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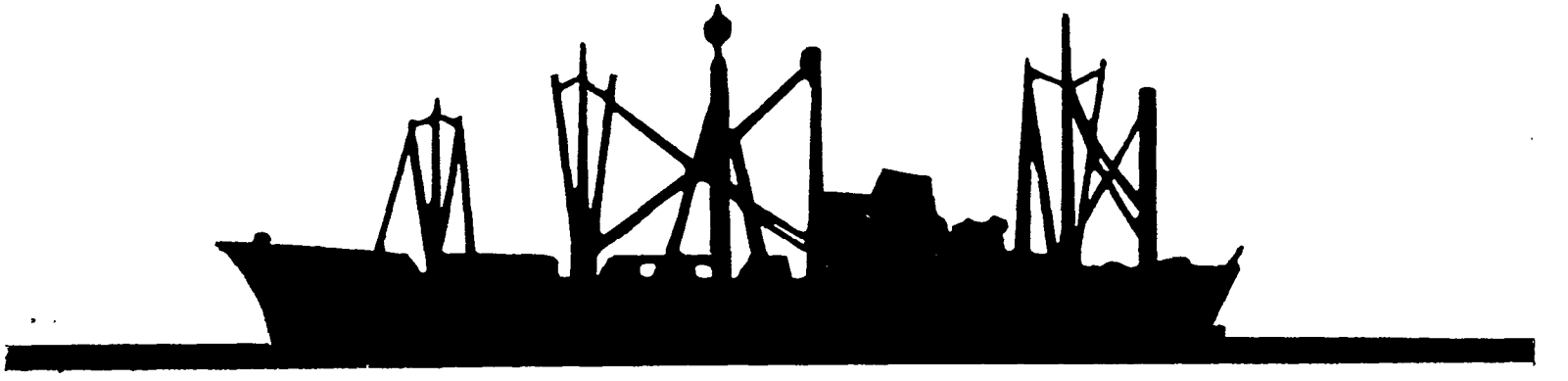

INSTITUTE FOR RESEARCH AND ENGINEERING FOR AUTOMATION AND PRODUCTIVITY IN SHIPBUILDING

I R E A P S

0009

RAPID DEVELOPMENT OF PRODUCTION SCHEDULES WITH STANDARD PLANNING MODULES

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Mr. Knapp is currently developing a formal shipyard planning document which will be available to client yards using the Standard Planning Module discipline. Recent achievements include the development of a planning network for the Saint John Shipbuilding and Dry Dock Company, Saint John, New Brunswick, Canada, for an AKER designed, semi-submersible drill rig, and directing the planning of the "Debbie D", an imaginary drill rig work boat used by SPAR for client training. Another ongoing task is the development of a 7000.2 compatible material cost performance report as a feature of SPAR's MAT-PAC material control system.

Mr. Knapp has been active in the Planning and Scheduling aspects of the shipbuilding industry since 1977, and has been an annual speaker at REAPS sysmposiums since 1979. He holds a bachelors degree and has completed post-graduate work in computer science.

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PREFACE

Following the premise of engineering standards, Standard planning Modules represent production work package arrangements which are predefined to simplify the creation of planning networks at the central planning level, The approach centers around the notion that a vast majority of production activities can be established without the aid of available, detailed engineering. The creation of workpackages under this approach is dependent solely upon historical production performance, adaptation of work from previous vessels of the same class, specific details provided by the vessel's specification, and general arrangement engineering drawings. Final production schedules, at the workpackage level, become a derivative of the planning schedule as detailed information becomes available from engineering, material procurement, and other sources,

TRADITIONAL PLANNING'

The nature of planning a ship's construction has historically dictated that most, if not all, of the ship's details be known. Working from production drawings, Planning generates the varied labor workpackages necessary to support the fabrication and installation of steel and systems, Since Planning waits for such detail to be available, the timing of the production schedule development tends to occur immediately before those schedules are needed by the yard. In fact, a common complaint of many shipyards is that the production schedules are often published after preliminary construction has begun, normally in the form of steel cutting and substructure assemblies, This tardiness further re-

stricts the ability of Planning to conduct such analyses as manpower availabilities, facility readiness, and cost-to-schedule trade-offs.

Such studies are necessary to give the shipyard any advanced notice of production problems, Other analyses which are of equal benefit are those which can improve the producibility of the vessel by planning for pre-outfitting, modularization, and family manufacturing, The ability to foresee production problems and to plan for alternative construction techniques are other benefits which are lost due to the timing of traditional planning,

Another observation is that, under this information-constraint approach, Planning in incapable of assisting any of the departments which lead the vessel's construction. Therefore, engineering tends to dictate to production the release, and hence, the building, schedule for ship's construcion, Material procurement, often faced with the complication of long-lead time item purchasing, must use either the drawing release schedule, historical purchasing trends, or purchase the troublesome items early and hope for the best.

Given today's economic pressures on the shipyards' order books, Planning must derive a mechanism to permit a more rapid development of the production schedules, Even if the preliminary schedules are to be classified as estimates, they Offer the shipyard the opportunity to inspect a potential plan well in advance of construction, It is better to criticize a plan dubbed as "crude" than to have no plan to inspect at all.

COMPARISON TO ENGINEERING STANDARDS

The concept of engineering standards, as is known throughout the industry, is to affix production labor and material cost estimates to production activities, The term "estimate" is weak in that the discipline of engineering demands a more formal assignment of production requirements to the elements of the project. Working from recognized standards, engineering is able to derive the accepted time durations and costs associated with *any* detailed *aspect* of the vessel.

This approach forms the foundation for planning standards, While the shipbuilding industry lacks any documented data on fabrication and installation of production requirements, each yard can develop a sufficient standard-base from which adequate planning estimates can be derived, Such standards would specify:

a) Workpackage content

b) Trade classes required

c) Assigned workpackage budget in manhours

d) 'Trade class manhours or distribution percentage'

e) Optimal duration in work days or weeks

f) Cost account

While the method of assigning standard data to a single package may seem interesting, the approach can be taken further by the definition of standard modules, These Standard Planning Modules, or SPMs, permit the development of standard relationships between the already defined standard workpackages, Thus, the inclusion of a SPM into the plan for the vessel will automatically define all of the associated work elements needed to complete the task, An example of one SPM would be a set of workpackages to procure, engineer, fabricate, assemble, erect, and weld a steel unit,

Although SPMs constitute a building block of planning standards, there is no limit to the number of such SPMs which can be defined. If a documented SPM proves inadequate, or if an alternative construction approach is desirable, a "clone" of the SPM can be easily defined and used.

A Standard Planning Module is given the following attributes:

a) It should contain all of -the necessary production and non-production workpackages so as to fully accomplish the desired task.

b) It should be presented in a form conducive to the normal planning methods used by the shipyard, That is, if the yard's planning staff uses a networking system, the SPM should be presented as a subnetwork.

c) For networks, it must contain all of the necessary "dummy" links to insure proper package-to-package relationships.

d) All packages within the SPM must be defined under the rules for a standard workpackage,

e) Workpackages cannot. be assigned fixed dates,

f) Relationships of packages must be in a variable format so as to permit their adaptation to any portion of the plan. That is, such numbers as zones, work centers, and hull numbers should be undefined until actually incorporated into the plan,

Experience with the use of SPMs has shown that two basic types of SPMs are required for the shipyard, The are classified as "standard" and "ship's specificU SPMs, The differences lie in the fact. that. certain classes of vessels will require certain work pack age configurations which may never be presented in a shipyard's set of standards. An example of a ship's specific SPM would be the command and control hardware installation for a combatant, The establishment of such SPMs would incur a one-time-only cost, and would be used for the preliminary plan in the same manner as the normal, standard SPMs.

With adequate shipyard planning procedures to facilitate the use of such standards, Planning should be capable of defining most of the vessels workpackage requirements working from the yard's usual chart-of-accounts, general arrangement design drawings, and the specification for the vessel.

Documentation of the SPMs is vital to insure that all planners are using the correct versions of each SPM. A master book, or some adequately maintained computer file must- be used to record each SPM, along with supporting data to describe the standard workpackages contained therein,

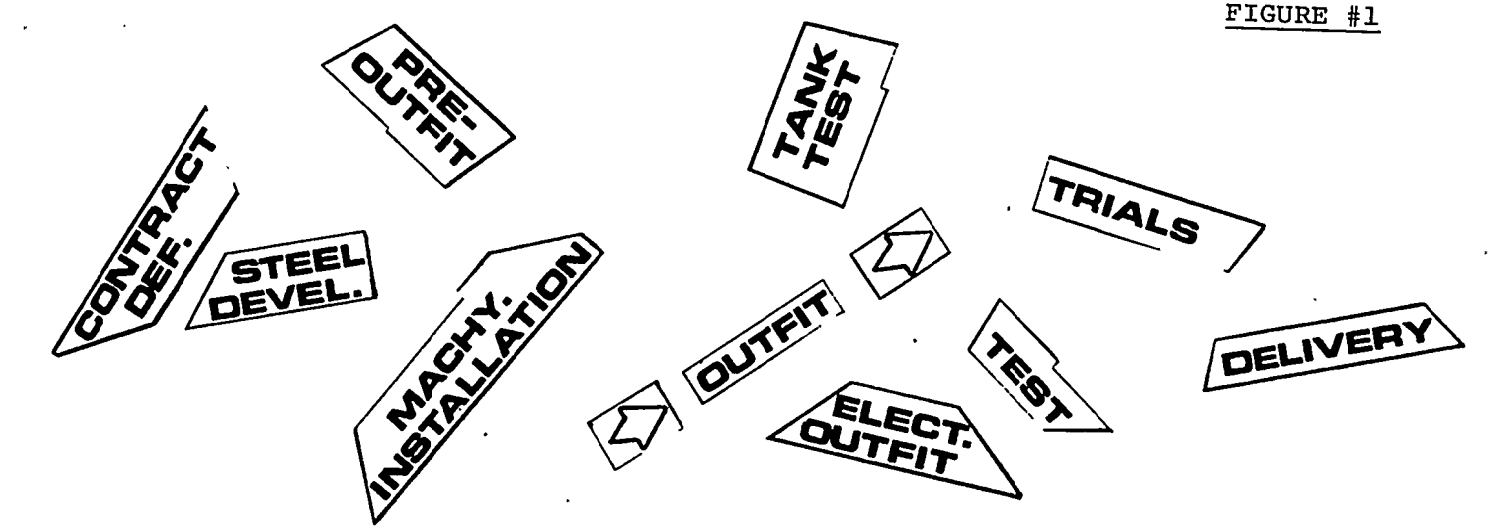
ADAPTATION OF STANDARD PLANNING MODULES

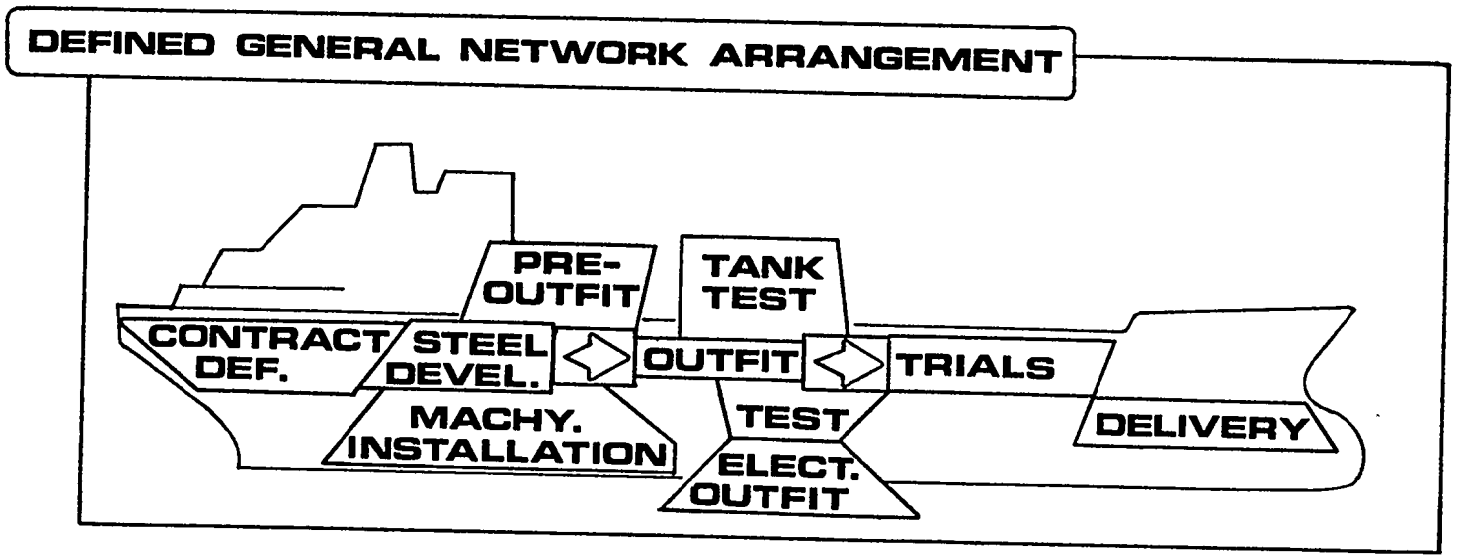
The process of creating a ship's plan involves the coordination of work activities covering the entire realm of ship construct.-ion. Visualized as a jig-saw puzzle (Figure 1), the objective of Planning is to combine all of these required elements into a cohesive plan, and if all of the parts are present, then the resultant. plan will be completely defined, With the introduction of Standard Planning Modules, the process of combining the required work becomes simplified, since the definition of the SPM insures planning completeness at a finite level.

Accuracy of the plan is defined as the proper relationship of workpackages to one another, Working from a realistic gameplan of plan generation, the incorporation of the SPMs insures that. work relationships below the master plan level retain their pro-

PRODUCTION SCHEDULE DEVELOPMENT

FIGURE #1





per relationships,

With the SPM providing a firm foundation for the plan, the next objective is to provide a proper mechanism for the gathering of the SPMs into a complete plan. Since the underlying theme of standardized planning is to advance the timetable of the planning process, Planning must rely heavily on the definition of the standards since production drawings will probably not be available, The collection process centers around a plan framework which represents the major milestones or prevalent work paths through the construction process, If viewed as a network, this framework is a skeleton network comprised solely of dummy (zero duration) activities (see Figure 2). The framework identifies major steel blocks, outfitting zones, and recognized systems test criteria. Where required, each of these categories can be further subdivided to improve clarity for the planners who will subsequently “fill” the skeleton with SPMs.

Simply stated, the loading of SPMs to the plan merely requires that the Planner select a single SPM which best describes the work elements for any piece of the vessel. The specification for the vessel should provide ample descriptions of the required systems (cost accounts) that will be required. Marking with the shipyard's chart-of-accounts and the specification, the Planner choses the most likely SPM to accommodate that system in any given zone (note #1). Repeating this process through all systems : selecting or discarding accounts based on the experience of the planner, indications from the specification, and interpretation of the design drawings, the Planner creates the preliminary plan. Figure 3 shows a simple SPM used to create all of the steel workpackages for a single steel unit, When used repetitively for all steel units defined or assumed for the ship, all of the steel related activities will be defined in the plan. The only remaining step for steel is to apply linking activities, which may be another SPM, so as to realize a steel erection plan,

A SPM can be simple, as in the case of Figure 3, or a compound SPM which gives the Planner additional, optional selections from which to choose for loading to the preliminary plan. Figure 4 illustrates a compound SPM. Note that not all of the activities need be chosen, and that this single SPM actually presents numerous subnetwork paths, any of which may be used. The Planner need merely insure that an unbroken path is ultimately selected when using this SPM.

Note #1 : SPAR’s planning discipline supports the zone approach, in that workpackages are defined as cost account by zone.

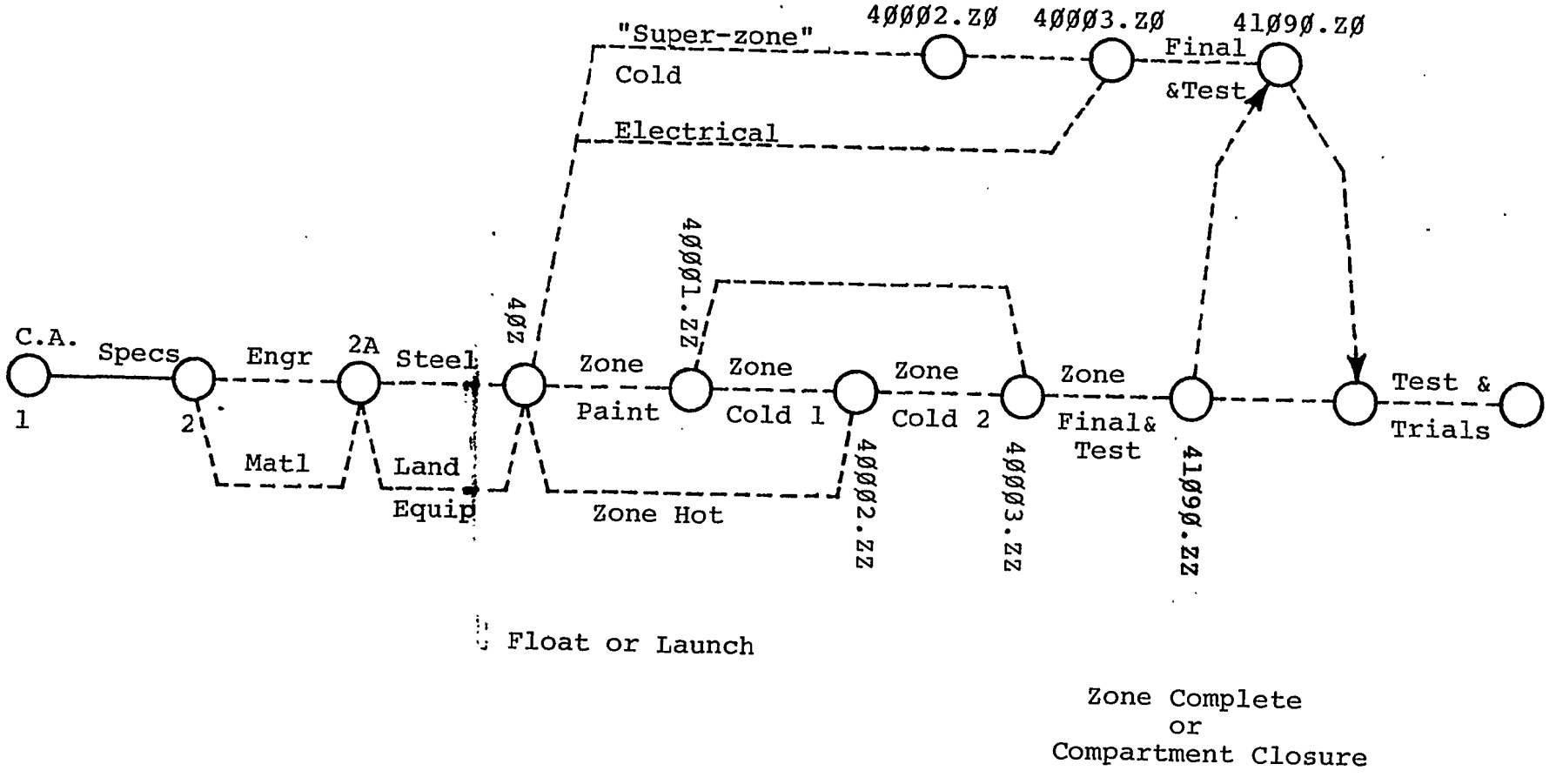
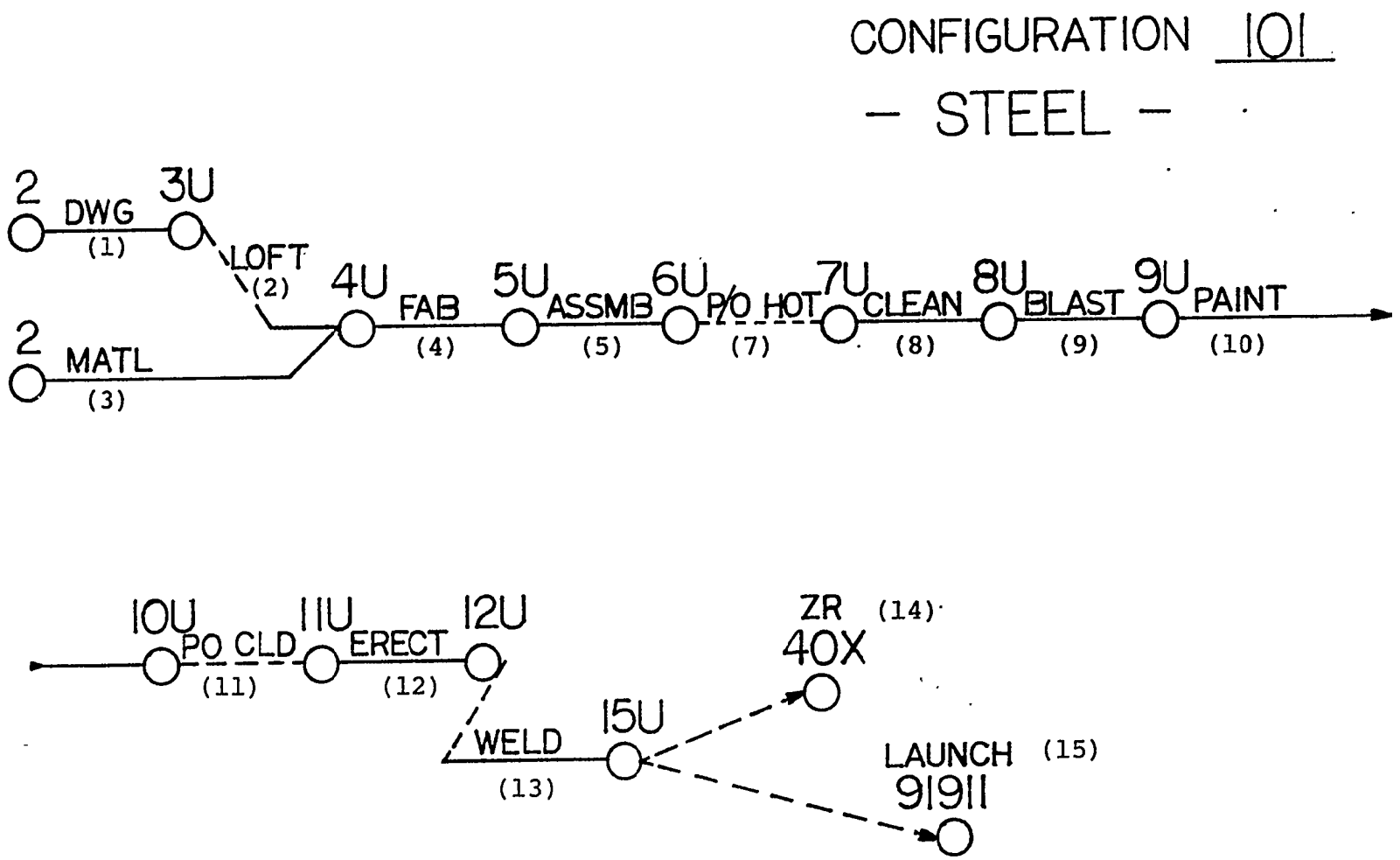


Figure 2: SPM Network Skeleton

FIGURE #3: Steel SPM



CONFIGURATION 3

- OUTFITTING -

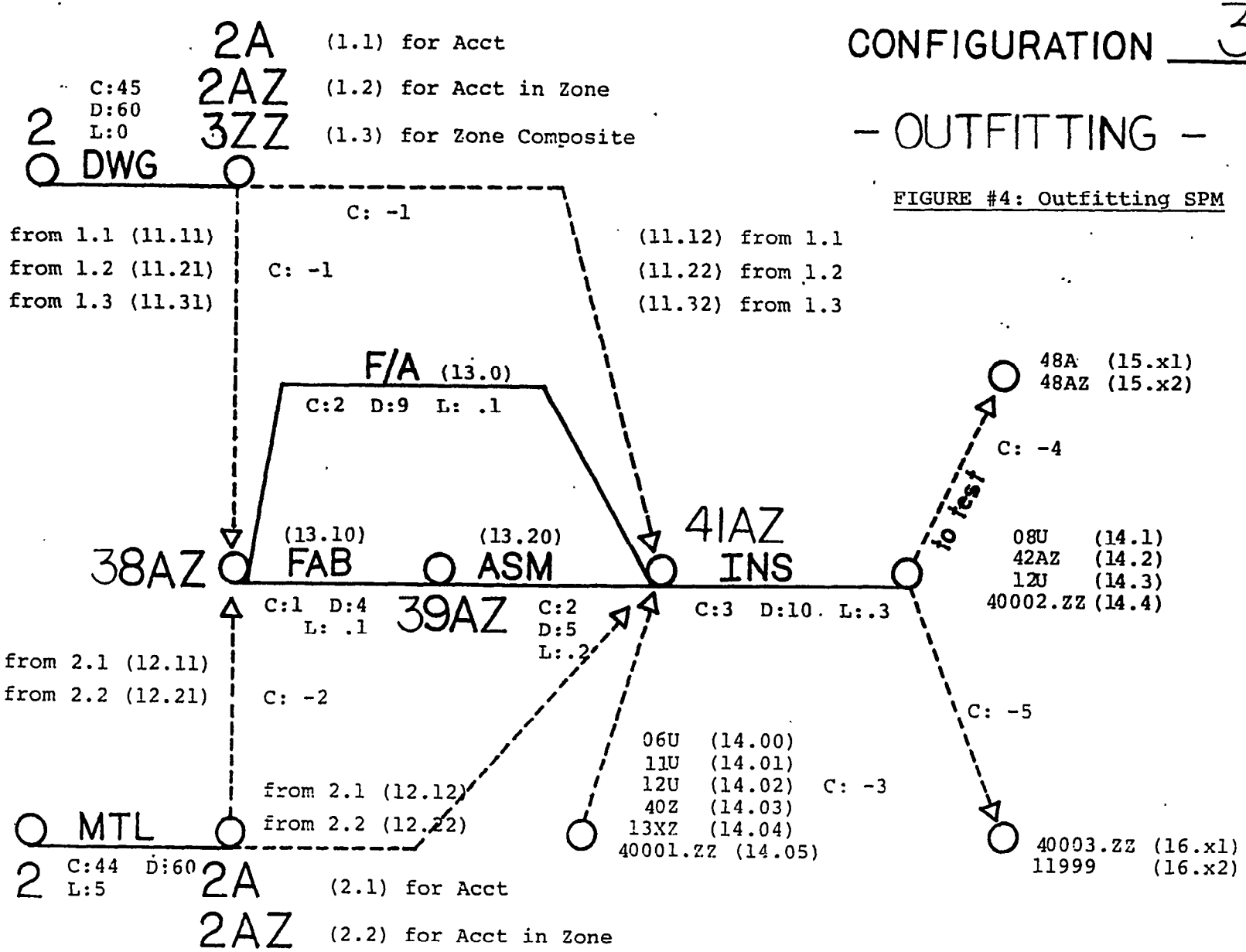


FIGURE #4: Outfitting SPM

Equipment is accommodated in the same fashion, with the Planner using SPMs specifically designed for the installation of major machinery, In this case, the SPM contains activities for the fabrication and installation of equipment. foundations, and for the procurement, assembly, and installation of the machinery itself. Sophisticated equipment SPMs can contain dummy linking activities for the constraint of closing steel units, and can be adapted for pre-outfit equipment installation or modules requiring multiple systems, Figure 5 depicts one Standard Planning Module for machinery installation,

Procedures must be in place within the Planning organization to insure that SPM selections are documented to show which systems have been planned, the degree of steel completed, pre-outfit and modules defined, and whatever variations in SPM selection was required, One recommendation for this approach would be the development of a ship's Plan Book, The form of the Plan Book (not defined in this paper) constitutes a working document. through which Planning can communicate the progress, problems, and assumptions of the plan to all concerned shipyard departments. Such documentation is important because the advanced, preliminary plan does not constitute a production schedule, due primarily to the lack of production drawings. The Plan Book will provide for a formal guide for the transformation of the preliminary plan, and its resultant schedule, into the final production schedule,

THE PRELIMINARY SCHEDULE

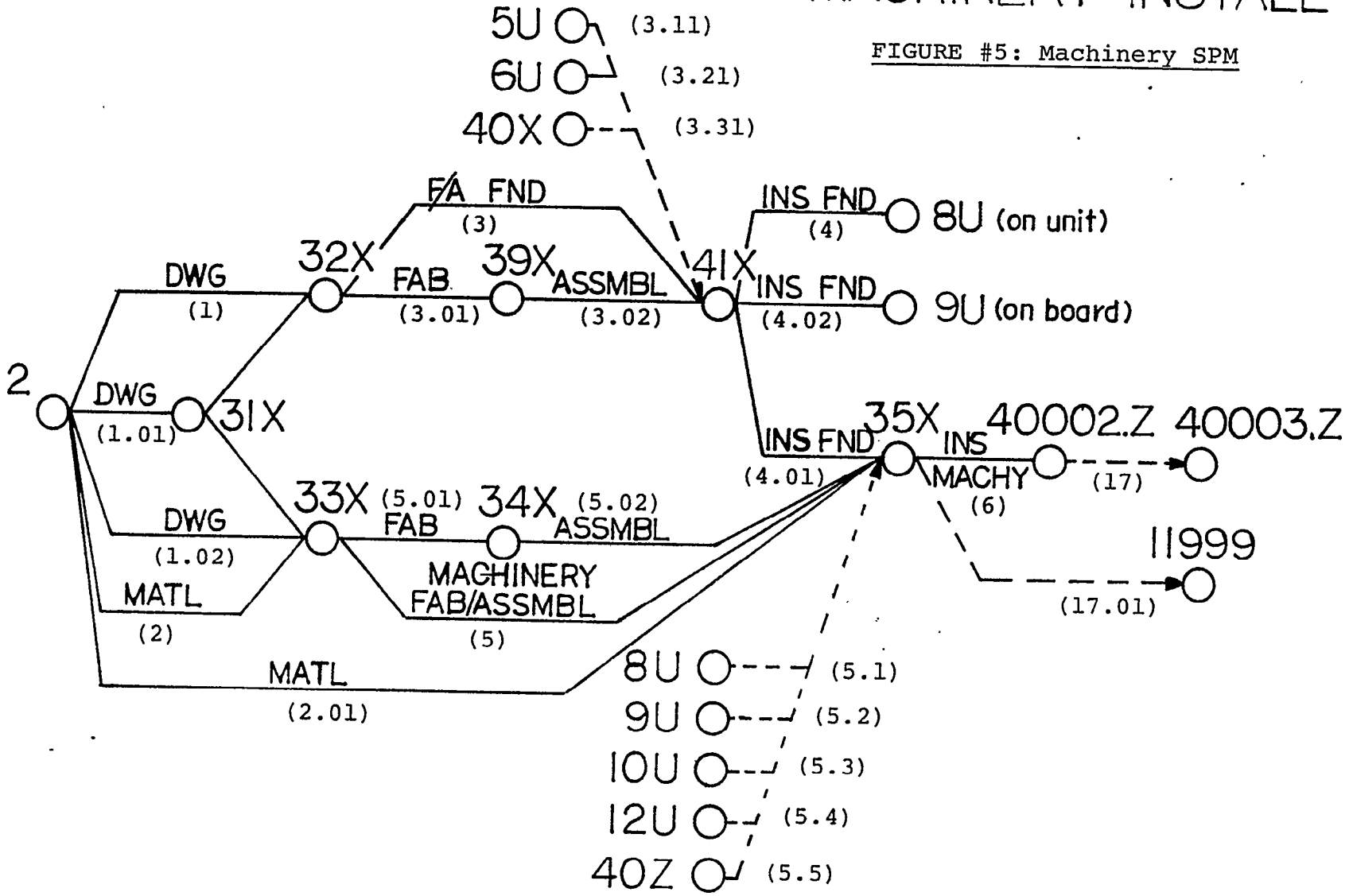
The result of collecting SPMs is a conglomeration of standard workpackages. If the shipyard is using a networking system, these workpackages are tied together via the relationships of that computer system. The networking system need only be executed to derive the dates for each of the workpackages. If t-he shipyard is not using networks, each workpackage must. be scheduled either manually, or through some form of static scheduling system (note #2).

Note #2: No known computer system can schedule workpackages on a static basis unless dates are manually input and subsequent schedules adjusted based on resource contraints or other criteria,

CONFIGURATION 11

— MACHINERY INSTALL —

FIGURE #5: Machinery SPM



Regardless of scheduling method, the resultant schedule could not possibly be used for production, This is because:

a) Standard steel durations vary depending upon unit complexity,

b) Special systems may not be identified from available data sources,

c) Specific production strategies may not be obvious from design drawings,

d) Budget and duration estimates may not be realistic,

e) Trade class requirements may not. be completely visible, and

f) Any number of other obstructions could cloud the plan,

But, the initial objective of the standardized approach is to derive a plan which can be criticized, With proper use, over 80% of the production workpackages will be defined. By understanding the specific functions of the vessel being planned, an additional 10% of the required workpackages can be added as "discrete" packages, which can come from the pool of standard workpackages, It is understood that the remaining 10% of the workpackages will be included as more-and-more details become available to the Planning staff, These will be added to either the preliminary plan as detected, or to the final production plan after the transformation has occurred.

This preliminary plan, and its schedule, offer the shipyard numerous advantages, even considering its generalizations, Of principle interest is the potential for conducting initial assessments of construction timing, manpower loading, facilities availability, and milestone definition,

From the workpackages, budget estimates can be summarized to cost account levels and compared to contract, or bid, estimates to gain some indication as to the level of accuracy of the components of the bid, With Production involved in the evaluation of planning standards as applied to the vessel in question, Planning can determine which cost accounts will possibly offer the most problems in terms of actual to estimated costs.

Manpower loading reports (note #3) and the network's critical path report can give indications as to which aspects of the vessel's production will require more extensive cost/schedule controls.

The preliminary schedule's milestone report can be compared to contractural milestones to determine the accuracy of the plan's "fit," Large deviations in milestone dates can pin-point those areas where more investigation into the relative accuracy of the standards is needed.

The preceeding analyses can be repeated as often as required until the preliminary plan assumes a form acceptable to Planning, Information drawn from this advanced planning allows the shipyard to extract vital data, such as:

a) What material/equipment is demonstrating a potential purchasing problem,

b) What the general fireing order of engineering drawing release will be required,

c) What shops in the yard are suspect to have manning problems, and

d) Which areas of the production approach should be given special attention for alternative methods,

TRANSFORMATION TO PR0DUCTION SCHEDULES

Since the preliminary plan is comprised of any number of gross estimates at. the workpackage level, Planning must transform that plan into a viable production plan and schedule, The changes required can be itemized.

Note #3: We assume that most networking systems will have some form of resource loading or manpower loading capabilities,

a) DELETE packages or entire cost accounts that were assumed for the vessel but are not actually required.

b) ADD packages or cost accounts that were omitted due to insufficient information. These will mostly be those seldom used accounts or new accounts not previously in existance at the yard.

c) ADJUST packages in terms of their duration or budget or trade class assignments as supported by the production drawings,

Since SPMs were used in the development of workpackage groups, the deletion of those packages requires that the SPM loading process merely be reversed, This can be accomplished by the deleting of each individual workpackage or dummy link, or by some automated process whereby the system can recognize the SPM load and automatically remove the packages. In a similar fashion, the computer system should be capable of deleting workpackages under a given cost account,

The addition of workpackages under new or existing cost accounts involves the continued use of the SPM concept, inserting the required workpackages as would have been done during initial plan development had that work requirement been known at that time.

The adjustment of existing workpackages will constitute the majority of the transformation process, This comes about When Planning gets the necessary, additional information from the production drawings and is better able to derive realistic budget and duration estimates. The role of the SPM has no influence in this case,

Of interest to note is that this entire transformation process requires very little time to adjust and enhance the plan. Since most of the required workpackages will exist in the plan, it becomes a matter of reviewing each package, or groups of packages as generated by a SPM, and modifying the plan based on the improved availability of information. Ongoing to this transformation of the preliminary *plan* to a production, the repeated evaluation of interim schedules can continually upgrade the decision making process of the shipyard regarding production techniques and alternatives. Engineering and material procurement cycles can be evaluated on a continual basis and markedly improve the responses of these departments to the dynamic posture of the vessel.

IMPROVED PLANNING RESPONSE

The question of timing began with the introduction to Standard Planning Modules, with the general statement of increased Planning response time via planning standards, As mentioned, the necessity for waiting for production drawings from engineering is eliminated in favor of standards, all of which would be tailored for the individual shipyard.

Figure 6 presents the sample computations, with assumptions, that indicates the possible timing savings of the SPM approach. The figures do not represent any actual ship, but are established for the point of comparison only. What is not immediately apparent is the advanced planning development schedule which falls out of the SPM techniques, that being the availability of planning schedules much earlier in the ship construction cycle. It is theoritically possible to begin this planning process at the point of Request-for-Quote, but it would more naturally occur in an overlapping time frame with the contract award. In situations where all of the production engineering must be done, that is, no such engineering is available at contract award, there is no reason why all of the required central planning cannot be completed prior to any start of construction,

Standard Planning Modules, Example of Time Savings
(Figure 6)

TASK DESCRIPTION	Mandays w/o SPMs	Mandays w/SPMs	Remarks
Review Spec	5	5	Same for both
Review Design Dwgs	2	2	
Zone Ship	3	3	
Unit Ship	3	3	
Review SPMs	0	2	Not req'd for traditional planning
Write 80% of workpackages	60	0	SPMs provide standard workpackages
Write 10% of workpackages	10	5	SPMs reduce time to develop discrete pkgs
Write 10% of workpackages	10	10	Same for special pkgs
Gather SPMs	0	30	
Evaluate Schedules	5	5	
"Transformation"	0	10	See text for discussion
Final Review and publication	5	5	
Totals	103	80	For a 22.3% time span reduction

A SYNOPSIS OF STANDARDS

The adaptation of standards to the shipyard planning environment is by no means a simple task, The best planning experience must be coupled with a active involvement of the production, material, and engineering departments to derive standards by which planning can make realistic attempts of planning the ship without detailed production drawings, Also, the estimating department must become a close ally to planning since the SPM concept through planning can enhance the efforts of the estimators.

Furthermore, the use of such standards requires a re-evaluation of the planning policies and procedures, Experpience has shown that the traditional approach to planning, generally preferred by the "old salt" planner, is usually a detriment to the successful implementation of SPMs. Shipyards which have or are currently adapting this concept are realizing the necessity of establishing some form of planning discipline, coupled with a semiformal (of even formal) set of written guidelines to direct the development and use of standard workpackages and the SPMs. Training and a more strict approach to planning management also contribute to the successful use of planning standards,

APPLICATIONS

SPAR Associates began a formal development of the SPM concept in 198l while developing workpackage plans for a 37,000 DWT tanker, Experience from that vessel lead to the development of a ship's “Plan Book” which attempted, somewhat. trivially, to define the discipline by which SPMs could be adapted, and to present a formal document for planning,

In the Winter of 1981/1982, SPAR employed the Plan Book approach and its standards to a semi-submersible drill rig. The approach developed approximately 12,000 of the eventual 13,500 activity network, which represented over 5,000 production workorders. further refinement of the standards insued *as* insight was gained into the problems of a “large” network.

From experience on this drill rig, SPAR formalized its SPM control document and planned a theoritical work boat, the "DEBBIE D," so as to experiment with such items as "super-zone" definition, block to grand-block relationships, more visible preoutfit reporting, and *a* re-definition of certain network methodologies such as node numbering and pictorial presentation,

The development of a discipline for incorporating planning standards is on-going, and is gaining momentum as SPAR continues to develop plans for client shipyards.