1.0 INTRODUCTION

1.1 Background

Even now, many years after welding replaced riveting, improved shipbuilding methods that welding made possible are still developing. Before welding, each ship's hull was built in essentially the same sequence. A keel was laid, frames were positioned and plates were fitted "plank by plank" reflecting the time honored sequence for building wood ships. The process was system oriented, i.e., first the keel was assembled as a system, then the frame system was erected, next the shell system and so on. System-oriented planning, including the preparation of system-oriented hull-construction drawings, was appropriate.

The advent of welding meant that parts of frames could readily be joined to portions of a shell. Such weldments could incorporate parts of decks, bulkheads and a keel. Therefore much assembly work was shifted from the building ways to platens in or near shops where work is performed with greater safety, efficiency and accuracy.

When sufficient block-like weldments were accumulated, a ship's hull was erected block-by-block. Thus, hull construction had become zone oriented. A few shipbuilders evolved zone-oriented hull-construction drawings to suit. The sequence specified for their preparation was the same as that planned for hull erection. Both detail design and production people concerned with hull construction were responding to the same building strategy.

With rare exception, even when block construction became routine, outfitting and painting continued as successor functions. That is, each hull was essentially complete before most outfit work was performed. Many outfit components were measured, fabricated and fitted on board with all attendant inefficiencies.

Some shipbuilders prescribed *preoutfitting* of blocks which is the division of outfit work into *two* basic stages, i.e., on-block and on-board. However, many continue to employ system-by-system outfit drawings and their work orders specify performance of outfit work by systems or portions of systems. Work order contents are relatively large so as to complicate attempts to achieve uniform and coordinated work flows. In response to such orders each work team usually competes with other teams for access to work. Within blocks being outfitted, to a lesser but still significant degree, the same problems are encountered as in conventional outfitting. There are redundant temporary services, e.g., staging, welding cables, compressed-air hoses and flexible ventilation ducts. Most overhead fitting work is still performed by workers reaching over their heads.

No less illogical, people who perform detail design, material definition and material procurement system-by-system are unnecessarily preoccupied with portions of systems that will not be required for some time. Detail design and material definition, both vital aspects of planning, and material procurement are system oriented whereas preoutfitting is zone oriented. Under such circumstances, the efficiency of even comprehensive preoutfitting is inherently limited because of the conflicting building strategies. Focus on a single zone-oriented strategy led to the development of scientific shipbuilding methods.

The traditional approach was replaced by the world's most productive shipbuilders with integrated hull construction, outfitting and painting characterized by a number of remarkable features, e.g.:

- the Hull Block Construction Method (HBCM) wherein hull parts, sub-blocks and blocks are manufactured in accordance with the principles of group technology (family manufacturing) in organized production lines (also process or work flows),
- the Zone Outfitting Method (ZOFM) which disregards the archaic notion that outfitting is a successor function by providing precise zone-by-stage control for which there are *three* basic stages: on-unit, on-block and on-board outfitting and a sub-stage for *down-hand* outfitting on overheads when blocks are upside down,[1]
- family manufacturing, such as in Pipe Piece Family Manufacturing (PPFM), which replaces job-shop thinking with group technology logic in order to obtain production-line benefits for the manufacture of many different items in varying quantities, and most significantly
- adoption of a Product Work Breakdown Structure (PWBS) which facilitates the integration of the foregoing inherently different types of work by emphasizing expertise in contriving and classifying ideal interim products, e.g., parts and subassemblies which permit coordinated work flows.[2]

The history described in the foregoing, leading to integrated hull construction, outfitting and painting, is illustrated in Figure 1-1. Because shipbuilders who have mastered such integration routinely achieve over 90-percent completion of outfitting at time of launching, they had to substitute more meaningful progress indicators:

- percent of outfitting completed at *keel laying*, and
- percent of *outfit planning* completed at keel laying.

For them, achieving 35 and 85 percent respectively is not unusual.

1.2 Impact on Hull Construction

Integrated hull construction, outfitting and painting (IHOP) impacts on every aspect of hull construction. Traditional organizations of people, information and work are not suitable. As the most productive shipbuilders have proven and are continuing to perfect IHOP, shipbuilders who must compete have no alternatives. They too must master IHOP. For them, changes in functional structures, employment of information, and work processes are inevitable.

Because of the usual predominance of hull construction at the expense of the other types of work, effecting the necessary changes for hull construction is likely to be the most difficult. Some traditional managers would not find it easy to accept, let alone direct, what appears to be subordination of "steel" throughput in order to achieve IHOP. But if they did, they would be surprised because the disciplines for achieving coordinated process flows for different types of work, also improve hull-construction productivity.

As shown in Figure 1-2, IHOP requires unprecedented collaboration between all shipyard departments. As theirs is a lead role, production engineers for hull construction must understand outfitting and painting needs. Integrated planning is achieved by discussion, trade-offs and ultimately mutual consent. The overriding goal is an increase in productivity for an entire *shipbuilding system.*

---

[1] The word *unit* is used to designate an assembly of just outfit materials. Thus, *on-unit outfitting* does not involve any hull structure.

[2] Other publications by the National Shipbuilding Research Program refer. See "Product Work Breakdown Structure - Revised December 1982" which describes the hull block construction and zone painting methods, "Pipe Piece Family Manufacturing - March 1982" and "Outfit Planning -December 1979". Limited supplies of these publications and others referenced herein are available to U.S. shipbuilders at L.D. Chirillo Associates, P.O. Box 953, Bellevue, WA 98009.

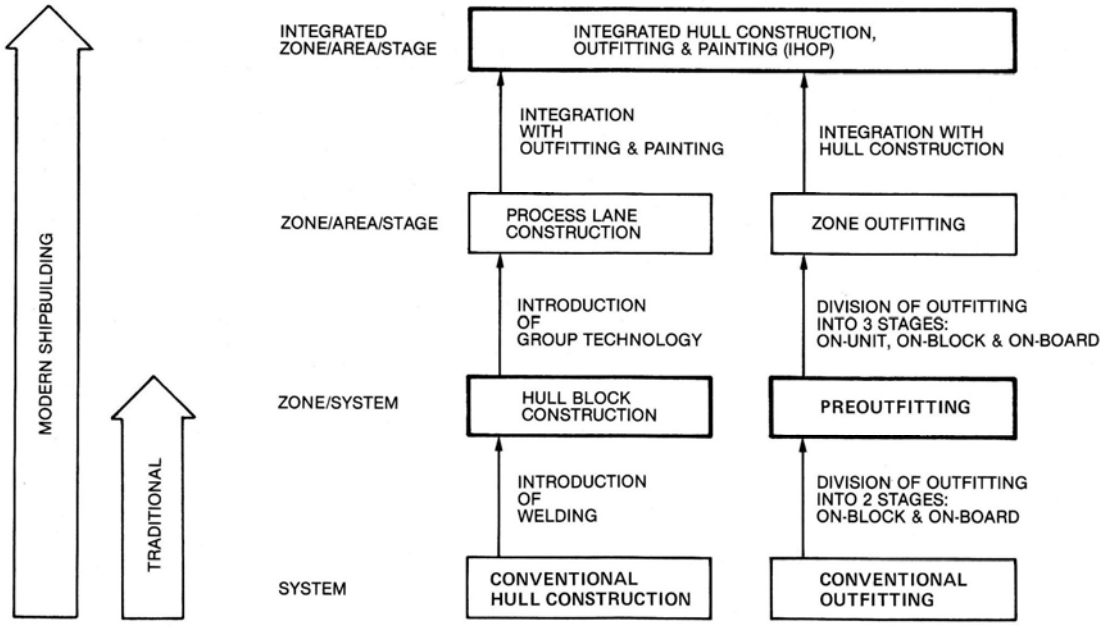

FIGURE 1-1: History of Basic Improvements in Shipbuilding Methods.

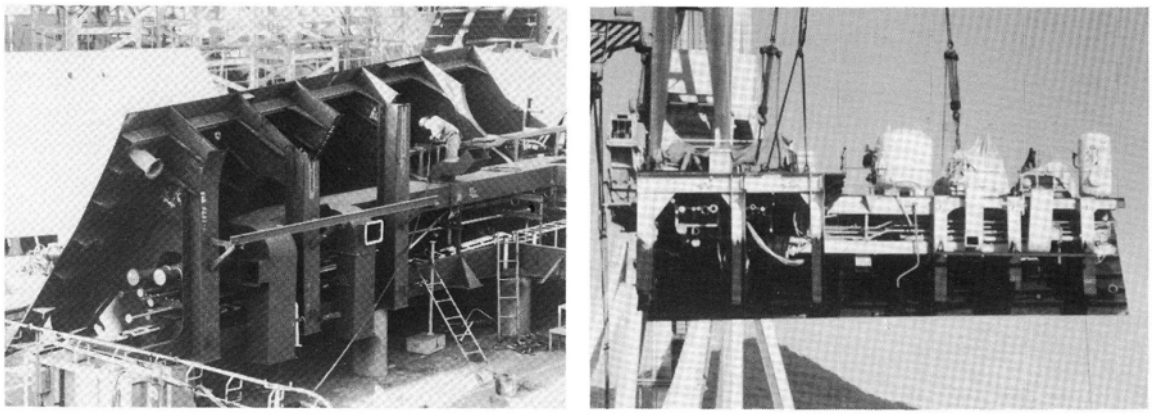

FIGURE 1-2: An extensively outfitted and painted block, shown before and after turnover, manifests integrated hull construction, outfitting and painting (IHOP). Opportunity for down-hand work on ceilings and access for extensive amounts of outfitting and painting work in accordance with the principles of group technology, enhance productivity.

(NOTE: Page 4 is blank)