active use in the traditional manufacturing industry could be more extensive compared to what it is at present. Easily accessible, free or inexpensive, easy-to-use applications are available for generating and disseminating information. Many applications are interactive, so you can also collect feedback. Producing content is as easy as writing a report or implementing other similar content. Security issues are one of the major slowdowns and threats to business adoption of new technologies. Smartphone cybersecurity is known to be vulnerable and for businesses information is an important competitive factor. Much attention has been paid to this and security risks can be reduced as long as the matter is studied with sufficient seriousness.

Business perspective eco-efficiency through digitalisation can create many completely new service business openings. New services could support for "Right at once" – attitude via creating more value for shipyards define works tasks. This will speed up execution of work process and create cost-effectiveness as well as increase competitiveness. One example could be improving internal logistics using the help of digital tools. With these new tools, materials can be found and tracked real time. Knowing the location of the materials helps to save work time and creates an opportunity to start making on time delivery to different work stages.

The human perspectives was taken into account in pilot training processes. On a general level, the employees were encouraged to individual learning processes and personal competence building. During pilot training processes we learnt that the technical skills are necessary, but future shipbuilding professionals need also other skills, like digital skills, green skills and transversal skills. Different kinds of digital skills are needed as new technologies are implemented in the maritime industry. Automation will replace some tasks but, at the same time, it requires new skills and this puts pressure on developing employees' digital skills and training. The digital skills are mainly related to Automation, Robotisation, Cybersecurity, Internet of Things, Big Data, Cloud Computing, 3D Printing, Virtual Reality, Augmented Reality, Digital data processing, Digital communication and collaboration, Digital content creation, ICT safety, Green skills and strong sense of environmental responsibility. There will be an emerging need of green skills in manufacturing industry including shipbuilding industry as seen in

chapter "Eco-efficiency training piloting process". Combining all these with also transversal skills, such as attitudes and values, social interactions, teamwork, diversity is a huge task in training.

The pilot training included BSR perspectives in many ways, 3D scanning being one example. The industry at the Baltic Sea basin work together intensively as seen also in the ECOPRODIGI Project. The company level collaboration in manufacturing will probably increase due to workload variations and well-built cooperation structures. Manufacturing the hulls and blocks for Meyer Turku Shipyard the in the Baltic Sea Region will continue. Mobility of workers will probably increase as the lack of skilled workforce continues in the coming years as workforce is ageing. University-level cooperation in RD and education and training has already been active in BSR. The activities in vocational education and training (VET) probably increases because of the new digital training tools which make it much easier to build trainings activities in the future. There are many opportunities for future collaboration in training in the BSR level: a) Designing and implementing training programmes and even common curricula for vocational programmes in shipbuilding by using digital training methodologies; b) Testing and implementing new innovative VET teaching and learning methods to respond to the needs of specific target groups.

Key findings

The lessons learnt of ECOPRODIGI Project pilot training are numerous. The pilot training showed that digitalisation offers many advantages, including the ability to solve the challenges that are inherent in traditional manufacturing. Benefits are obvious: customer satisfaction, efficiency and accuracy in production, better quality and flexibility leading to eco-efficiency in manufacturing processes. Manufacturing becomes safer, has lower risks, fewer costs, which lead to competitive advantage, increased competitiveness and growth. The environmental values - less waste, less energy – are huge benefits. Digital tools used to test products allow for a more efficient production process, as well as a platform for sharing and increasing knowledge. There are some challenges in digitalisation; new technology infrastructure, business risks, cybersecurity risks and demand for competent workforce in all levels.

The constant competence building and training is obvious already at the moment but it will be even more necessary in the future. The different kinds of joint VET programs or training modules for both student, adult-learners and for VET trainers could be developed. These programs can be based on relevant VET sectoral qualifications and can be piloted by several VET trainer or higher education institutions (HEIs). In the future, more innovative virtual learning methods are also used. Digital solutions and distant learning possibilities together with new classroom learning methods are more and more available and easy to use. The digital solutions are, for example, VR/AR solution, simulators, gamification methods and open educational resources. It is also important to test and implement new innovative VET teaching and learning methods to respond to the needs of specific target groups of learners.

There are various findings to improve the quality of training and to bring it closer to the needs of the sector. Other types of skills transfer in the field of work based learning, internships, apprenticeship and dual scheme, highly demanded by stakeholders, are being adopted by the shipyards, which in several cases already have long tradition with these learning experiences.

New teaching technologies, such as simulators, are being adopted by shipyards, and equipment providers to improve the quality transfer and shorten the learning periods. VAR, Virtual and Augmented Reality, is considered as a promising technology that may open new possibilities and bring benefits for the sector, as it may link the design, maintenance and learning processes.

To exploit the full potential of new technologies in the learning processes, lifelong learning opportunities, new environments and new methodologies are being implemented in training systems. Further concepts linked to the training process, such as acknowledgement of qualifications and the validation of prior learning are supported by institutional strategies that need stronger implementation. Complexity the manufacturing processes and vast number of employees mean that the training processes must be comprehensive, accurate and fast.

One finding is improvements of quality management. Mobile apps are one example of risk management, quality control and management. Introducing new technical tools as seen example in Case Welding. The mobile app is one of the tools which gives fast and accurate information between employees, supervisors or partners and workers on the entire supply chain.

Next Steps towards eco-efficiency through digitalisation

The maritime technology industry as a whole is a very global business where a significant part of growth is done in international planning and in network-based operations. Competitiveness is based on strong knowhow and increasingly on R & D based products and services. The industry will be high-tech sector also in the future when diverse knowhow is needed in manufacturing technology, energy technology, information technology (design, device development, project management). /3/

Investing in the development of know-how requires experts to be trained in very different fields of technology and the current situation requires not only quick and effective short-term actions, but also a shift in the long-term systemic approach, particularly in higher education. In the future, work life requires a new kind of competence, while there are fewer financial resources available for education. VET must respond more swiftly to the changes in work life and operating environment and to adapt to individual competence needs.

In EU level the "New Industrial Strategy for Europe" was presented by EU on March 2020 with a new SME strategy, the Single Market Barriers Report and the Enforcement Action Plan for the Single Market. /4/ With this new EU Industrial Strategy, the European Commission recognises industry as "central to Europe's future progress and prosperity" and announces a comprehensive set of measures. The strategy explicitly recognises the role of maritime technology industry in driving the twin "green" and "digital/smart" mobility transitions, supporting Europe's industrial competitiveness. In addition, the EU Green Deal. /5/ will support the ongoing efforts of shipyards to build and retrofit innovative climate-neutral ships as well as maritime equipment companies to manufacture climate-neutral maritime technologies and new applications of clean fuels. These EU policies give a strong support to develop the maritime technology sector competence and competitiveness in the future.

[3] ECOPRODIGI. Road to Shipyard 4.0: The state of play, a brief history of maritime developments, and a future roadmap.
[4] EU (2020) Industrial Policy https://ec.europa.eu/growth/industry/policy_en
[5] EU (2020) EU climate action and the European Green Deal https://ec.europa.eu/clima/policies/eu-climate-action_en

Further reading / References

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