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SHIPBUILDING PROCESS FROM PROJECT MANAGEMENT PERSPECTIVE

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Abstract: *While there are considerable differences between yards most face common economic conditions, in a global market. As a result, yards are putting in place new information systems to support great design flexibility and more efficient production processes. Their goal is to improve their competitive position through innovative design, increased quality, faster time-to-market and more efficient cost controls. Therefore, improving project management becomes critical in meeting these challenges. Project Management in the 21^{t} century is market by two paradoxical trends: an emergence of new technologies that allow project team members to function globally in increasingly effective way and a movement to re-emphasize the art of project management – active listening, negotiating, conflict resolution, problem solving, communication, influencing and other leadership skills [3].*

Key words: *design, project management, planning team, blocks assembly, outfitting.*

1. INTRODUCTION

The shipbuilding process is a complex interaction among the shipyards, organization, owners, partners, suppliers, class and authorities. The ship is considered a one-of product and is handled as a distinct project. The processes are recognizable, but very slightly from shipyard to shipyard and based on the ship type involved.

The active parties in this process are: the shipyard, the owner, the classification society, national authorities, consulting and engineering offices, equipment suppliers, subcontractors [4].

The owner and the shipyard are the key players. The roles of the other groups vary depending on the stage of the project, but continuous involvement throughout in whole period is standard.

The interests of these stakeholders are different.

The owner is interested in receiving a high-standard ship according to the contract specifications and delivered on time. In the end, the yard is responsible for building the ship in a technically and economically sound way.

2. INFORMATION

The shipyard management must have access to the information necessary to make the right decisions. Good planning and an efficient ERP (Enterprise Resources Planning) system should give the management the decision- making tools it needs [5]. Once the ship contract ha been are based on the developed master schedule, shipyard management has few additional opportunities to influence the success of the project. The shipyard must setting up a full project organization for what the project management and his project team are chargeable with. The project manager, who generally reports to the managing director, should have considerable decision power inside the project.

The separated chronological phases which form a typical shipbuilding process can be presented as follows:

1. pre-contract stage;
2. contract – start of manufacturing;
3. start of manufacturing – delivery;
4. guarantee period

a) Precontract stage

During the pre-contract stage, the shipyard must respect the contract specification according to the requirements of the owner, set the contract price and set the vessel delivery date.

Concept design at least to some extend is typically driven by the owner, although the yard often is involved.

Today, the owners used their own experts and outside consulting companies to develop contract aspect, leaving less space for yards to develop their own approaches.

Contract design is a very important documentation because it explicitly defines the ship project both technically and economically [1].

Decisions made during this stage dictate a major portion of the possible variables (types of ship, navigation zone, classification society, deadweight, principal engine, autonomy) making them difficult to change afterwards.

Calculation of price must advance along with contract design.

In this phase it is necessary a tightly cooperation among the project development team (which realized a preliminary calculus of price, respectively which established the auction documentation), planning team and procurement team.

The price of the equipment must be established quickly after choices have been specified.

Typically, shipyards divide the equipment into groups according to its importance. The most important items affecting the majority of costs and having the biggest importance is scheduling – receive the greatest amount of attention. These items must be ordered as much as year before delivery and tie the yard to non-flexible contractual obligation. By contrast, the purchase of non-costly items, which are easy to purchase but represent perhaps 80% of the item numbers ordered, can be left to the designer level.

The procurement team strives to handle the major equipment (20% of all equipment ordered) technically and commercially making it possible to place orders as soon as the ship contract is signed.

A well-defined product model and database help, and e-commerce is speeding up the process, creating a potential for more reliable data.

Coordination of a project is based solely on the build strategy and on the different level schedules prepared by planning. The schedules together with the strategy clearly set up which activities are taken care of by the yard with its own resources and which must be subcontracted.

The production planning team creates a preliminary build strategy, providing the necessary construction guidelines for the project development team. The build strategy consist of: block split (hull assembly blocks), hull assembly "serial cartoon", and investment proposal.

The build strategy becomes the basis of work-hour estimation and a preliminary production schedule. The planning team's role is the key: they define the possible delivery time and estimates work hour.

The coordination planning process is one of the most important activities in shipbuilding. Failure in planning can lead to dramatic consequences in a ship project. The possible hazard factors are: miscalculation of production hours, miscalculation of design hours, insufficient subcontracting reservation, incorrect scheduling.

Miscalculation of work hours is the great error that can be made in planning. Cost estimation is always performed as precisely as possible. This information is provided to sales manager and the managing director, who are responsible for setting the actual price of the contract. After the contract, the owner has a supervising role, the monitor that everything is designed and built according to the technical specifications. They also have approval authority for suppliers and turnkey contractors. However, the shipyard provides inspection material, such as drawing copies and equipment data, and arranges the inspection during productions.

b) Contract-start of manufacturing

After the contract is signed, the ship specification, the price and the delivery time are fixed. Therefore, it is extremely important that all activities scheduled to start immediately after the contract signing, to be well planned and that all the necessary resources are available to enable a head start.

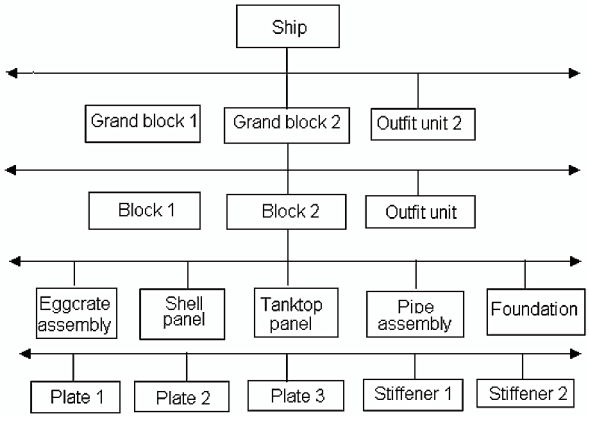

Fig. 1. Example of build strategy.

Basic engineering and procurement go into full swing at this point. The goal is prepare documentation for approval of authorities, of the owner and for the basis of detail (production document) engineering. Basic engineering needs accurate information about equipment and systems specified in the contract material.

The most important tasks at this stage are specifying material needs and coordination with procurement and detail design schedule.

Technical handlers give the technical data to the procurement team and they are responsible for building the equipment as efficiently as possible.

Basic engineering is the design phase where the ship is defined to a functional level.

The most important decision-maker in this stage is the owner's new building director, heading the owner's design team, but the most important designer is the project engineer, who may come either from the owner or the shipyard. He is the person who manages the design work in the initial design phase, and the quality of the design is heavily depending on his vision, experience and know-how.

The design work is usually organized under project engineering to whom the discipline managers report. The discipline distribution in traditional shipyard practice is: steel and structural design, machinery design, out fitting design, interior design, electrical and automation design.

In all departments a so-called discipline manager is typically nominated. This person is responsible for all activities in his design area and reports to the project manager, who is responsible for the overall design. The start of detail engineering is linked to the start of manufacturing. By estimating the required lead times and design hours, it becomes possible to set the detail design start date.

The main purpose of detail engineering is to provide sufficient information for the production and material department to build the ship. Detail engineering is based on the basic design documentation, build strategy information ad shipyard standards. In order to realize an entire project, are usually involved several design offices, so that part of the design is subcontracted. This leads to a complicated network of information as interface among all the parties.

Planning is responsible for preparing the detailed build strategy and master plan. The build strategy is absolutely necessary for the detail engineering, because most of the design solutions are based on knowledge of how a particular element is going to be built and installed. This build strategy, together with the master plan, sets the need dates for the major equipment. This information is necessary to allow procurement to time the deliveries.

The active teams and persons during this period are project manager, project engineering, basic design discipline managers, basic design project manager, detail design project manager, detail design discipline managers, production manager, planning manager, planning team, basic design teams, detail design teams, owner and subcontractors.

c) Start of manufacturing – delivery

Initiation of production is a major step in the process. After this the costs start to accumulate rapidly and it

becomes extremely difficult to make additional changes to schedules or to the technology of the ship. The detail engineering continues for a long period, concurrent with production.

The purpose of the detail engineering is to provide sufficient documents to enable efficient manufacturing and installation work. Equally important are the material and parts lists attached to the drawings. Normally the design team creates these directly in the shipyard's material management system, together to ensure availability of the material at the right point in production [2].

The work order is delivered to the production departments for dissemination to the responsible engineers and foremen, who takes care of organizing the actual work. The production phases can be clearly separated as follows: steel preparation, steel parts manufacturing, pipe prefabrication, unit prefabrication, block assembly, block outfitting, grand block assembly, grand block outfitting, hull erection, area outfitting. Production begins with steel parts fabrication and block manufacturing. Steel production is a well defined process and is relatively easy to follow and control. If calculated in terms of work hours and material costs, the amount of steel is not significant even in a complicated ship. However, the steel block and complete hull become the basis for all the outfitting work, and any failure in steel production can cause massive problems for the project.

Concerning the pipes, most of them installed on board are prefabricated in the pipe workshop; the proportion of prefabricates can reach more than 90% of all pipes in a specific space. Compared to fabricating in place aboard the vessel, prefabrication is much easier, yields pipes that are accurate and of good quality and simplifies installation.

The design department makes the decisions on prefabrication and prepares the pipe spool drawings for the pipe shop.

Concerning the units (pumps, filters, heat exchanges, valves, electrical installation), these are prefabricated as an adjacent system, but which are built together on a common frame. The unit can be completely assembled and functionally tested in a workshop. The installation of units is easy during the block assembly stages, when the spaces are often and direct lifting is possible. A subcontracting company often manufactures the units.

The ship is divided into grand blocks and these grand blocks are further divided into blocks. One grand block consists of several blocks, typically 4 to 8 units.

During the block assembly phase, steel parts and small subassemblies from parts manufacturing are assembled into blocks. This normally happens close to three parts manufacturing location often in the small hall. The lifting and transportation capacity dictates the maximum dimensions of the block.

Outfitting work is started during the block assembly stage. During the various block and grand block assembly stages, outfitting work starts with installation of piping, steel outfitting, equipment, cabling, insulation etc. Achieving an early start to outfitting while maximizing the number of blocks outfitted is the target.

The prefabricated components and other material must be available or the outfitting must be done in later stages. But this increases the cost dramatically, because it is likely that components will not be usable as built and must therefore be modified.

Grand block assembly is nothing more than fitting and welding together the assembly and outfitted blocks. By using grand blocks, the assembly work and outfitting can be brought from the building dock to the assembly walls where the work can be done in sheltered conditions.

Outfitting work continues during the grand block assembly. Part of the outfitting work is done simultaneously with the grand block assembly work. However, it is normal for the schedule to include a period that is reserved exclusively for this work. This period can be 2–3 weeks, depending on the complexity of the block.

During this outfitting period, the grand block requires a construction space and auxiliary space for stores and equipment. The scheduling of the building space is done in the production planning department. At most yards, it must be done carefully due to the large number of blocks under construction at any given time. The planning team maintains a daily schedule of block movements in the shipyard area. This schedule is coordinated with material management to ensure that needed material reach the right places at the right times. During this stage, a large number of subcontracting companies and the shipyard's own personnel are involved.

The sequence of lifting and joining the grand blocks is designed to make the bed time as short as possible, because building berths are often the bottle-neck in total production capacity.

During hull erection, the block concept ceases to exist after the blocks are welded together.

One of the key elements in production is an efficient change management. Changes in production documentation are guaranteed to occur for a wide variety of reasons including: owner's requirements, architect changes, requirements of classification societies and authorities, errors in design, delayed design, delayed equipment deliveries.

Quick and fluent communication between the design and production functions is vital. If the yard can reduce the required production lead times, the chances of tackling the changes improves.

d) Guarantee time

The guarantee time is set by the contract. It is usually 12 months and starts from the delivery of the ship. During this period every deviation of the ship systems from the specification is recorded and reported to the yard which is responsible for replacing and repairing them. If the problem requires immediate solution, the yard is responsible for scheduling the right repair team onboard for maintenance.

Some of the problems discovered during this phase can wait to the end of the guarantee period, when the ship comes to the yard for guarantee repairs. This is by far the most economical and convenient solution for each party.

The shipyard usually appoints a guarantee engineer, who acts as a liaison officer for the owner and the equipment suppliers. The guarantee engineer must have a comprehensive database of system information, including all the operational / service manuals and access to the design documents.

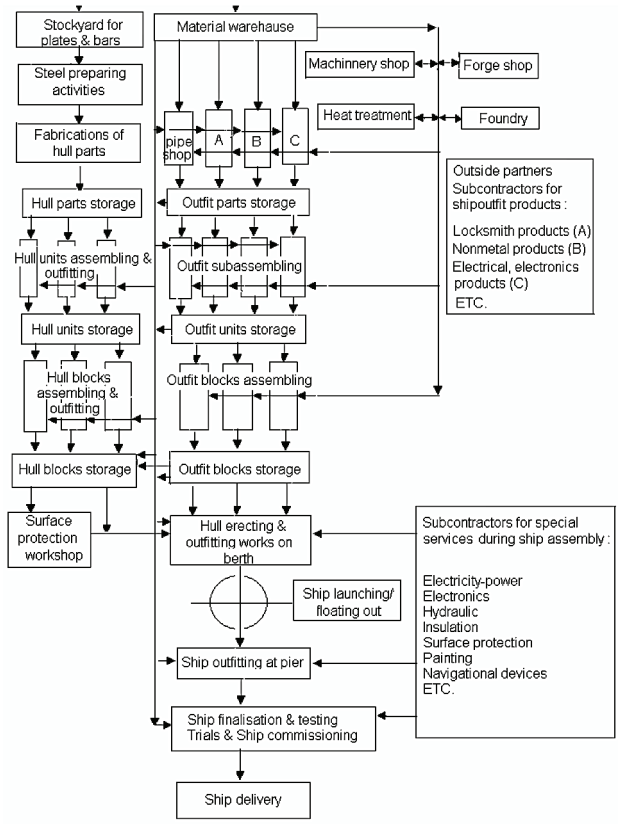

Fig. 2. Shipyard's main production flows.

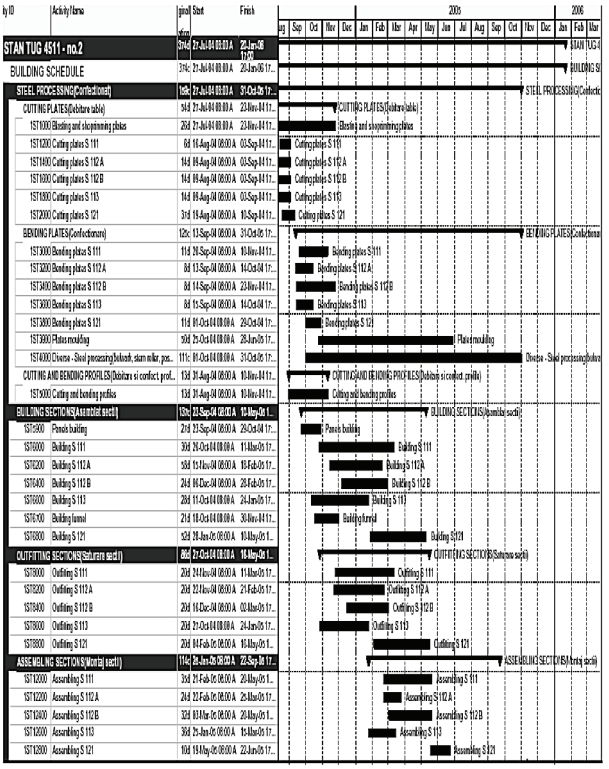

Fig. 3. Part of Gantt example in shipbuilding.

Guarantee is of particular interest to the owner. He typically negotiates additional guarantees and spare parts directly with the supplier without the shipyard's involvement.

3. SCHEDULING THE PROJECT PLAN

To make effective decisions and take related actions, it is necessary that the project manager and the members of the team have a high level of competency in planning, scheduling and control and these functions are directly connected.

One of the most important responsibilities in a project is the planning of activities, analyzing and integrating their effects and executing the resulting project plans.

The scheduled plan is a tool to determine the activities necessary to complete a project and the sequence and timeframe within which activities must be completed.

In Fig. 3 is presented an example of Gantt diagram in shipbuilding.

4. CONCLUSION

Shipbuilding actual process is based on principles such as structural building in blocks, block outfitting to a maximum degree, modularization of outfitting into units, utilization of prefabrication in pipe work, ducting and cable trays, pre-assembly of pipe packages and outfitting of units such as cabins, cold rooms etc. All this requires concurrent design, engineering and installation. Coordination of design and procurement has become a central and necessary problem. Delivery of equipment in the correct phase for outfitting is crucial. Even more important is that the information be received in time for the design, which means that procurement handling is driven by design.

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