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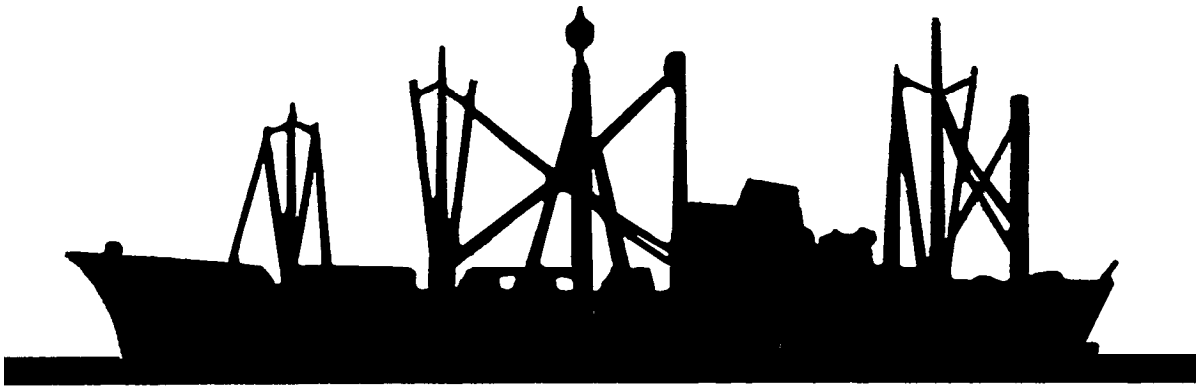

INSTITUTE FOR RESEARCH AND ENGINEERING FOR AUTOMATION AND PRODUCTIVITY IN SHIPBUILDING

IREAPS

IMPLEMENTATION OF A PRACTICAL PLANNING AND PRODUCTION CONTROL SYSTEM IN SMALL AND MEDIUM SIZED SHIPYARDS

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ABSTRACT

Small and medium sized shipyards (200 to 1000 employees), particularly those growing rapidly from hands-on control by a few managers to a size requiring delegation of authority to superintendents and foremen, find that they have all the management control problems of the major shipbuilders but without the staff and administrative resources to easily cope with them.

Typically we find the small shipyard operating at best with a schedule covering a few key events, no integration of engineering output with production needs, an accounting system which accepts cost charging to few accounts but without budgets or work packages to control scope, schedule and manning, drawings without bills of material and every supervisor in the company participating as a material expeditor.

Although the depth of detail required in a small shipyard planning and production control system will vary with product complexity, personnel strengths, and contract construction period, the basic elements of a sound system are markedly similar and cannot be ignored without incurring loss of performance, deterioration of productivity and schedule delay.

INTRODUCTION

In our visits to small and medium (even larger) shipyards, the difficulties and key to practical planning production control might be compared to the story about the telephone superintendent who sent two crews out one morning to set poles along the highway. Late in the afternoon when he checked out the days progress, he found one crew had set 27 poles and he complimented the foreman on his progress. His, perhaps unfounded, pleasure continued until he questioned his other foreman and discovered that crew had only set six. While being berated for his performance, the foreman defended his work by advising that his crew could have set as many as the first crew if they also left 30' of poles sticking out of the ground. In a slightly more apocryphal and ethnic version of the same story, the low productivity is justified by the foreman's difficulty in overcoming the six Polish crew members complaints about being set in the holes, upside down.

In either version, or a combination of stories, you can find some of the production control problems that face all shipbuilders. Questions quickly come to mind;

- Did the crews have a drawing or a work instruction to tell them what was to be done? and How?
- Did they have a schedule and a budget to tell them how many poles they were expected to set each day?
- And if we can laugh and not cry at the possible misinterpretation between wooden and human poles, we can ask where was the bill of material?

Now all of this, is a gross oversimplification of production control but how much more prone are we as shipbuilders to repeat this type of performance when attempting to construct one of the most complicated products known to man under the typically erratic contracting and delivery conditions imposed by our competitive market.

Much has been written in the last few years concerning production and inventory control theory and practice, and some small segment of these writings are applied to shipbuilding. They describe the glories of network planning in all its forms, computerized integration of engineering, materials and the production process, MRP, computer aided design, and on ad infinitem. If you research these writings very carefully and apply your best inductive logic to the hints between the lines, a few glaring realities become apparent.

Most, if not all, of the production theories have been created, or modified from, theories developed, in large mass production companies with large experienced staffs of engineers and systems people. Most of the production control systems published concerning shipbuilding have been based on experience in large ocean going shipyards and yet even with these sophisticated systems, profitability in the major yards has not been encouraging. But of more importance, the successful systems demand that a basic minimum set of prerequisities and conditions be in place in the yard before these highly touted systems can be implemented and before meaningful performance measurement can be expected.

What is surprising to us as consultants as we go about trying to improve our medium sized clients capacity, productivity or profitability is the infrequency that these basic prerequisites are in use and the further rarity of any reliable measure of the yards capacity to use as a baseline for future performance measurement even when strong productivity improvement programs are being attempted.

Perhaps to put this situation into context, I can describe an atypical small shipyard which is attempting to grow into a medium size yard. It was probably created by an eager entrepreneur with a few loyal and energetic friends who could purchase the materials and construct a simple boat or ship without going bankrupt. We find a yard superintendent with some experience as a crew boss at a steel fabricators or at the waterfront doing voyage repairs, a storekeeper or buyer learning to become a materials manager, a timekeeper or production clerk attempting to plan and control ship production, and all the staff trying to become estimators and financial managers. The yard manages its personnel and manufacturing via hands-on daily control by the several senior officers but is growing "like Topsey" and usually has not developed those systems or skills of delegation required to make sense of the larger company it is becoming. In-depth in-house engineering is a dream and most often is a service purchased from a design agent who contributes little to the yard's internal disciplines. Oh, you of the major yards and the shipbuilders councils may ask; Can this be? Can they survive? The rather pragmatic answer is, that some of those yards which survive, by dint of very hard work and rather frantic juggling of day-to-day problems, seem to make quite generous profits, but expansion comes very hard.

So what are those conditions that large yards and companies depend on as a foundation for good planning and production control but which seldom are adequately developed in the smaller yards. If they are available in your own yard, you are blessed and should be complimented, and probably don't need this paper.

The minimum conditons to produce good performance, production control and accountability of cost, labor and material, not just in construction but also in engineering materials and preparation of work packages, are:

a) 'A schedule for construction drawing issue integrated with the production schedule.

b) An accurate and comprehensive bill of material for each drawing and accurate list of owner furnished material.

c) A schedule delineating both production's requirement for receipt in yard and necessary ordering dates to meet the production work start date.

d) Engineering acceptance of responsiblity to requisition all material for the ship.

e) A dependent sequence construction schedule tied back through prerequisite shop manufacture, material procurement and engineering activities to contract award.

f) Published, well scoped, work packages which describe jobs.which are to be accomplished by one trade, at one location and in one relatively continuous span time.

g) Material accountability by work package.

h) Labor cost assigned to work packages and accumulated against a moderately detailed cost account system.

i) A cost account system which simply summarizes labor costs in most frequently encountered production packages.

j) A construction estimate fragmented into the cost account units.

At this point, I'm sure, some listeners will confidently assure themselves of a place in the shipyard hall of fame with an "of course, what else?" and more will react rather defensively that their peculiar market place never allows enough time between sale and construction for all that bureaucracy, folderol, etc.. I can suggest that without some of the items, if your ships are delivered on time and for a profit, it's probably due more to good luck than good management. With others, even if you don't think they are being done, they really are, but more expensively and by the wrong departments.

MANAGEMENT'S ROLE IN PLANNING

Planning is one of the most powerful tools in each manager's bag of tricks. Each functional manager must be responsible to plan his own departments output in a manner that supports the shipyards efforts to meet its contractual commitments. It is all too easy for managers to avoid departmental planning and merely react to events as they occur. Thus the late signing of a contract automatically justifies engineering and material delays and delayed engineering excuses a late ship delivery. Obviously management cannot also automatically accept the inevitability of these impacts on contractual delivery commitments, Therefore, we want to encourage a strong commitment to planning by all senior shipyard managers with a dedication to self initiated recovery plans to offset any prerequitite delays they suffer. Never-the-less, because unenlightened self-interest or self-sympathy sometimes overwhelms enlightened attempts to keep the program on the track, it is also desirable to have a planning and production control function independent of line managers organizations to promote objectivity and pragmatism in analysis of the shipyards performance. In a small shipyard it is highly desirable that this group report to the chief operating officer of the company. The function can be placed under a line department in the yards organization but always with the risk that the planning groups objectivity will become compromised when their line departments delinquent performance begins to directly impact the shipyards ability to deliver ships. It can be even more devastating if the planning group is used. as a vehicle to misdirect blame for shipyard delays.

Although it has been easy for the industry to acknowledge the reported benefits that have occured from the pre-planning and production engineering in major ocean going complex ship programs it is a quantum leap to accept and implement the same techniques in simpler ships where no qualified staff exists in any depth in the yard. But without some attention to early strategic planning and institution of formal management control of the work, schedule and budgets, then the small shipyard is just as vulnerable to the stumbling and fumbling and delays and even less well staffed to manage a recovery.

Planning and production control is not a luxury, it is an absolute necessity.

For effective control of production, management must apply a different viewpoint at each level from foreman, to superintendent, to production manager, through Vice President of Operations and on to President, or whatever echelons are in place. Not only must the viewpoint change,

but the form and content of analytical and progress reports are different at each level. For instance, the quality of production control is not enhanced if a foreman's work order delinquencies are merely reviewed at successively higher management levels with increasing frustration and fury and with decreasing knowledge of the facts and conditons creating the delinquencies. We can clarify this by a brief look at the span of control appropriate to each level.

The FOREMAN is principally concerned with accomplishing a weeks worth of work orders every week by assigning men on his gang skillfully and sequencing assembly operations for minimum cost and shortest time. He works to a list of work orders in sequence of scheduled start dates. He has a planning responsibility to look ahead a few days to avoid downstream interferences with another craft and to offset a delay in one area with an acceleration elsewhere. The foreman must be encouraged to report cost and schedule performance accurately even when performance is less than favorable. We must always remember that the first line foreman job is not principally to meet contract milestones nor to chase material but rather to secure employee performance and complete individual work orders within budget and schedule.

The SUPERINTENDENT, unlike the foreman, has a primary responsibility for a geographic area, be it a shop, a ship, a platen and the efficient application of several foremen to avoid conflicts in the use of people, space and equipment. The superintendent must use an area list of work orders sequenced by scheduled start date, to constantly drive to start work on or ahead of schedule and secure first class assistance from Production Control to confirm that scheduled jobs are workable with drawings and material available. He is principally responsible to document the realities of significant schedule and budget variances and report them to Production Control to improve the quality of future estimates and schedules and to differentiate between poor performance and incorrect budgets and schedules.

The PRODUCTION MANAGER'S efforts must be directed toward balancing manpower and resources to achieve completion of specific ships on schedule. It must be recognized that, although he is usually held accountable for poor cost performance, his principal influence on costs is achieved by insuring a clear perspective of priorities between areas and contracts and by creating an efficient workplace. He can periodically analyze those cases of poorest work order schedule and cost performance to remove the causes for the poor performance. One of the Production Manager's most useful tools in a work order list for each contract in sequence by scheduled start date, with-which he can anticipate

delays due to missing drawings and material and identify jobs which can't be started due to personnel or facilities shortages. The Production Manager and Planning and Production Control Manager together represent a team which must constantly scheme to recover delays and complete prerequisite activities so that the Superintendents are in a position to exploit good performance elsewhere. You must be ready to smile when you get kicked in the pants by success.

Finally the VICE PRESIDENT OF OPERATIONS and the Chief Operating Officer are principally concerned with insuring that production receives timely support from engineering, materials and production control and with balancing workloads in a multi-plant operation. Further they must maintain a very clear perspective of the manpower required to meet the demands of all ships under construction. All too often, wishful thinking concerning anticipated productivity improvements, possible reductions in absenteeism, inflated predictions of success in hiring programs, and sheer self delusion. chat undermanning can improve budget performance, are substituted for man load forecasting based on realistic current performance. Once top management allows the yard to continue undermanned until a significant percentage of all work orders are no longer accomplished close to schedule, it becomes virtually impossible for lower levels of production supervision to manage the complex priorities required for recovery. Serious work assignment errors start to occur. Rarely, if ever, can shipyard performance be improved by forcing the foreman to underman jobs in hope of reducing costs while allowing schedules to slip. A foreman can be expected to manage the assignment of working jobs on schedule to the limit of assigning his available crews correctly. He cannot consistently handle the multiple problems of undermanning jobs, no meaningful schedule and an unclear demand to improve productivity. In these terms productivity is a symptom of good planning, sound budgets and schedules and correct manning. It is not a function assignable to line foremen.

WORK ORDERING

In most modern manufacturing companies and in many shipyards, some form of job order, shop order, manufacturing order or work order, is issued to the production department to direct the accomplishment of tasks on a contract. Frequently only a small portion of all the direct charging work is covered by work order while the balance is merely charged to a few standard cost accounts. Some shipyards only use a cost account list and we have worked with yards which use as few as three cost accounts for a complete ship and with each account valued at more than 20,000 manhours! Patently this approach only provides a vehicle for cost accumulation but offers neither useable work scope direction to the foreman nor any hope of schedule or cost control

by management via the work ordering system. To be useful and helpful at the foreman level, a work order must provide a-manageable work scope, a schedule and cost envelope which compliments and defines how and when the content of a drawing and its bill of material is to be incorporated into the ship. After reviewing the work ordering process in many shipyards, we have concluded that, regardless of format, an adequate work order needs certain features which should be developed in a planning or production control department. If these features are not provided in the work order then ultimately they must be researched and produced by other groups, with poorer records, with less lead time before construction starts, and almost always at greater cost and confusion. If a ship is to be built at all, then before it is completed, someone (and if no one else, then the foreman, fitter or mechanic) will determine which jobs are to be done, in what sequence, where, when and with which drawing, materials and manpower. Unfortunately, the more this burden falls on the foreman, the better the chance for last minute delays due to late or missing drawings or materials and for conflicts between trades to develop. Even more damaging is the removal of the foreman from his primary function of crew assignment, on-the-job instruction, operations sequencing and cooperation with other foremen working in the same area. Although a foreman should never be completely relieved of his responsibility to plan his own jobs, it should be obvious that administrative planning can be done cheaper and at a much earlier date in the contract by professional planners working directly with Engineering and Materials groups to prepare well scoped work orders. Figure 1 lists the minimum information required in a comprehensive work order,

The time span and maximum budget for a "good" work order has always been a topic for lively discussion in production control groups. Again, there does not seem to be a "magic number for either cost or time, but experience dictates that the order should be comprehensive and manageable by a single forman and the work should be accomplished in a relatively unbroken time span. When tasks start to exceed one thousand manhours or a couple of weeks span, planners and superintendents should restudy the job to try to uncover a logical split which will also feel comfortable to the foreman. Work orders which are larger or longer than the 1,000 hour/two week size tend to get out of control before the typical work order reporting of '*start", "complete" and "hours expended" reflect a problem. When the work order reporting system does not provide control, then it's back to eyeball progressing, guesstimates, little black books and all the other alternative controls that have been used for centuries. Thus the correct size of a work order will give the foreman a meaningful job to do and will give management cost and schedule control.

SCHEDULES

It is not surprising that most shipyard managements would probably agree that schedules are a necessary element to pace the work on a shipbuilding contract. What is surprising is the infrequency of integration of engineering, procurement and production schedules into a program of what must be done to meet contract delivery. What is even more surprising is the infrequency that the schedules are used as a working decision making tool to keep the constuction on track. For example, we find assiduous use of milestone schedules unsupported by either a tautly constructed dependent sequence between construction requirements and their engineering procurement prerequisites' or a resource analysis to confirm that manpower and facilities support the milestones. With this dilemma, meeting or missing milestones provides no real evidence of progress toward contract completion. When a milestone event is achieved, what guarantees does management have that all work planned to be complete by the event date is actually complete? Or do we have a successful milestone surrounded by an incomplete ship?

There are a variety of scheduling tools in the planning/production control kit whose content and degree of detail can be tailored to satisfy the full range of shipbuilding programs from simple barges and work boats to complex ocean going Naval warfare vessels. 'Table A describes this collection of schedules. *Once a shipyard becomes involved in construction of more than one [redacted] at a time some of these schedules are mandatory to provide control of resources, ship-to-ship sequencing, optimum ship construction approach, priorities for work orders at each work station, and to integrate engineering and procurement support of production. Briefly these are:

a. Master Construction Schedule defines major key events on each ship and usually reflects useage of the ship ways and final erection areas, Usually developed for each additonal ship contracted for from historical data on similar ships, and then refined as detailed construction scheduling is completed. Since this schedule represents the principal strategic plans of the company, it is not revised without top management approval. All subsidiary schedules should be complimentary to it.

'*Note: The timing and distribution are variable with the product mix and frequency of delivery.

b. Ship Construction Schedule defines the dependent sequence of fabrication, assembly, erection and systems installation for each ship. This provides a baseline for detailed work order scheduling. Until a shipyard can hire or train experienced ship planners, this schedule must be created using the best available shipbuilding talent in the yard; usually construction superintendent, production manager, et al.

c. Work Order Master Schedule is initially a forecast of all work orders required for a ship and then is refined as drawings become available. This schedule paces, not only all production work but also paces work order release and is the baseline for detailed drawing and material schedules.

d. Drawing Schedule starts with a forecast of all drawings required to define the ship so that production planning can tell engineering when each drawing is required to support its respective work orders. Since many long lead material items cannot be procured until they have been defined on a drawing it may become necessary to schedule drawing completion to earlier dates to support material ordering. Engineering assumes this added responsibility.

e. Material Schedules start with a forecast by engineering of principal material categories and long lead specialties which planning can schedule to show production material required in yard dates. Procurement can back off ordering lead times to create a schedule for Engineering material requisitions. This document paces both material ordering and delivery and should be integrated with the work order master schedule.

The approach used in the foregoing schedules is.to create a forecast early in the contract to pace the program and then refine detailed line items as the design is developed.

Depending on the complexity of the product, the complexity of shipyard layout, and the difficulty of managing specific work stations, a wide variety of area and assembly schedules can be created to pace and sequence the work priorities. In general the effort should be directed toward use of the work order schedules tabulated by area (work center) to achieve necessary control. However, in troubled areas, it may become necessary to schedule in more detail (below work order level).

It should be noted that the foregoing discussion applies to the typical small or medium sized shipyard that is involved in a mix of customers, a variety of ships and low volume production runs. For large production runs of identical vessels, techniques more akin to MRP techniques are preferred.

Thus far we have not considered the use of automated data processing ADP techniques in ship planning not because of any aversion to its use, but more to highlight the absolute necessity to develop certain basic data and planning disciplines whether manual or automated systems are used. If any thing,the data base disciplines are more demanding than for manual systems and until each department can develop the data, the organization, the discipline and the personnel to implement such a program, ADP in the small yard is just one more confusion factor in Production management..

MANPOWER PLANNING AND PROGRESSING

Any shipyard, in fact any business, is concerned about cost and labor performance. The merit of this desire is obvious but the measure requires a baseline against which we can compare performance.

Although a formal work order system can provide such a baseline, any other task breakdown, which can be scheduled and have manload assigned to each day or week, will also be useful as a manpower and schedule baseline for performance measurement. The key to this performance measurement is the establishment of a planned manload against the calendar which consists of discrete and defined work packages, As long as we can assign manpower to each weekly increment of each task, we can plan our manloading. Subsequently we can measure performance in two ways:

al by comparing actual manpower usage vs planned usage, and

b) by estimating whether we have earned an hour's worth of production for each hour expended.

For the statisticians among us, these are not dependent variables.

We can expend hours without earning progress -- this is the "wheel spinning syndrone" and occasionally we can progress without excessive manhour expenditure -- which might be called the "sometimes we get lucky syndrome",

but more accurately, we find that management is not always in control of the factors which produce progress.

In simplest terms we need to assign men or manhours to each task for each time period and accumulate these hours each week of the plan. First we measure actual manning expended each week and compare short fall or over-manning to the baseline each week. Separately we must determine whether we have achieved a day's progress for each job and guesstimating % progress achieved. In theory this approach appears sound; in practice, consistency and repeatability are doubtful since little effort is expended in training foremen. as estimators and planners. Better progressing methods are available but they depend on precise work packages, short span times and task budgets developed by knowledgeable planners from sound historical data.

In any event, the benefit derived from applying manpower to each ship under construction in accordance with a forecast manpower plan is considerable compared to assigning manpower to whichever foreman or superintendent cries the loudest or, has maximum "clout" with the production management or conversely to routinely apply maximum manpower to the earliest ship to deliver regardless of impact on other programs.

Figure 2 is a simple version of a manpower forecast with weekly actual usage and variance recorded. The sample is for two ships but comparable tables-map be created for 'individual trades or a collection of trades or ship programs.

CONCLUSION

So what is the ubiquitous "bottom line" for a workable PPC system in the small shipyard? In summary we need:

An independent planning and production control group working with and reporting to the Chief Operating Officer..

A master strategic plan and an integration of schedules for construction, engineering and procurement very early in each contract.

Creation of small budget,short span work orders manageable by a foreman.

Clarification of production managements role at each level -

- work orders at the foreman level

- area control by Superintendents

- ship completion for the Production Manager

- multi-plant integration by VP of Operations

Manload forecasting and progressing summarized from work order budgets and schedules.

Material requirements correlated to individual work orders and based on an accurate bill of material from Engineering.

A dedication by line Managers of each functional group to progress their departmental efforts to the integrated schedules, and notify follow on departments of pending delays before they happen.

As we frequently tell clients production managers, "our job is to provide you with a PPC system that will turn you into heroes". To which one Manager responded, "1 hope not posthumously? So do we!

Brief Work Order Criteria

Size of Job	One continuous operation (preferably 40-400 manhours).
Span Time	Continuous operation (usually less than 2 - 4 weeks).
Supervision	One foreman.
Sequence	Uninterrupted by another work order.
Location	One work station.
Material	Finite collection of: Piece marks or, Assemblies, or Work orders, or Combination of above
Cost	One cost code (charge number).
Budget	For each department/craft.
Schedule	For issue, required material availability, production start and complete.
Routing	Source of parts to be used and feed (delivery for next operation or in-process storage).
Special Equipment	Tools, jigs, fixtures, templates unique to the work order.
Scope	Minimum narrative to describe task and provide instructions on technical or sequence conditions.
Issue Data	Name of work order initiator and actual date of issue (that is - the date of release to Production with drawings and material available).
Work Order Number	A unique number for each work order, consisting of: Contract, Unit (Hull), Cost Code (item/sub-item), Serial and Revision.

Figure 1

MANLOAD PLAN

	TO DATE	7/1	7/8	7/15	7/22	7/29	8/5	8/12	8/19	8/26	9/2	After 9/2
SHIP "A"												
Planned mh/wk		2000	2100	2500	3000	3500	3500	2500	2000	1000	1000	2785
Actual mh/wk	4000	1800	2000	2300	3100	3800	3900					
Over/under (-)		-200	-100	-200	100	300	400					
Cumulative +/-	-300	-500	-600	-800	-700	-400	-0-					
SHIP "B"												
Planned mh/wk		-0-	400	600	1000	2000	2200	2600	3100	3600	3500	7000
Actual mh/wk	1000	300	600	600	800	1500	2200					
over/under (-)		300	200	-0-	-200	-500	-0-					
cumulative +/-	-0-	300	500	500	-300	-200	-200					
All Programs												
Planned		2000	2500	3100	4000	5500	5700	5100	5100	4600	4500	9785
Actual		2100	2600	2900	3900	5300	6100					
over/under (-)		100	100	-200	-100	-200	400					
cumulative	-300	-200	-100	-300	-400	-600	-200					

Figure 2.

TABLE A

REPORT OR SCHEDULE	FORMAT AND FREQUENCY	WHO USES AND WHY	HOW REPORT/SCHEDULE IS USED
MASTER CONSTRUCTION SCHEDULE Identifies all contracts in yard and for each contract shows key event schedules for delivery, launch, transfer, start construction, drawing completion and steel order and delivery	Bar chart. Monthly or when new contract is announced	Officers and managers. and planning. Monitor completion of major key events. Plan resources to avoid facilities conflicts	Executive staff, Production Manager and Production Control Manager should review at least bi-weekly and each division head should be prepared to report on ability to meet key events he is responsible for and secure agreement on corrective actions he will take to recover delinquencies.
WORK ORDER MASTER SCHEDULE Identifies (and forecasts) all productive work required on a firm contract and includes schedule dates for W.O. issue, work start and complete with area where work is to be performed and budget. Schedule has ability to be maintained with actual dates and manhour cost.	ADP tab run Monthly by job in W.O. number sequence	Planning Basic contract work control schedule	Planning uses WOM to insure that all work required on the contract is identified, sequenced, budgeted and scheduled.
	ADP run Biweekly by area in schedule start sequence for incomplete work to date and two weeks in future	Superintendents and foremen and planner. Area control schedule and delinquency analysis	Basic control tool to identify which jobs in priority sequence should be manned and worked first. Markup progress and problems by foreman to review with superintendent in weekly delinquency meeting. Superintendent uses to solve area holdups and manning and can be used for backup answers in wookly Superintendent progress meeting with Production Manager
	ADP run. Biweekly by job in schedule start sequence for incomplete work to date and two weeks (or perhaps four) in future	Production Manager Production Control Manager Contract control delinquency analysis	Basic control and analysis tool to quickly identify contracts with large W.O. delinquency and take corrective action.

Note: All tab runs from the work order master should include all columns in the "Job Status Summary" and the area run has to add a column for "Job Number"

Work order masters are not revised to correct for production delays or poor performance. They will only be revised to correct erroneous planning, reflect major contract changes, or Master Construction Schedule policy changes.

REPORT OR SCHEDULE	FORMAT FREQUENCY	WHO USES AND WHY	HOW REPORT/SCHEDULE IS USED
AREA SCHEDULES Area schedules are developed for several different purposes but initially are for planning to insure that ship erection, assembly and fabrication heel and toe sequences and span times are correct. Secondly they become a planning tool to analyze the various areas of the shipyard to insure correct manloading and avoid capacity overloads. After comprehensive contract work order schedules have been developed, the area schedule in either tabular or graphic form can be used as a control tool for an area foreman particularly in heavily loaded areas.	Bar chart or W.O. tab run in schedule sequence Biweekly Typical area schedules are: Angle shear Flame plane N/C burn Plate shear Press break Plate bender Panel line Assembly slab(s) Erection jig Module assembly	Planner, to work out area sequence and span time and manload or machine capacity. Foreman as an area control tool. Planner to develop area recovery schedule on a one shot basis	Planner develops an area sequence schedule as a tool to assist in the refinement of work order master schedules and to interrelate the schedules for several contracts work in the same area of the yard. As work on a contract proceeds, special area schedules may be developed to help highlight and analyze overloads and delinquency situations on a one shot basis. Planning should not attempt to continuously revise these in lieu of the work order master nor should a recovery schedule replace the Job Status runs as the control for each job. NOTE: If area schedule development and analysis demonstrates that major key events must be rescheduled this may be done with approval of the Vice President - Operations, however delivery schedule will only be changed with approval of the President
MATERIAL SCHEDULE Identifies by category of material (and specific equipment components) when requisitions must be given to Procurement, when purchase orders must be placed and when material must be received in yard and provides actual dates of accomplishment and purchase order numbers. When appropriate, schedule should also define when vendor technical information and release for manufacture is required.	Biweekly. by contract Tabular list Typical categories: Steel plate Structural shapes Castings Forgings Hull fittings Pipe Valves/fittings Machinery components Electrical controls Coatings	Materials Manager as basic control document to insure material order and delivery Planning to integrate material delivery in support of work order start schedules. Engineering to control purchase requisition preparation.	Materials Manager should make review and expedite Engineering for any requisitions not received to schedule. Once order is placed, Materials should advise Production Control continuously of any delivery promises which do not support required delivery schedule via a markup of the material schedule. Planning and Production Manager use markup report to develop work around and recovery plans to offset delinquent deliveries. Engineering should analyze the purchase requisition schedule and insure that order information is prepared to support even though drawing development is not complete or scheduled to the same date.

NOTE: Materials Manager should develop standard lead times for each category of material and for conversion of purchase requisitions into purchase orders so that Planning can schedule the material list not only for delivery but for material requisition and purchase order placement.

Material Manager should expedite Engineering to provide material requisitions to support his required ordering schedule, expedite and negotiate with vendors to secure not only material delivery but vendor information to schedule, and must advise Planning and Production management when ordering, information and delivery dates are not being met.

REPORT OR SCHEDULE	FORMAT FREQUENCY	WHO USES AND WHY	HOW REPORT/SCHEDULE IS USED
MANLOAD PROJECTION Distributes work order budgets in equal weekly increments across the work order schedule span time and summarizes the total budgeted manhours weekly either by contract or area.	Tab run. Monthly by contract for all work orders scheduled to be started and not complete as of the report date together with total manhours for all contracts by week and for each contract. Summarize backlog manhours.	Production management to determine manning requirements for each contract and overall yard	Basic planning tool for Production management to predict and act on manpower implications for planned contracts. Note: By inserting "dummy" work order masters in the file for potential business, similar projections can be made to analyze impact on the workforce.
	Monthly by area similar to the "by contract" run.	Superintendents to use to analyze forthcoming work center overloads and revise area manning	Planning and Superintendents can determine work center (area) manning or machine overlod or excess manning and prepare manning reassignments or farmout and multi-shift corrective actions.
STATISTICAL WORK ORDER REPORT The report is a statistical count by contract and a total of all contracts to reflect both total number of work orders in the file and delinquencies against schedule for work order issue, work start and complete.	ADP tab run. Weekly (when total delinquencies are low change to bi-weekly) by contract and counting number of work orders in the file and number scheduled, actual and delinquent as the report date	Production and Planning management to determine quickly where recovery action is required	Production management use as basis of selecting production agenda topics for the weekly meeting with the Superintendents.
	Graph by contract and one for total contracts weekly plot	Planning prepares for Production management review	Planning should analyze delinquencies by contract to select areas which require recovery scheduling or corrective manloading and make recommendations to the Production Manager and Production Control Manager
	ADP tab run Biweekly by area with same counts as by contract	Superintendents to spot delinquent performance by area quickly. Planners use report the same way	Planners and Superintendent review each report and select most delinquent areas for detailed work order analysis and developmen- of corrective action recommendations

REPORT OR SCHEDULE	FORMAT/ FREQUENCY	WHO USES AND WHY	HOW REPORT/SCHEDULE IS USED
LABOR PERFORMANCE A measure of manhour productivity versus budget by either area or contract. There are a variety of calculations that maybe developed. One of the simpler is described here.	Tab run. Biweekly by area for all work orders closed out in previous quarter (13 weeks).	VP Operations, Production Manager, Production Control Manager, to identify areas of significant budget overrun or underrun.	A consistent budget overrun/underrun can indicate either poor production performance or erroneous budgets. Either situation requires analysis and correction at the work order/work site by Production Manager and Production Control Manager together with the cognizant Superintendent and Foreman. If budget is erroneous this should be corrected (certainly on the next similar job, and if it is significantly affecting progress measurement, then on the current jobs). If Production performance is poor then several actions are in order: a) Adjust area manning levels to be consistent with performance so that area is not over/undermanned. b) Determine whether work site facilities, tools and conditions need modification. c) Correct personnel assignments and training to produce costs below budget.
	Tab run. Biweekly by contract for all work orders closed out on the contract.	VP Operations, Production Control Manager to evaluate performance between similar ships within a contract and compare to similar ships on previous contracts.	If performance at comparable stage of contract completion is significantly poorer (or better) than previous similar ships, first confirm that cost charges to job are being correctly applied. Then if performance is poorer, do a detailed analysis and comparison of work orders to isolate the principal (area) contributors to the problem. Direct Production Manager to take corrective action with area Superintendent. If performance is better than expected learning curve (and repeatable on follow ships), adjust forecast manload and manning assignments to avoid overmanned follow ships.
SHIP CONSTRUCTION SCHEDULE Identifies major area and system critical path schedules and controlling relationships between each area. Schedule is most useful on ships with more than a one month construction period.	CPM, ADM, PDM, Bar chart or key event chart updated monthly with actual dates	Officers, Production and Production Control Managers Superintendents to secure visibility into ship schedule and progress activity	This schedule is a high visibility document which quickly shows the next major event to be accomplished in each area and gives an insight into the significant controlling paths from contract award to delivery so that the impact of event delays may be analyzed and corrected.
NETWORK & STACKING SEQUENCE SCHED. Basic planning tool to develop dependent sequence scheduling of all significant contract activities commencing with contract award and including engineering, material procurement, fabrication, assembly, outfit, test, trials and delivery.	CPM, ADM, PDM, PERT etc. (that is, any form comfortable to and within the competency of the planner and Planning Manager, which describes both dependent sequence and span times. Frequency may be one time as a base for work order scheduling or periodically to analyze delay impact and resources	Planning. To insure accurate work order, material and engineering scheduling and to analyze manpower and facilities usage.	From historical data a dependent sequence of activities is prepared for ship construction and all prerequisite activities leading to and supporting ship construction (engineering, procurement, work ordering, ship construction). Each activity may be described in terms of work scope, span time, manning and perhaps cost anf facilities usage. The network then provides the basic schedule framework for these activities and the detailed schedules for their performance and also acts as a vehicle for future analsis of program delay to the most critical (shortest) paths to delivery.