8. ADVANCED OUTFITTING

8.1 Fitting Out Ships

This includes a large number of operations of which the main components are hull, machinery and electrical fitting out. Work carried out under these categories includes:

Hull: Deck equipment - windlass/winches/boats/davits
Accm. spaces - joinery/electrical/plumbing/ventilation
Piping - fuel/ballast/cargo mains
Miscellaneous - ladders, walkways, gratings, etc.

Machinery: Stern tube, main and tail shafts, propeller
Rudder/stock
Main engines
Auxillary machinery/equipment
Piping

Electrical: Engine Room, hull main services.

8.2 Traditional Practice

In the past, the tendency has been to separate various trades and to commence outfitting only after a significant proportion has been erected. The principal features is this mode of work where the ship spending a relatively short time at the assembly/fabrication stage and comparatively long periods on the building berth and in the basin. Figure 8.1 illustrates the work rate under this scheme.

Typical steps for accommodation work following approximate completion of steelwork as listed below:

- make pipe/trunk/electrical penetrations
- fair buckled plate
- install airports/windows
- perform hose testing
- paint steelwork
- fit insulation/wiring/ducts pipes
Figure 8.1: Traditional Sequence of Production Events
- fit joiner partitions/bulkheads
- install plumbing fixtures
- lay floor covering
- install built-in furniture/doors/fixtures
- complete painting
- fit carpets/curtains
- install portable furniture.

Although it appears simple, this manner of work has a number of disadvantages associated with it:

(1) longer build time
(2) uneven labour requirement
(3) larger space requirements
(4) extensive re-work
(5) uncomfortable work environment
(6) difficult to plan
(7) access problems

8.3 Current Practice

The commercial situation today is gloomy and competition between shipyards is fierce. From a financial viewpoint there is pressure on the yards to maintain lower levels of stock. There is a need to reduce production time and increase productivity. This has been the primary factor enhancing the use of advanced outfitting. The approach is illustrated in Figure 8.1. The main features of the work are relatively longer time in the fabrication and module shops and relatively short times on the berth and in the wet basin.

Advanced outfitting may be regarded as fitting to the ship structure, before and after erection, on the building berth, of outfit items as a significantly early time in the building sequence. The concept can be categorised into three types, namely:
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On unit
- on block
- on board (either on berth or afloat)

“On-unit” advanced outfitting involves construction of packages of equipment on bundles of pipe and other systems on a common foundation. The work is performed in a shop environment. The packages will typically include utilised foundations and/or support bases, equipment, small tanks, pipe fittings, controllers, electric cables, etc. and are almost completely painted. Where required and possible, the packages are tested before installation “on-block” or “on-board”. Typical examples of “on-unit” advanced outfitting are shown in Figures 8.3 and 8.4.

“On-block” advanced outfit involves installation of “units” (or equipment modules), pipe bundles, foundations, etc on a structural assembly before it is erected on the building berth. Structural assemblies may be erected as assemblies or joined to other assemblies/modules to form an erection module. Figure 8.5 illustrates a typical example in this category.

“On-board” advanced outfitting consists of installing “units” or individual pieces of equipment into the ship as it is on the building berth or afloat. Figure 8.6 shows a pre-outfitted cabin which is ready to be installed on the ship. A special approach here is the “open deck” or “blue sky” method: a complete compartment such as a machinery space is left open (with the deck off) until all the equipment is installed. This approach, illustrated in Figure 8.7, is normally used in shipyards with covered building berths for warship construction.

The merits of advanced outfitting are:

- levelling of work load
- shorter overall building time
- savings in staging costs
- better access/work conditions
- better workmanship
Figure 8.2: Current Sequence of Production Events
Figure 8.3: Pipework Package – U.S. Practice

Figure 8.4: Pipework Module – European Practice
Figure 8.5: Aft Engine-Room Module

Figure 8.6: Cabin Module
Figure 8.7: “Blue-Sky” Outfitting
The possible restrictions and requirements for implementation are:

- number of berths or dock time may be limited (economic problem as to whether hull erection sequence modified or launch date delayed to facilitate outfitting).
- a limited launch weight or overall distribution of weights (eg. main engines, accommodation block, etc).
- limited crane capacity (eg. in the case of heavy machinery or complete deck house).
- sub-contractors items required at much earlier stage.
- large storage areas may be required to complete outfitting and painting prior to erection.
- dependent on early and efficient planning and a good liaison between hull steel and outfit departments in order to integrate the two functions.

### 8.4 Some Definitions

Because different counties, companies and even people use different words to explain or describe the same item, it is necessary to give definitions for the specific purpose of this chapter. The confusion that can result from the lack of clear definition can be appreciated by examining Figure 8.8.

**Module:** A structural item consisting of one or more subassemblies/assemblies which will be erected on the building berth and joined to other modules.

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

**Subassembly:** A structural item which is fabricated from processed plate and shapes, and which when completed will be incorporated with other subassemblies into an assembly or module.
**Figure 8.8: Differences in Product Definition**

<table>
<thead>
<tr>
<th>ITEM SKETCH</th>
<th>USA</th>
<th>JAPAN</th>
<th>BRITAIN</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Sub-Assembly</td>
<td>Ditto</td>
<td>Ditto</td>
<td>Ditto</td>
</tr>
<tr>
<td>Assembly</td>
<td>Sub-block</td>
<td>Section</td>
<td>Sub-unit</td>
</tr>
<tr>
<td>Module</td>
<td>Key assembly</td>
<td>Block</td>
<td>Large section</td>
</tr>
<tr>
<td>Unit</td>
<td>Package Unit</td>
<td>Module</td>
<td>Unit</td>
</tr>
</tbody>
</table>
Unit: A packaged group of 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.

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

8.5 Unit Design

The design of an actual unit is dependent on the equipment to be incorporated, space available, location of the unit relative to the supporting structure as well as production facilities, methods and detail preferences. The unit should be designed to be self-supporting during construction, transportation and installation into the module or ship. If the weight of such capability is unacceptable, a temporary means of supporting the unit must be provided. Some shipyards have developed and constructed special lifting frames to enable up to eight-point lifts for units, thus eliminating the need for additional support structure. The following general points need consideration during the design and planning stage.

- Develop the unit with as many “systems” as possible integrated into it, such as walkways, gratings, ladders, ducting, piping, cable trays, etc.
- Select the equipment grouping such that a minimum number of pipinf connections are required to a major stand-alone piece of equipment or to another unit.
- Consider similar size items of equipment so that a single large items will not require a completed unit to be located in “open” space relative to deck height.
- The design of the connection of the unit to the ship’s structure must enable welding without damaging protective coatings in tanks, insulation under decks, etc.
- When practical, design unit piping to run below working-level floor plates rather than above for the obvious reason of efficient support integration.

- When locating equipment, check that there is sufficient distance between items for fittings, valves, gauges, etc. that must be located between them so as to avoid pipe looping to achieve this as a later fix.