ISSN 0554-6397
Stručni članak
(*Professional paper*)

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Implementation of various outsourced outfitting detail design approaches in particular shipyard

Abstract

In today competitive shipbuilding market, it is not unusual that shipyards are using outsourced detailed documentation into their production program or to continue outfitting a ship that originally had been designed and started in another shipyard or design office. That involves some difficulties in adapting to different requirements which can require overhead organisation, a multiskilled work force, and the ability to respond rapidly to emerging conditions that affect a ship's operating schedule. Also, the detail design approach in various design offices is mostly different, and can be a result of differences in information included within detail documentation, such as more or less advanced outfitting approach, zone-oriented outfitting versus discipline, or system oriented outfitting approach. In this paper the outfitting process in a particular shipyard is observed through comparison between two principles of production design approaches, one originally made in observed shipyard and one which was designed in outsourced design office. The main goal of this paper is to develop a procedure of evaluating ship outfitting processes, using detail design as a way to establish appropriate shipbuilding production process. Hence, it should reduce building costs related to adopting different types of outsourced detail design documentation to the own shipyard production process.

Keywords: shipbuilding, detail design, outsourcing, outfitting process, advanced outfitting

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1. Introduction

Ship's design is primarily divided into three stages: basic design, system design, and detailed design. Basic design identifies the main ship's features such as purpose, size, propulsion, structural integrity, stability, and efficiency and is used in contractual stage in negotiation with ship owner as well as is base for developing the system design. Basic design may be made in shipyard by own designers, outsourced in particular design offices, or may be given directly from ship owner. By system design is defined the ship systems according to their functions on board such as hull, piping, machinery, ship's outfitting, electrical, HVAC, insulation, painting. In system design drawings are schematically shown and are used for detail designing, inspection, commissioning and testing the ship systems during ship construction and as delivery drawings upon ship completion. Detail design is used directly for ship production in shipyard. In this stage are produced production drawings which consist of arrangement drawings for installation of ship's parts with accompanying material lists and fabrication drawings for fabrication of ship's parts with corresponding material lists.

Every shipyard has its particular approach how to make detail design suitable for own ship production. It depends of technological level of shipyard, shipbuilding technology and outfitting approach which means system-oriented outfitting versus zone-oriented outfitting and level of advance outfitting usage. Some shipyards have their own design office which produces all drawings according to shipyard's technological standard and procedure. Such shipyards, in case if they don't have enough capacity or is short schedule, may use other design offices to make drawings which are on critical path. Example of such shipyard is *Fincantieri* shipyard Italy where one of authors worked. On the other hand, some shipyards don't have their own design office and they have to outsource system and detail design, and basic design usually is given by ship owner. Example of such shipyard is ASL Shipyard Singapore where as well as one of authors worked.

More, some shipyard such as *Fincantieri*, outsource part of ship to be built in another shipyard with whole drawings prepared according to *Fincantieri* standard, technology and practice. In such case outsourced shipyard must adjust given drawings to be suitable for its technology and practice, for example size of blocks and block division must be suitable for crane capacity. It involve some difficulty in production, because need extra time for preparation of ship production process and need multiskilled workers who can use various type of drawings and solve problems directly on spot.

In this paper procedure for evaluation of different detail designs from various shipbuilding concepts is developed, as base to evaluate efficient ship production procedure in implementation of different detail design approaches to own production process. For better understanding in this paper are shortly explained terms advance outfitting and system-oriented outfitting versus zone-oriented outfitting,

2. Advance outfitting

Advance outfitting means the installation of outfit systems and components on a structural block or outfit unit prior to shipboard erection [1]. It happens in earlier stage of ship construction 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. The use of advance outfitting reduces the time spent for ship outfitting but require more time and investment during ship detail design, construction and preparation of the production process. That is consequence of adapting ship detail design to the concept of advance outfitting and necessity of higher quality of documentation. [2]. The advance outfitting usage is in direct correlation with detail design.

Number of working hours in earlier stage of shipbuilding is increased, because some work from on-board is relocated to earlier stages such as on-unit outfitting and on-block outfitting. Unit is a packaged group of outfit items installed on a common support system prior to installation in an assembly, module, or ship, and designed to be treated as a single component. Term on-unit is used to identify the activity of installing a group of outfit items into a package consisting of equipment, support, pipe, wiring, gratings, and controls. Term on-block is used to represent outfit installation on a structural block prior to erection onboard.

3. System oriented outfitting

System oriented outfitting represents installation and testing of systems. Design of ships and installations are based on analysis of each single system such as the firefighting system, the ballast system, the fuel system, the steering system, the HVAC system, etc [4]. Information and documents are focused on systems during detail design, even CAD drawings and models are mainly specific for each system such as mooring system, auxiliary engine system etc.

System oriented outfitting is based on the principle that each team (could be just 2 men) shall outfit a specific system independent of the geometrical extent of the system. This might be natural when system knowledge or speciality is required of the craftsmen for instance for hydraulic systems, stainless steel systems or systems with very high dimensional tolerances. But if whole outfitting concept is based on system-oriented outfitting may involve many difficulties. For example, if two different teams (say welding and painting or electrical or piping work) are working at the same location conflicts may arise. The physical components may collide or the craftsmen may disturb each other. Accurate planning of work is essential to this type of outfitting.

4. Zone oriented outfitting

Term zone represents 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. Zone outfitting is a contrast to system-oriented outfitting because all activities are related to zones which mean that systems which span over more zones have to be split. And different systems located in the same zone will have to be combined which means combined drawings and material lists. This requires extra work in the design phases.

Zone outfitting means that a job is defined as all necessary activities limited by [5]:

- the geometrical borderlines of a zone,
- the milestones defined by a stage (= phase),
- the disciplines defined by an activity.

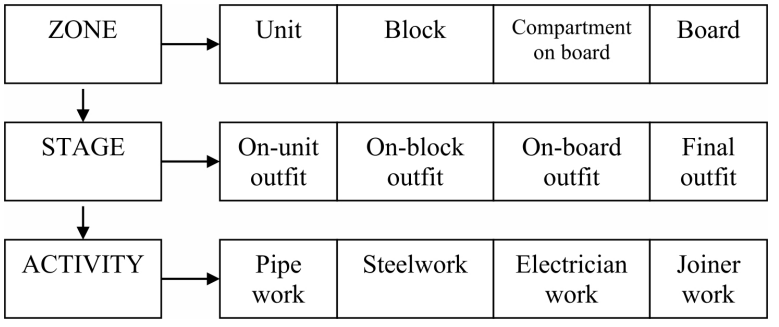

Figure 1. *Zone oriented outfitting concept*

During blocks construction it is of course natural to choose each block as a zone. But after blocks' erection at the building berth it might be suitable to choose the borderlines between zones independent of blocks. A team which is allocated for finishing a stage of an area within a zone will receive a collection of all documents needed to fulfill just that job.

5. Procedure of rating the detail design

If the shipyards could succeed in changeable world market, they should be capable to use various kind of drawings given from outsourced design offices or from another shipyard, that require changes in own ship preparation and production process. To faster adoption, important role performs the better evaluation of various production drawings, given from various outdoors side and rating them through comparison with its own capabilities [6], [7]. The questionnaire for evaluation of various detail designs are depicted in Table 1. Each factor is evaluated with adequate rate from 1 to 5: excellent = 5, very good = 4, good = 3, satisfactory = 2, unsatisfactory = 1. Weight factor is used to

strengthen importance of same factors and can be from 1 to 100. Score for each factor is obtained by multiplying rate with weight factor (1):

$$Score = Rate \text{ x } Weight\ factor \tag{1}$$

The total rate is obtained by addition of score for each factor (2), and then compared with its own rate:

$$Total\ score = \sum_{i=1}^{n} Score \tag{2}$$

Table 1. *Questionnaire for evaluation of detail design for outfitting process*

Factor	Rate	Weight factor	Score
Pipe work included in drawings			
Steelwork included in drawings			
Sheet metal work included in drawings			
Machinery work included in drawings			
Electrician work included in drawings			
Carpentry work included in drawings			
Painting included in drawings			
On-unit outfit included in drawings			
On-block outfit included in drawings			
Onboard outfit included in drawings			
Final outfit included in drawings			
Material lists suitable for production			
Installation drawings suitable for production			
Manufacturing drawings suitable for production			
Zone oriented outfitting approach			
System oriented outfitting approach			
Pipe work not included in drawings			
Steelwork not included in drawings			
Sheet metal work not included in drawings			
Machinery work not included in drawings			
Electrician work not included in drawings			
Carpentry work not included in drawings			
Paint work not included in drawings			
		Total score:	

If such obtained total score is lower than in observed shipyard, it indicates that given detail design is made for lover level of production organization, with smaller facilities and with multiskilled, flexible work force, what request to adopt changes in its own production process. In spite of lack of information in documentation, faster respond in solving production problem is required through finding appropriate solution that shall be agreed directly on the spot. That needs more experienced and well educated multiskilled workers, and production organization with fast respond to establish material procurement and technological process. The scheduling becomes more difficult because the activity can't be foreseen in advance. Thus, planning is made through agreement between trade and shop foremen. Trade and shop foremen may be forced to make resource and scheduling changes with no idea of the impact on other jobs and other trades, resulting in trade conflicts, rip-out of installed items, excessive work and waste material.

If obtained total score is higher than in observed shipyard, it indicates that observed shipyard has lower level of production organization. It requests to adopt larger team, more extensive facilities and management organization. Detail scheduling of work and material order should be established, as well as changes in production concept towards zone oriented outfitting approach and group technology.

In circumstances that require adoption of new production concept and technology, both possibilities may influence on financial risk in running a business and managing a shipbuilding process.

5. Conclusion

To quick respond in adoption various kind of production drawings, made in outsourced design offices or other shipyards, the shipyards have to develop own procedures to evaluate various design approaches to find the best solution to adopt it in own production processes, in order to avoid financial risk and production difficulties. The key role is to perform benchmarking of various types of outdoors production drawings and compare them with its own, which can enable improving and simplifying own production process. Thus, financial risk and loses may be avoided. In this paper a new procedure for better evaluation of various detail designs approach is developed, as a vehicle to adjust in changes of shipbuilding production process in particular shipyard. It is important if shipyard use deferent type of outdoors design, which requires adopting shipbuilding process different of an existing one.

Acknowledgements

This research is supported by funds from the support research at the University of Rijeka for the project "Development of Methodology for Ship Design and Production towards Industry 4.0. Concept"

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