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Rajko Rubeša
E-mail: rajko.rubesa@gmail.com
Shipyard "3.MAJ" d.d., Liburnijska 3, Rijeka, Croatia
Marko Hadjina
E-mail: hadjina@riteh.hr
Tin Matulja
E-mail: tin.matulja@riteh.hr
Faculty of Engineering University of Rijeka, Vukovarska 58, Rijeka, Croatia

Criteria for Evaluation the Technological Level of Ship Pre-Outfitting in Shipyard

Abstract

In today's highly competitive shipbuilding business, gaining a competitive advantage between shipyards is extremely important. In order to have a competitive and sustainable shipyard, it is important for the management to continuously monitor and raise the productivity, efficiency and quality of the production process. One of the major issue in today's shipbuilding is how to organize and conduct the efficient ship outfitting process as one of the most complex task within ship design, supply chain and production activities, particularly for high value added ships. To be able to manage, improve and optimize ship outfitting process it is necessary to establish its current technological level and relevant activities. Hence, in this paper authors are analysing the ship outfitting process with special attention to ship outfitting prior to ship launching, with a purpose to define and explain the criteria to be used for such technological level evaluation.

Keywords: shipbuilding, technological level, outfitting, evaluation, efficiency, sustainability

1. Introduction

In today shipbuilding, especially for complex types of ship with high added value the outfitting, and equipment supply process, the shipyards try to become successful and competitive on the world shipbuilding market [1]. Thus they have to build quality ships, to enable a lower cost of the production process and to shorten delivery time of the ship. Shortening the time in the shipbuilding process by using the pre-outfitting concept is one way of reducing total ship production time and improving efficiency and cost performance [2]. But pre-outfitting could be problematic for some shipyards

and ship types due to obstacle in technological and production areas in shipyards. In this paper will be analysed particular criteria of using ship pre-outfitting in shipyards to evaluate their level of advance outfitting. The criteria will evaluate obstacles in shipyard such as shipbuilding preparation process, technological requirements and technological limitation through particular important sub-criteria. The result will be evaluation the level of pre-outfitting capabilities in observed shipyard and finding critical point that shall be improved to achieve higher level of advance outfitting usage which lead to shorten the time in ship outfitting process and reduce the outfitting cost.

2. Overview of outfitting process

In general, the process of ship outfitting (Figure 1) is typically divided into two separated outfitting stages: pre-outfitting, otherwise known as advanced outfitting and on board outfitting [2].

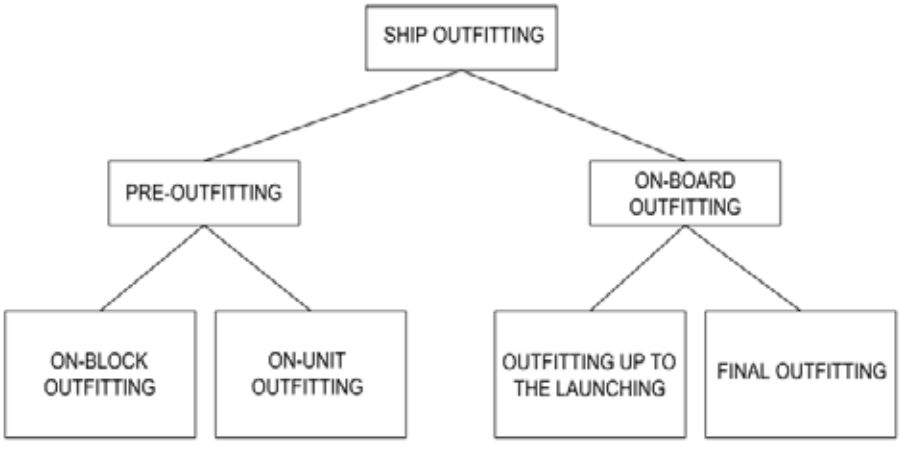

Figure 1 Breakdown structure of outfitting stages

For pre-outfitting process is characteristically that it takes place in time almost simultaneously with the hull construction and is divided into two independent outfitting stages: On-blocks outfitting and on-unit outfitting, otherwise known as modular outfitting. On board outfitting is also divided into two separated outfitting stages: on board outfitting up to the launching and final outfitting that is performed on board after launching.

On-blocks outfitting relates to the outfitting on panels, hull assembles and blocks with numerous parts of equipment such as pipelines, cable trays, ducts, penetrations through the structural parts for pipes, cables and ducting, stairs, ladders, railings, manholes, hatches and etc. Detail definition of on-block outfitting is depicted in Chapter 3.

On-unit outfitting represents the assembling of ship's equipment in workshops as assembly unit, machinery unit and structural unit [3]. Detail definition of on-block outfitting is depicted in Chapter 3.

On board outfitting will begin immediately upon block's erection on the building berth, where it continues with the installation of ship equipment up to the launching. The last stage of ship outfitting comprises final outfitting that is performed after launching when are installed the ship's equipment that are subjects of damage, such as instruments, equipment for communication, navigation and signals, electronic and computer equipment, lifesaving equipment and equipment that are not installed during the early outfitting stages.

3. Terminology definition

Because different countries, companies, and even people use different words to explain or describe the same item, it is necessary to provide definitions for the use of specific words [4]. The confusion that can result from the lack of clear definition can be appreciated by reference in chapters 3.1, 3.2 and 3.3. The following definitions applicable for shipbuilding process in overall are described in this paper.

3.1. Terms applicable for outfitting

OUTFITTING. A broad definition of all non-structural equipment and systems which are to be installed in or on a ship, including machinery.

PRE-OUTFITTING (ADVANCED OUTFITTING). The installation of outfit systems and components on a structural block or outfit unit prior to shipboard erection. It happens at an earlier stage of construction of the ship than is traditional as a means of shortening the construction time, and to increase productivity. It also enables the traditional outfitting crafts manning peak to be smoothed out.

GROUND OUTFITTING. Outfit installation during on-unit or on-block outfit stages.

ON-UNIT OUTFITTING. Outfit assembly and installation on an outfit unit prior to erection onboard.

ON-BLOCK OUTFITTING. Outfit installation on a structural block prior to erection onboard.

ON-BOARD OUTFITTING. Outfit installation following structural block erection. This means outfitting on the berth or in the dock before ship launching.

FINAL OUTFITTING. Outfit installation on-board which means outfitting of the ship along the quay after ship launching.

ZONE. An assigned area or compartment in the shipyard and/or onboard the ship for the purpose of organizing information, planning, material, and resources to support the design and construction of the ship.

UNIT. A packaged group of outfit, equipment and machineries designed to be treated as a single component, installed on common supports and foundation and manufactured in workshop independently of the hull construction.

ON UNIT. Term used to identify the activity of installing a group of outfit items into a package consisting of equipment, support, pipe, wiring**,** gratings, and controls.

ON BOARD. Term used to identify the activity of installing units or individual outfit items in or on a ship on the building berth or afloat.

3.2. Terms applicable for hull construction

SINGLE PART. A structural item which is fabricated from plates or shapes and after cutting will be incorporated with other single part into a subassembly, assembly or block.

SUBASSEMBLY. A structural item which is fabricated from processed plates and shapes, and which when completed will be incorporated with other subassemblies into an assembly or block.

PANEL. A structural item consisting of two or more butt welded plates with fillet welded longitudinal shapes.

FLAT PANEL BLOCK. A structural item consisting of a single panel made up from individual plates, shapes, and subassemblies, such as deck, shell, bulkhead, etc.

ASSEMBLY. A structural item consisting of a single panel made up from individual plates, shapes, and subassemblies, such as deck, shell, bulkhead, etc.

BLOCK. Hull structural interim product which can be erected as a block or combined as grand block. It consists of one or more subassemblies/ assemblies.

GRAND BLOCK. Assembly of two or more structural blocks mated prior to onboard erection.

RING UNIT. A structural item consisting of large and heavy types of blocks. A ring unit is an assembly of a number of conventional blocks between two cross-sections.

3.3. Terms applicable for pre-outfitting

ASSEMBLY UNIT. Steel assembly consist of steel parts of ship's equipment without mechanical or electrical drive such as pipe system supported on a common hanger system, outfit for walking such as platform, walkway and ladder, Figure 2.

Figure 2. Assembly unit

MACHINERY UNIT. Ship specific assembly consisting of one or more several outfit systems including all mechanical and electrical components and subsystems in an area. That means fabrication indoors close to the workshop equipment, Figure 3.

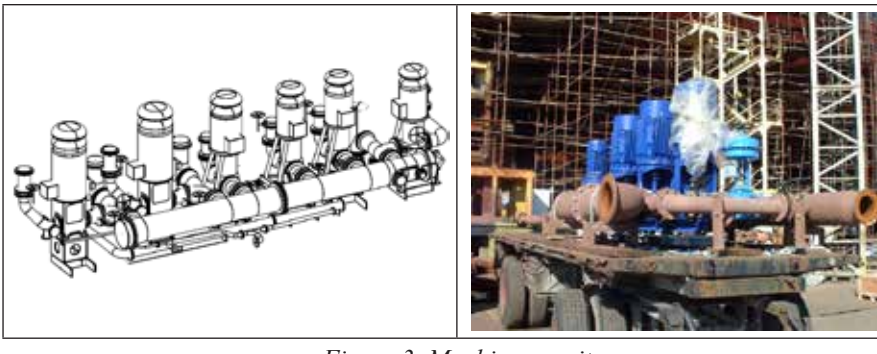

Figure 3. Machinery unit

SYSTEM UNIT. Assembly consisting of all mechanical and electrical components making up a single subsystem on a common foundation, Figure 4.

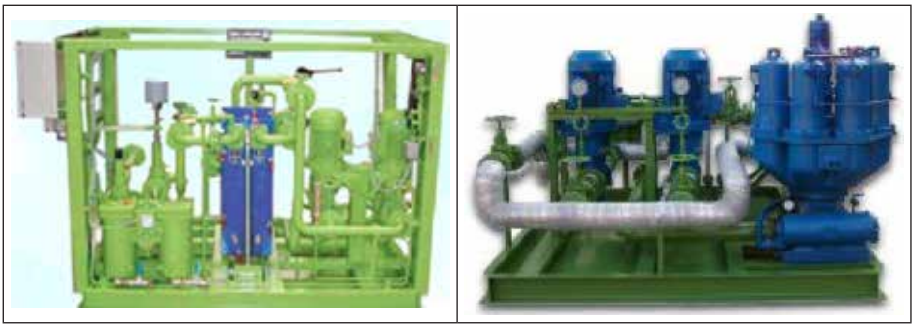

Figure 4. System unit

STRUCTURAL UNIT. Structural foundation and grating support for an outfit unit, Figure 5.

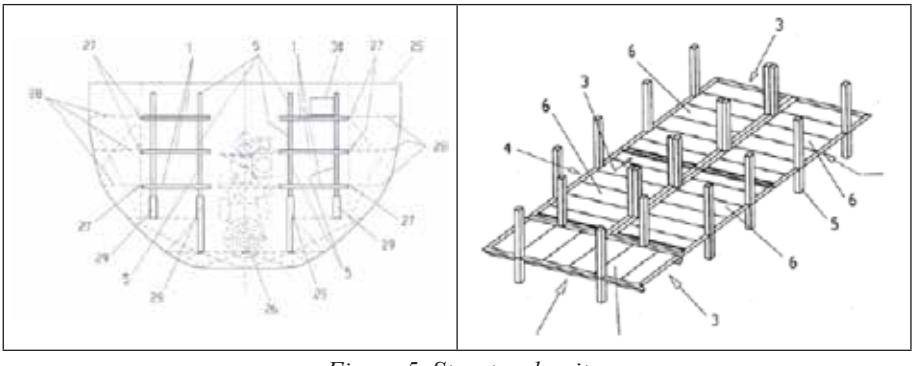

Figure 5. Structural unit

STRUCTURAL MACHINERY UNIT. Assembly consisting of a standard structural unit, one or more system units, and all ship's distributed systems in an area. The structural machinery unit design is based upon machinery unit structural and system interfaces, Figure 6.

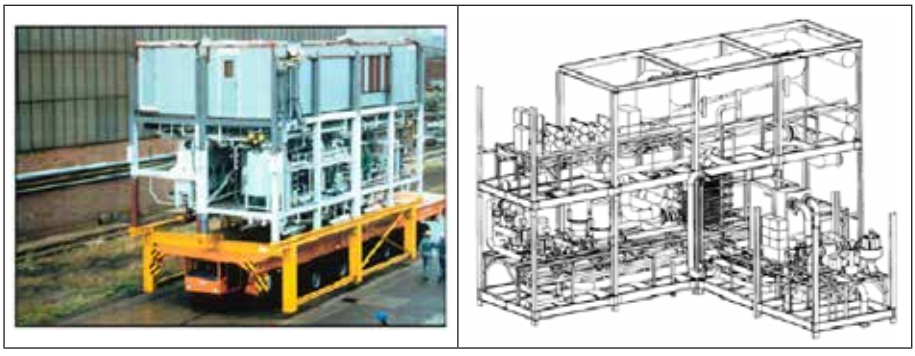

Figure 6 Structural machinery unit

PRE-OUTFITTED BLOCK. Block or sub-block outfitted before the block is erected at the berth or in the dock. Therefore, all designers always use the proper and latest version of the 3D model, Figure 7.

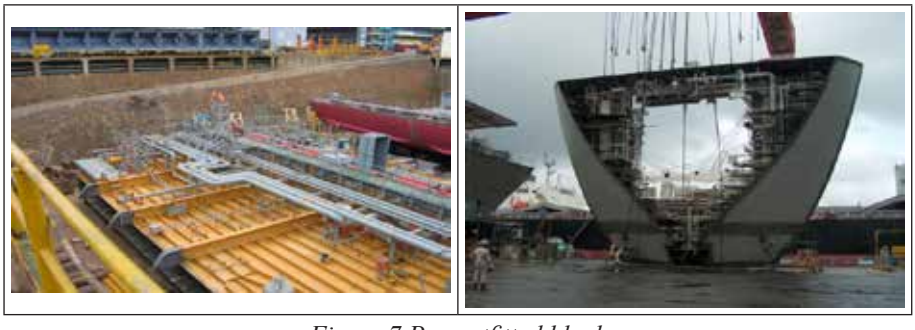

Figure 7 Pre-outfitted block

4. Criteria for evaluation the level of ship pre-outfitting

There are no clear and detail delimited the activities and recommended equipment that shall be installed in pre-outfitting stage. It depends on technological level of shipyard and its production limitations. In this paper are analysed the criteria for evaluation the level of pre-outfitting process in particular shipyards shown in Figure 8.

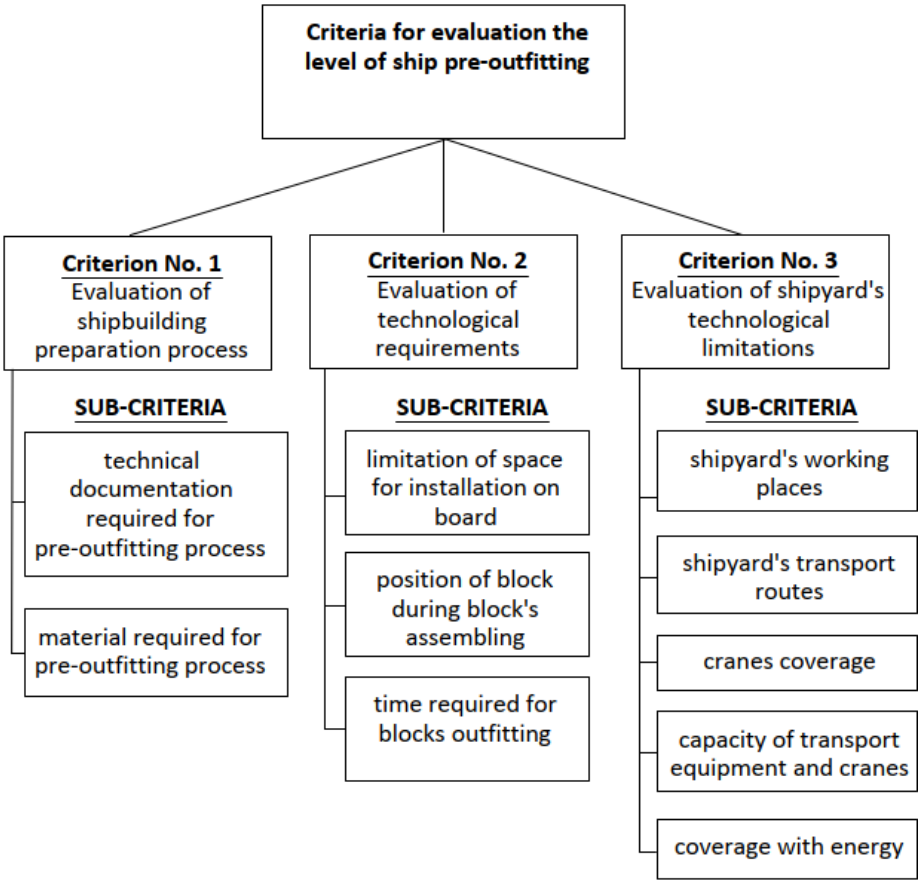

Figure 8 Breakdown structure of criteria for evaluation the level of ship pre-outfitting

The criteria for evaluation the level of pre-outfitting is divided in three main criteria: criterion for evaluation the shipbuilding preparation process, criterion for evaluation the technological requirements and criterion for evaluation the shipyard's technological limitations. Each criterion is divided in particular sub-criteria. Criterion for evaluation the shipbuilding preparation process is divided in two sub-criteria: sub-criterion for evaluation the technical documentation required for pre-outfitting process and sub-criterion for evaluation the material required for pre-outfitting process. By evaluating the technical documentation required for pre-outfitting process is rated the technical documentation suitability for ship pre-outfitting, while by evaluating the material required for pre-outfitting process is rated material preparation suitability.

The higher rate means greater justification of shipbuilding preparation process for the application in pre-outfitting process.

Criterion for evaluation the technological requirements is divided in three sub-criteria: sub-criterion for evaluation the limitation of space for installation on bord, sub-criterion for evaluation the position of block during block's assembling and sub-criterion for evaluation the time required for blocks outfitting. By evaluating the limitation of space for installation on board, the capability of space on board suitable for ship equipment and outfitting installation is rated. By evaluating the position of block during block's assembling, the possibility of ship equipment and outfitting installation during block's assembly process is rated. By evaluating the time required for blocks outfitting, the technological stage of ship euipment and outfitting installation during block construction is rated. The higher rate means greater satisfaction of technological requirements suitable for the application in pre-outfitting process.

Criterion for evaluation the shipyard's technological limitations is divided in five sub-criteria: sub-criterion for shipyard's working places dedicated for pre-outfitting, sub-criterion for shipyard's transport routes for the purpose of pre-outfitting, sub-criterion for cranes coverage on pre-outfitting place, sub-criterion for capacity of transport equipment and cranes for the purpose of pre-outfitting and sub-criterion for coverage with energy on pre-outfitting place. By evaluating the shipyard's working places dedicated for pre-outfitting, the suitability of working places on board for ship equipment installation are rated. By evaluating the shipyard's transport routes for the purpose of pre-outfitting, the capability of transport routes suitable for ship pre-outfitting are rated. By evaluating the cranes coverage on pre-outfitting place, the capability of cranes coverage suitable for ship pre-outfitting are rated. By evaluation the capacity of transport equipment and cranes for the purpose of pre-outfitting, the capability and the capacity of transport equipment and cranes suitable for ship pre-outfitting are rated. The evaluation of the energy coverage on pre-outfitting places, the level of energy coverage suitability for ship pre-outfitting is rated. The higher rate means less shipyard's technological limitations in pre-outfitting process.

5. Conclusion

Pre-outfitting is a way to shorten the time of the shipbuilding process and reduce costs, without investment in new facilities, machines and tools, and may increase competitiveness of shipyard. On the basis of the results obtained by this research, it is possible to measure cost benefit results as a consequence of using the pre-outfitting concept within the shipbuilding process. In this paper the clear terms and definitions used for advanced outfitting are defined. To avoid confusion between various terms and definitions the authors suggest using them as a standard. The main goal of proposed approach is possibility to evaluate the level of pre-outfitting capabilities in any particular shipyard as well as to find critical point that shall be improved to achieve higher level

of advance outfitting usage which will be visible through: maximising work during most productive stage of outfitting (On-unit or On-block), minimising work during less productive stage of outfitting (On-board), maximising work under cover, maximising access to working place, minimising material handling and transport, minimising non-productive activities, maximising productivity of available manufacturing process, to ensure all necessary resources are readily available at work times scheduled (such as: drawings, materials, tools, facilities and manpower), to exploit benefit of engineering, material and production standards. Furthermore, the authors suggest continuing this research by evaluating technological level of shipyard by rating its overall technological capability.

Acknowledgements

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