Planning New Construction
&
Major Ship Conversions

(Using *PERCEPTION*® Version 7)

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Abstract

Shipyard planning has three fundamental objectives:

- Ensure that all required resources (drawings, material, labor, subcontractors and facilities) are all available when the work is scheduled
- Organize the work to be the most productive possible
- Monitor progress and measure actual costs and schedules against budgets and plans
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This document presents the fundamentals for planning and managing new ship construction and major ship conversion contracts. The discussion outlines a framework from which the shipyard can develop a logical, well-organized production plan from the outset of a contract. The discussion focuses on build strategies that exploit group technology manufacturing, modular construction, and pre-outfitted hull blocks and zone outfit methods. It also addresses requirements for integrating all necessary activities supporting production: engineering, purchasing, material control, and subcontractors.

Chapter 1: Introduction

New ship construction and major conversions are complex businesses involving many different inter-related activities: engineering, planning, purchasing, material control, production trades, support services, vendors, and subcontractors. In addition, ship owners, representatives, outside consultants, advisors and classification societies also are heavily involved. All these efforts have their own sets of interests and priorities, which need to be recognized and accommodated in ways that can result in a successful and profitable contract.

Planning for all these activities, developing appropriate sequencing of events and ensuring that each activity can perform with maximum effect, is a non-trivial job. Without good planning, the full measure of a successful contract cannot be achieved.

Successful & Unsuccessful Project Management Practices

The following discussion is largely excerpted from an article by Casper Jones, founder and chief scientist for Software Productivity Research LLC. His article, which focuses on managing software development projects, was published in the October 2004 issue of "CrossTalk", a publication co-sponsored by the U.S. Air Force Air Logistics Centers and others.

While the discussion has been modified to address the specific issues facing shipyards, its elements clearly are pertinent to successfully managing almost any large-scale project, regardless of the industry in which it must operate.

Successful & Unsuccessful Project Planning

Project Planning includes creating work breakdown structures and apportioning tasks to work centers over various periods of time. The planning process creates timelines and critical paths, including Gantt charts, PERT charts, or the like.

Planning for successful large-scale projects involves the following:

1. Using automated planning tools
2. Developing work breakdown structures
3. Conducting critical path analysis of project activities
4. Reviewing and determining resource requirements over the time of the project
5. Considering subcontractors and other team players
6. Factoring in time for requirements gathering and analysis
7. Factoring in time for handling changing requirements
8. Factoring in time for quality control activities
9. Considering multiple re-planning efforts if requirements growth is significant.

Successful projects do planning very well. Delayed or cancelled projects almost always have planning failures. The most common planning failures include:

1. Not dealing effectively with changing requirements

2. Not adequately anticipating resource requirements during the project
3. Not allotting time for detailed requirements analysis; and
4. Not allotting sufficient time for inspections, testing, and defect repairs.

Successful project planning tends to be highly automated. With many commercial project-planning tools on the market, successful projects all use at least one of these. Not only are the initial plans au5tomated, but also any changes in the requirements scope or external events will trigger updated plans to match the new assumptions. Such updates cannot be easily accomplished via manual methods; planning tools are a necessity for large projects.

Successful & Unsuccessful Project Cost Estimating

Cost estimating for large projects is far too complex to be performed manually. As with planning tools, there are a wide variety of cost estimating tools in the market, but each more typically is oriented to meet the unique needs of a specific industry. Successful projects all use at least one such tool and the usage of at least two is not uncommon.

Estimates produced by trained estimating specialists also are noted on many large successful projects, but not on failing projects. Successful cost estimating for large projects involves using the following:

1. Software estimating tool(s)
2. Formal sizing approaches for major deliverables based of manufacturing/assembly process.
3. Availability of trained estimating specialists or project managers
4. Inclusion of new and changing requirements in the estimate.
5. Inclusion of quality estimation as well as schedule and cost estimating.

By contrast, large failing projects tend to understate the size of work to be accompl8ished due to inadequate sizing approaches. Failing projects also omit quality estimates, which are a major omission since successive defect levels slow down testing to a stand-still. Over estimating productivity rates or assuming that productivity on a large project will be equal to or better than on a small project are common reasons for cost and schedule over-runs. Many large projects err on the side of excessive optimism.

Successful & Unsuccessful Project Measurements

Successful large projects are most often found in companies that use project performance measure systems for capturing productivity and quality historical data. Thus, any new projects can be compared against similar projects to judge the validity of schedules, costs, quality, and other important factors.

The most useful measurements for projects include the following:

1. Accumulated progress and cost against planned progress and cost
2. Period progress and cost against planned progress and cost

3. Project interim product (for example, hull & outfit modules) productivity or efficiency to both cost and schedule
4. Work center productivity or efficiency to both cost and schedule
5. Cataloging of defects & corrections, their impact upon costs and schedules, by work center and stage of construction

The measures of effort should be granular enough to support work breakdown structures. Cost measurements should be complete and include development, management, subcontract, and overhead.

Since the bulk of schedule delays and cost overruns tend to occur during testing and are caused by excessive defect volumes, it can be hypothesized that lack of effective quality control on large projects is a major contributor to both cost and schedule overruns.

Successful & Unsuccessful Project Milestone Tracking

Milestones sometimes refer to the start or completion of an activity. Sometimes, they may be merely calendar dates.

Project management is responsible for establishing milestones, monitoring their completion, and reporting truthfully on whether milestones were successfully completed or encountered problems. When serious problems are encountered, it is necessary to correct the problems before reporting the milestone has been completed.

Failing or delayed projects usually lack serious milestone tracking. Activities might be reported as finished while work was still ongoing. Milestones might be simple dates on a calendar rather than completion and review of actual deliverables. Some kinds of reviews may be so skimpy as to be ineffective.

Successful project, on the other hand, regard milestone tracking as an important activity and try to do it well. There is no glossing over of missed milestones, or pretending that unfinished work is done. Delivering documents or production interim products that are in-complete, contain errors and defects and cannot support downstream efforts is not the way milestones occur on successful projects.

Another aspect of milestone tracking on successful projects is what happens when problems are reported or delays occur. The reaction is strong and immediate: corrective actions are planned, task forces assigned, and corrections occur as rapidly as possible. Among lagging projects, on the other hand, problem reports may be ignored and very seldom do corrective actions occur.

Successful & Unsuccessful Project Change Management

Successful change control includes the following:

1. A joint customer/shipyard change control board or designated experts
2. Formal review of all change requests

3. Revised cost and schedule estimates for all significant changes
4. Prioritizing change requests in terms of business impact.
5. Formal assignment of change requests to specific releases
6. Using automated change control tools with cross-reference capabilities.

Changes will always occur for large projects. It is not possible to freeze the requirements of any real-world application. It is naïve to think this can occur. Therefore, leading companies are ready and able to deal with changes, and do not let them become impediments to progress.

Successful & Unsuccessful Project Quality Control

Effective quality control is the most important single factor that separates successful projects from delays and disasters. The reason for this is because finding and fixing problems is can be the most expensive cost element for large systems and can take more time than any other activity.

Successful quality control involves both defect prevention and defect removal activities. Defect prevention includes all activities that minimize the probability of creating a defect in the first place. Examples of defect prevention include streamlining design and engineering to simplify a product and render it easier to manufacture and build. Using formal design and production standards can reduce defects by their very nature of repeatable design elements and repeatable manufacturing products and processes.

Defect removal includes all activities that can find defects in any kind of deliverable. Examples of defect removal activities include requirements inspections and all types of testing.

Some activities benefit from both defect prevention and defect removal simultaneously. For example, participation in design and inspections can be very effective in terms of defect removal and also benefits defect prevention. The reason why defect prevention is aided is because inspection participants learn to avoid the kinds of problems that inspections detect.

The combination of defect prevention and defect removal activities leads to some very significant differences in the overall number of defects compared between successful and unsuccessful projects. One of the reasons why successful projects have such high defect removal efficiency compared to unsuccessful projects is the use of design and production inspections. Formal design and production inspections can average 65 percent efficiency in finding defects. They also improve testing efficiency by providing better interim products for test cases.

Unsuccessful projects typically omit design and production inspections and depend purely on testing. The omission of upfront inspections causes three serious problems:

1. The large number of defects still present when testing slows the project to a standstill
2. The bad fix injection rate for projects without inspections is alarmingly high
3. The overall defect removal efficiency associated with only testing is not sufficient to achieve defect removal rates better than 80 percent. That leaves 20% defects to surface

later during warranty periods, stages of construction most expensive to perform corrective activities.

(Note: The term bad fixes refers to secondary defects accidentally injected by means of patch or repair that is itself flawed.)

Conclusions

There are many ways to make large projects fail. There are only a few ways to make them succeed. It is interesting that project management is the factor that tends to push projects along either the path to success or the path to failure.

Large projects that are inept in quality control and skimpy in project management skills are usually doomed to either outright failure or massive overruns.

Among the most important practices leading to success are those of planning and estimating before the project starts, absorbing change requirements during the project, and successfully minimizing defects.

Successful projects always excel in these critical activities: planning, estimating, change control, and quality control. By contrast, projects that run late or fail typically had flawed or optimistic plans, had estimates that did not anticipate changes or handle change well, and failed to control quality.

PERCEPTION, an Integrated Shipyard Management System

PERCEPTION is SPAR's integrated system for planning, estimating, managing project resources, and tracking and forecasting cost and schedule performance. *PERCEPTION* is designed specifically to address the unique projects inherent in the business of ship building, large-scale overhaul, and modernization and repair contracts.

Baseline Planning

New construction and conversion, despite its complexity of details, evolves from a build strategy, which is fairly simple in its basic formulation (Figure 1-1). The strategy focuses upon the primary stages of construction: parts manufacturing, hull block construction and zone outfit.

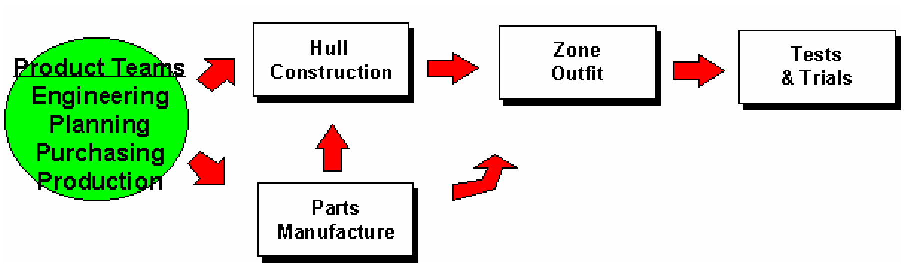

Figure 1-1: General Sequence of Work for New Ship Construction

World-class shipyards develop building plans exploiting the significant cost savings from work performed at the early, more productive stages of construction. Work performed off-ship generally requires much less effort, is more convenient, and is easier to access work areas. Off-ship work can cost 40%-60% less than comparable work done on board.

However, to be successful, these early work activities need more effort to plan, engineer and marshal necessary manpower and materials. If all the supporting materials, including technical information, are not available, these potential cost savings cannot be realized.

This basic plan is then expanded (Figure 1-2) to include general schedules for design and procurement processes. This plan is the basis for the Master Schedule.

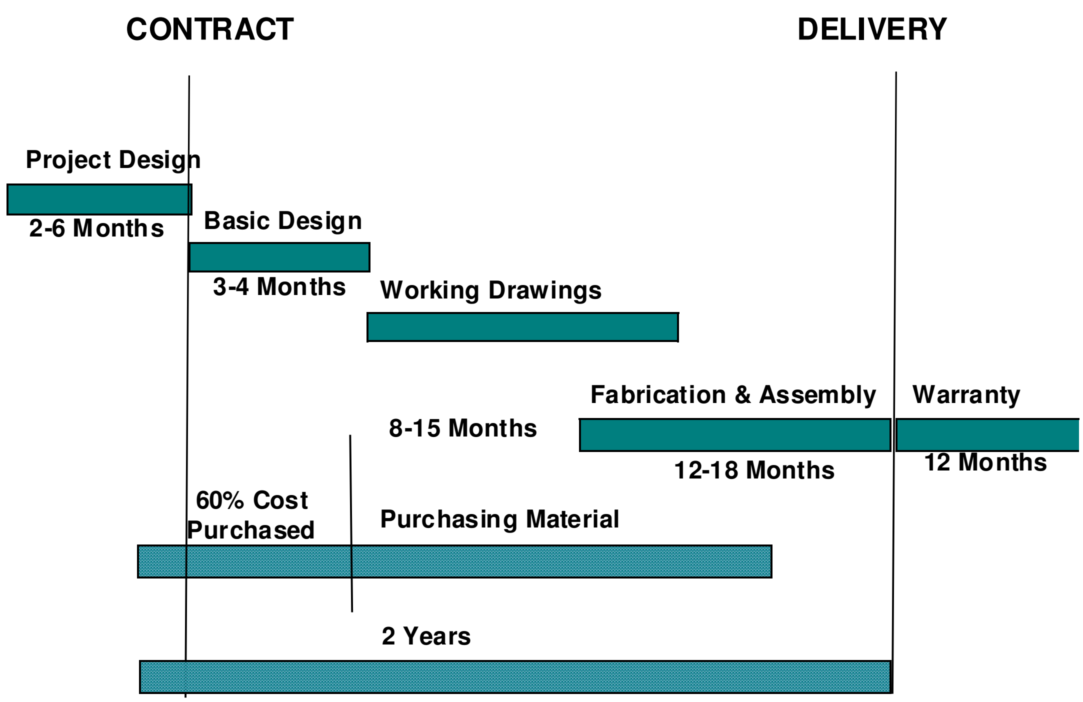

Figure 1-2: Typical Commercial Ship Construction Schedule

The planning process then identifies traditional ship construction milestones.

- Start fabrication
- Lay keel
- Launch (float out)
- Delivery

These milestones may be directly related to the ship owner's payment schedule. The planning process needs to address the cash flow requirements of the contract, both revenues and expenses. If a plan cannot provide for an adequate cash flow, a profitable contract may be doomed from the very beginning.

Operations Planning Versus Detail Planning

Planning should be done at two levels: "operations planning" organizes and coordinates all efforts, while "detail planning" is done locally at the production level of the shipyard. The idea is to allow detail planning to solve specific problems in their specific areas: design, hull and outfit. However, since each area has a tendency to optimize their specific operation at odds with other departments, a central planning group can introduce the required compromises so that the shipyard can operate the best way overall.

Operations planning provides the overall coordination of detail design and production planning to ensure that no single department can overly optimize its plans at the expense of the overall objectives of the contract. Operations planning further resolves intra-contract conflicts, such as scheduling of dry dock and limited availability of manpower. Such conflicts sometimes require the yard manager to set priorities around which each contract must adjust their detail plans.

Operations planning must work closely with the design, production and procurement departments. Figure 1-3 illustrates the iterative planning process from top to bottom.

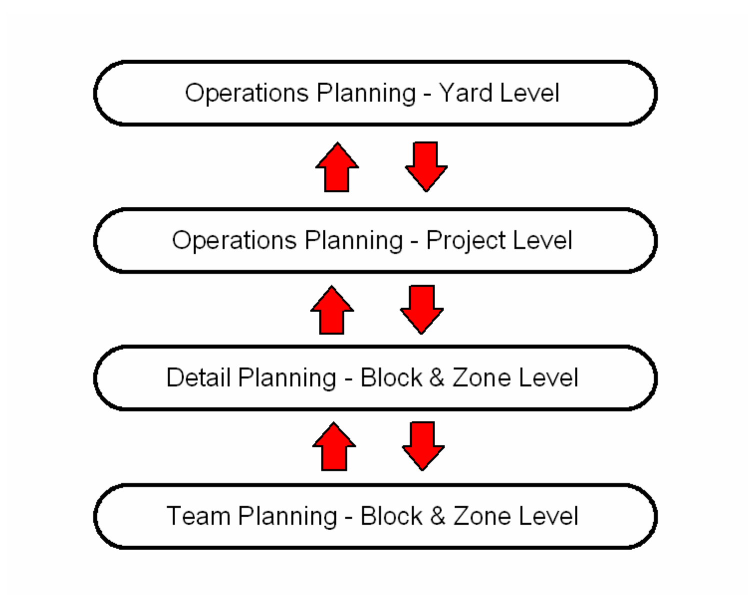

Figure 1-3: Iterative Planning Process

Shipyard Standards

Since much of this production work needs to be done at earlier stages of construction, the planning, engineering and material control efforts also must be accomplished much earlier in the construction period. Resources available for these up-front activities typically are limited.

Therefore, shipyards are quickly recognizing that a comprehensive program to develop engineering, planning, material and production standards help relieve the strains of excess resource requirements, while reducing overall costs as well.

Product Teams

Another way to expedite plans and ensure that the production work can be executed with maximum productivity is to organize what is called "Product Teams". These teams, headed by an overall project manager, focus upon the engineering, material and production resource requirements of each hull block, each equipment and outfit module and finally each of the ship onboard zones during the later stages outfit. These teams are formed with participants from engineering, planning, purchasing, material control and production. Such a composition of team members allows many problems to be solved before production actually gets under way. It also allows a cross-section of expertise to concentrate together for quicker, more considered and effective solutions.

Chapter 2: Basic Elements of A Build Strategy

The build strategy outlines the general approach to be taken for engineering and building the particular ship. This strategy identifies the basic elements of construction:

1. Hull Block Construction, including the manufacturing and assembly of structural parts and the outfit of various ship systems onto the bocks prior to erection.
2. The Erection Sequence that defines the sequence that the hull blocks will be erected. This erection sequence also accommodates the landings of major equipment and outfit modules that are directly affected by the erection sequence of the blocks.
3. Zone Outfit that defines the work required onboard necessary to complete the on-block outfit.
4. Equipment and Outfit Modules that can be most productively assembled in shop.
5. Manufacturing of Parts required supporting the needs of the on-block and onboard work.
6. Tests & Trials, which are the concluding efforts of the manufacturing and assembly processes

Hull Block Construction

Major interim products built by a shipyard are the structural hull blocks. Installing outfit materials on these blocks prior to erection offers significant cost savings. The working environment is better than onboard the ship. The work area on a hull block is easier to access, and the block can be moved and oriented for down-hand work, which is easier and less expensive than overhead work. Overhead work also may require expensive staging. Hull block outfit, typically is done either in an assembly hall or nearby material storage buffers and shops, allows work to be performed with material and tools that are more readily available and out of the weather.

Each hull block work needs to be planned in its natural sequence (Figure 2-1) of basic work activities: parts fabrication, assembly, outfits on block, and then erection and onboard welding. If blocks are painted prior to erection, the on-block outfit work may need to be divided into work performed before ("outfit hot") and after ("outfit cold") the blast and paint operation.

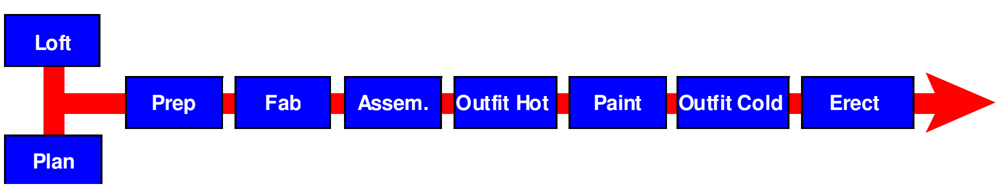

Figure 2-1: Sequence of Activities for Outfitted Hull Block Construction

Each type of hull block will require its own set of specific fabrication and assembly operations, but the sequence of fundamental events usually varies very little, block by block.